Improving Students’ Mathematical Self-Regulated Learning with Modified Moore Method

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Abstract. The research is aimed to describe the students’ mathematical self-regulated learning who follow the learning by modified Moore method and students who follow direct instruction in Linear Algebra courses. This research is quasi experiment with nonequivalent control group design. The research instrument used questionnaire of mathematical self regulated learning. Data analysis techniques used descriptive statistics and inferential statistics. The result of the research shows that: the students' mathematical self-regulated learning with modified Moore method is better than the students' mathematical self-regulated learning with direct instruction. The improvement of the students' mathematical self-regulated learning with modified Moore method is better than students with direct instruction. Learning using the modified Moore method can be used to develop students' mathematical self-regulated learning. Therefore, lecturers can use this learning as an alternative in Linear Algebra courses.

1. Introduction
The mathematical self-regulated learning is very important abilities for students in the learning process of mathematics. By getting used to learning mathematics, students can more easily develop mathematical thinking skills. Students who have high self-regulated learning tend to learn better, be able to, and learn effectively, improve study time and time efficiently, and get high scores so that they become successful learners [1][2][3][4]. Therefore, the mathematical self-regulated learning must be developed in the learning process of mathematics.

In getting used to learning mathematics independently, students experience many obstacles. These constraints occur especially when studying subjects that require higher-order thinking skills, such as the process of abstraction and proof. Students are generally very dependent on the guidance given by the lecturer so that learning is lecturer-centered, monotonous and less meaningful. As a result, students cannot apply the concepts that have been learned in solving practice problems properly [5], students' self-regulated learning is low, and are not actively involved in the proving process [6]. Students will learn a lot about mathematical concepts and proofs when they try to construct their own proofs. Therefore, the students’ mathematical self-regulated learning is developed in lectures.

Self-regulated learning as feelings, thoughts, and actions in students are directed to achieve a goal [7]. Self-regulated learning involves three main cycles, namely: initial thinking, performance control, and self-reflection. Initial thinking implicate analyzing the task and setting appropriate goals. Performance control refers to monitoring and controlling cognitive, behavioral, emotional and motivational influences on
performance. Self-reflection is concerned with making judgments about what has been achieved and changing behavior and goal orientation accordingly [8].

The characteristics of self-regulated learning include: (1) someone learns independently with personal goals; (2) the individual chooses a strategy and implements the learning design; then (3) the individual monitors their own learning progress, evaluates their learning outcomes and compares them to certain standards [9]. Self-regulated learning includes three aspects, namely independent, autonomy, and self-reliance [10]. A person is said to be independent if he can work alone physically, think on his own, compose expressions or ideas that can be understood by others, and do activities emotionally [11].

To develop the mathematical self-regulated learning, it is necessary to strive for a learning that provides opportunities for students to think independently and be actively involved in learning. One of the lessons that can be developed is learning with the modified Moore method [6]. The modified Moore method is a modification of the Moore method developed by RL Moore [12]. Learning with the modified Moore method is learning that provides opportunities for students to be actively involved in learning, where the teacher becomes a motivator, facilitator, who directs students to understand a concept independently and with a little help from the teacher so that students’ mathematical understanding and proof can develop better.

Based on these various descriptions, it can be necessary to conduct research on the description of the students’ self-regulated learning who take learning with the modified Moore method and students who take direct instruction in Linear Algebra courses. In addition, this study was conducted to determine the differences in the improvement of the students’ mathematical self-regulated learning who take learning with the modified Moore method and students who take direct instruction in Linear Algebra courses.

2. Method
This research is a quasi-experimental research with a nonequivalent control group design that compares the mathematical self-regulated learning of students in the experimental class and the control class. The study population was all 120 students who took Linear Algebra courses. Sampling was conducted using purposive sampling technique, namely 67 students in two classes with one class (39 students) as the experimental class and one class as the control class (27 students). The instrument used was a mathematical self-regulated learning questionnaire instrument. Before being tested, the self-regulated learning questionnaire instrument was validated by expert judgment. The reliability of the self-regulated learning questionnaire instrument was carried out using the Cronbach Alpha formula showing the reliable instrument with (r) was 0.849 (> 0.7). The research data analysis was carried out in two stages, namely descriptive statistical analysis and inferential statistical analysis. To test the hypothesis, the independent t test is used. To determine the increase in student self-regulated learning, this study used the normalized N-gain test.

3. Results and Discussion
3.1. Descriptions of Students’ Mathematical Self-regulated Learning.
The results of students’ mathematical self-regulated learning that are presented in the experimental class and in the control class. The description of the students’ mathematical self-regulated learning in the experimental class and the control class can be considered in Table 1.
Table 1. Descriptions of students' mathematical self-regulated learning

| Mathematical Self-regulated learning | N  | Score | Mean  | Percentage | Std. Deviation | Criteria |
|-------------------------------------|----|-------|-------|------------|----------------|----------|
| Before treatment                    |    |       |       |            |                |          |
| Experimental Class                 | 39 | 34    | 59    | 46         | 79.31          | High     |
| Control Class                      | 27 | 35    | 53    | 43.52      | 75.04          | High     |
| After treatment                     |    |       |       |            |                |          |
| Kelas Eksperimen                   | 39 | 36    | 57    | 48.03      | 82.81          | High     |
| Kelas Kontrol                      | 27 | 34    | 53    | 44.22      | 76.24          | High     |

Ideal Score = 58

Based on Table 1, the description of students' mathematical self-regulated learning before being given treatment, both the experimental class and the control class are in the same category. For the mean score of students' mathematical self-regulated learning in the experimental class is 46 or 79.31% (high category) with a standard deviation of 6.69 and the mean score of control class students' mathematical self-regulated learning is 43.52 or 75.04% (high category) with standard deviation 5.04.

Meanwhile, the description of students' mathematical self-regulated learning after treatment, both the experimental class and the control class are also in the same category. For the mean score of students' mathematical self-regulated learning in the experimental class is 48.03 or 82.81% (high category) with a standard deviation of 6.29 and the mean score of control class students’ mathematical self-regulated learning is 44.22 or 76.24% (high category) with a standard deviation of 4.59. The mean score of students’ mathematical self-regulated learning after receiving treatment with the modified Moore method was higher in collaboration with students’ mathematical self-regulated learning who took direct instruction. This shows that the application of the Moore method allows students to develop their mathematical self-regulated learning.

Students who take part in learning using the Moore method are students' mathematical self-regulated learning which develops better and evenly for students who take direct instruction. This is in line with the opinion of Mahavier, May, and Parker [12] which states that the Moore method is an effective pedagogical method in arousing students' interest to ask questions, explore, discover, and develop mathematics on their own terms. That is, the modified Moore method facilitates students to develop their self-regulated learning.

3.2. Improvement of Students’ Mathematical Self-regulated Learning

The improvement of the students' mathematical self-regulated learning who used the modified Moore method in the experimental class and the students' mathematical self-regulated learning who used direct instruction in the control class can be identified by calculating the normalized gain score. The description of the normalized gain score of the improvement in students’ mathematical self-regulated learning can be seen in Table 2.

Table 2. Improving students’ mathematical self-regulated learning

| The normalized gain score | N  | Score | Mean  | Std. Deviation | Criteria |
|--------------------------|----|-------|-------|----------------|----------|
| Experiment Class         | 39 | -0.6  | 0.36  | 0.084          | Low      |
| Control Class            | 27 | -0.5  | 0.29  | 0.001          | Low      |

N = lots of data, Ideal Score = 1
Based on Table 2, it shows that the improvement in students' mathematical self-regulated learning used modified Moore's method of learning is better than the improvement in students' mathematical self-regulated learning used direct instruction. When viewed from the average students' mathematical self-regulated learning, students who follow modified Moore's learning are better than students who follow direct instruction.

Table 3. Mann-Whitney U Test

| Test Statisticsa | N Gain Score |
|------------------|--------------|
| Mann-Whitney U    | 360.500      |
| Wilcoxon W        | 738.500      |
| Z                 | -2.192       |
| Asymp. Sig. (2-tailed) | .028       |

Thus, based on Table 3, the Mann-Whitney test, the significance value is 0.028 (< 0.05) so that H0 is rejected. This means that the improvement in the students' mathematical self-regulated learning who follow with the modified Moore method is better than students who follow with direct instruction. This is in accordance with the opinion of Maya and Sumarmo [6] which states that learning with the modified Moore method supports active students in the learning process by learning independently so that students can construct their own evidence. As a result, the ability of mathematical proof and students' mathematical self-regulated learning is growing. The results of this study are also supported by research by Saefudin et.al [13][14] which states that student center learning, one of which is the modified Moore method, can develop students' mathematical proving abilities and students' mathematical self-regulated learning. Thus, learning with the modified Moore method can be used as an alternative in developing students' mathematical self-regulated learning.

Apart from being seen from the increased students' mathematical self-regulated learning, Modified Moore method process allows students to actively ask questions and solve math problems, including explaining their work in front of the class compared to students who take direct instruction. In direct instruction, students listen more to lecturers' explanations. Modified Moore method also encourages students to be courageous and happy to complete evidence, providing counterexample, examples, and counter arguments [15][16]. Modification Moore's method makes students more active in asking questions, solving problems, and ready to present in class compared to students who take direct instruction [6].

Based on these various arguments, the modified Moore method can be an alternative in learning mathematics in higher education, especially in developing students' mathematical self-regulated learning and mathematical thinking skills. In addition, with this explanation, modified Moore's learning can be categorized as student centered learning.

4. Conclusion
The results of the research can be concluded that the results of the study are as follows: the students' mathematical self-regulated learning with modified Moore method is better than the students' mathematical self-regulated learning with direct instruction. The improvement of the students' mathematical self-regulated learning with modified Moore method is better than students with direct instruction. Learning
using the modified Moore method can be used to develop students' mathematical self-regulated learning. Therefore, lecturers can use this learning as an alternative in Linear Algebra courses.

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