Implementation of lesson study through guided inquiry learning model to improve students' critical thinking

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Abstract. This study aims to describe the application of guided inquiry models to improve students' critical thinking skills on the material of linear function class VIII A at SMP Negeri 1 Kota Agung. The type of research used in lesson study activities with guided inquiry consists of three stages of planning, doing, and seeing. Data collection techniques used in the form of interviews, tests, and documentation. The data analysis technique uses descriptive qualitative. The selection of material is based on the results of the midterm exams supported by the results of students' pretests. The subjects of this study were six students with low, medium and high skills. Students who have LS showed that the existence of critical thinking skills in the medium category with an N-Gain score of 0.4 to 0.45. Students who have MS have increased critical thinking skills in the medium category with an N-Gain score of 0.59 to 0.66. Students who have HS have increased critical thinking skills from the moderate to a high category with an N-Gain score of 0.68 to 0.76. The results of this study indicate that students' critical thinking skills in linear function material increased using Guided Inquiry through learning activities with low, medium or high skills.

1. Introduction

Mathematics is one of the basic sciences in various disciplines that can help develop the human mindset. Thinking is the process of representing new understanding and reasoning formed through the transformation of information with the interaction between mental attributes to create a concept. One of the thinking skills that must be developed in mathematics learning is the skill to think critically. In line with the objectives of learning mathematics according to [1] through mathematics, students can be equipped with the ability to think and cooperate. These competencies are needed so that students can have the skills to obtain, manage, and use the information to live better in an ever-changing and competitive situation. Students who think critically are capable of recognizing, gathering, testing, and interpreting information, drawing conclusions and solving problems correctly.

Someone who thinks critically has character traits that can be examined by looking at how someone responds to and resolves a problem [2]. Someone who thinks critically has a special character that can be investigated by seeing how someone responds to and resolves problems. This character is not yet possessed by most junior high school students in Indonesia. According to [3] (33.1%) Indonesian students can only work on problems if all the required information is given appropriately. Only (0.1%) can do mathematical modeling that requires critical thinking skills [4]. Data from observations in the field and interviews with mathematics teachers in class VIII A of SMPN 1 Kota Agung show that students cannot yet think properly. Seen from the learning process students tend to be less able to observe,
formulate problems, make statements of each question, plan experiments, develop ideas with various alternatives and students have not been able to respond and analyze questions given by the teacher. This condition influences students' thinking skills. This indicates the level of critical thinking skills of students is still low. Therefore, students' critical thinking skills in solving problems must be developed. As [5] states that the handling and serious attention to innovation in the learning process between (a) variations in media, (b) variations in methods and (c) variations in infrastructure, will reduce the impact of learning difficulties.

Based on the problem of learning quality of linear function material according to the factual conditions in the class, several problems can be identified as follows: (1) the process and learning outcomes of linear function material have not reached the optimal target. Student learning activities, responses, and creativity are still lacking, (2) students are classified as passive and teachers dominate learning. Student learning outcomes in the linear function material are still low, (3) the teacher acts as a transmitter of knowledge, not as a learning facilitator which causes the learning process to be less meaningful, (4) the learning process never begins with the presentation of the problem. The problem is not as a stimulus for learning but as a place to stabilize the material. (5) evaluation of learning only focuses on reflecting learning while thinking creativity aspects are always ignored. (6) students have not had a real learning experience. Student creativity will not increase if the learning model provided can improve understanding of concepts and be student-centered [6]. Based on these problems it seems necessary to do a review in the selection of learning models and the quality of the learning process linear function material. After analyzing the characteristics of subjects and learning models guided by inquiry, the researcher chose the guided inquiry model as a way to increase students' critical thinking skills.

The choice of guided inquiry learning model is based on the following considerations: (1) the student-centered learning process, students become more independent in solving problems, (2) the teacher's role is only as a guide and facilitator, (3) the students' learning activities become higher in intensity, (4) the learning process is more meaningful, (5) maximizing all students' abilities to search and investigate systematically, critically and logically so that they can formulate their findings with confidence [7] (6) students will get a real learning experience that will serve as a stimulus for learning in practicing thinking skills. Effective models for achieving thinking skills are inquiry [8]. The aim is to develop intellectual skills, think critically, and solve problems scientifically.

Critical thinking skills are one of the skills needed during the teaching and learning process. Critical thinking is sensible thinking and reflective thinking that focuses on making the right and accountable decisions [9]. Critical thinking is an active, persistent, and evaluative act about beliefs that are seen as reasons to support conclusions [10]. Based on the opinions of experts, it is obtained that the understanding of critical thinking is a process of deep thinking based on the knowledge obtained to decide the appropriate action to obtain conclusions and assess an opinion. Related to critical thinking skills according to [11] indicators of critical thinking skills can be categorized into three is (1) focus (able to formulate the main points of the problem), (2) clarity (able to express the facts needed to solve a problem), (3) reasons (able to choose logical, relevant and accurate arguments).

The learning process at school is expected to train students to think critically. Students are trained to observe events, raise problems, formulate hypotheses, observe and collect data and provide conclusions. Critical thinking trains students to think logically, be skeptical and find the right answer to a problem. Critical thinking skills can support students to develop talent, practice concentration, focus problems, and analytic thinking [12]. Through inquiry learning, students learn to solve problems independently and have critical thinking skills because they can analyze and handle information obtained appropriately [13].

Based on the background of the problem, it is necessary to research the implementation of lesson study using guided inquiry models to increase students' critical thinking. According to [14] through lesson study, the teacher can also learn from imperfect learning after the teacher designs, implements and discusses the learning that has been done.
2. Methods

This type of research is a lesson study by implementing a guided inquiry learning model. Data collection techniques used in the form of (1) interviews to find out information related to students’ critical thinking skills in solving linear function problems, (2) tests used in the form of essay questions compiled based on critical thinking criteria of linear function material, the questions given consisted of 2 questions from textbooks and 1 question for the 2018 Middle School National Examination, linear function material, (3) documentation aimed at obtaining data directly such as school data, student data, and students’ critical thinking skills test results. Researchers took six students of class VIII A SMPN 1 Kota Agung each consisting of 2 low, medium and high skills students as research subjects. This data was obtained from midterm and pretest results. Determination of the subject based on the purposive sampling technique. Data analysis using descriptive qualitative. This research was conducted by following the Lesson Study stages: (1) Plan: the teacher and the Lesson Study team designed the learning activities, (2) the do stage: a teacher teaching model while the other as an observer, (3) the see: teacher model and the observer together reflect the learning outcomes. The study was conducted in two cycles. Cycle I learning activities with the graph material equations and slope, Cycle II learning activities with material linear functions. Quantitative data are in the form of critical thinking skills values measured by a test technique consisting of three questions. Indicators of critical thinking skills consist of (1) focus: the ability to formulate the main points of the problem, (2) clarity: the ability to express the facts needed to solve a problem, (3) reasons: the ability to choose logical, relevant and accurate arguments. While qualitative data is the result of the observation of lesson study. Students’ critical thinking skills are assessed based on Ernie’s indicators of mathematical critical thinking skills which have been grouped according to Hassoubah. Scoring criteria for critical thinking skills tests used in this study refers to the scoring rubric developed by the pace.

3. Result and Discussion

Based on preliminary observations as stated in the identification of the problem, that the guided inquiry strategy has encouraged teacher-centered learning processes, activities, responses, and analysis of student learning are still lacking, students are classified as passive, student learning outcomes in subjects linear function are still low, the teacher acts as the transferring of knowledge, the learning process never begins with the presentation of the problem, students have not had a real learning experience.

The planning phase in the cycle I is as follows: (1) compile a learning program for the graphic material for equations and gradients by implementing the guided inquiry learning model. Students are expected to be able to analyze problems, plan and work on solutions and check the results of solutions, (2) establish problems to the equation and gradient graphic material that serves as a stimulus for learning. Problems raised by students with low, medium and high ability regarding graph analysis of equations. The do phase in cycle I is the implementation stage of learning showing that students with low, medium and high skills in solving problems are not analytical and structured. Students are less careful in analyzing questions and lack of evaluation of the answers that have been done. In the implementation of ongoing learning shows six students complete the task. Students with a Low Skills (LS) on average work on two questions, indicating the two answer was not right. Students with average Mid Skills (MS) are working on two questions but only one question has the right answer. Students with a High Skills (HS) on average do three questions with two correct answers. The see phase in the cycle I show that the Implementation of the guided inquiry learning model is not satisfactory. The thing that is of concern is the need for analysis in solving a problem. Activities, responses, and analysis of student learning are still lacking, students are classified as passive, students have not had a real learning experience, students’ answers are less analytical and structured, most students take notes more than asking questions. This shows students have not thoroughly learned about solving a problem. Students’ analytical skills are still low in solving problems. Learning is going well even though only a few students are actively involved.
The planning phase in the cycle II aims to improve learning in the cycle I and emphasizes the following aspects: (1) solving problems in analyzing questions so that answers are more detailed and evaluating the results of work on problem-solving, (2) equitable distribution of student involvement to maximize the role of the model teacher and help develop skepticism among students with low, medium and high skills. The do phase in cycle II of the material being taught is a linear function. There is an increase in student skills. Based on the examination of assignments and tests, especially in the critical analysis of solving problems, there are improvements, for example, seen when solving problems of linear function students can solve problems if known graphs and gradients. Each student with low, medium and high skills to solve a problem is more analytical and structured from the visualization of the problem to the evaluation of the resolution of the problem in question. The quality of the learning process in cycle II has improved compared to the cycle I. Phase see in cycle II the results of student work in solving problems are analytical and structured. Visualization until the evaluation of problem-solving has increased. Minor errors still appear mainly in mathematical calculations. Some aspects that stand out and work well are collaboration, and student interaction with the teacher. Students become more active. This shows increasing students' critical thinking skills both low, medium and high skills.

The results of interviews of six students showed that they experienced a change in the way of learning, from just memorizing formulas to more exercises and problem analysis so that students found many problems in planning solutions to the problems encountered. Also, the implementation of lesson study affects improving student learning processes through collaboration between students and between students and teachers. Critical thinking skills of students with low, medium, and high skills as a result of implementing a lesson study using guided inquiry learning models can be seen in tables 1, 2, and 3.

### Table 1. The Percentage of N-Gain Students' Critical Thinking Skills LS.

|                     | Cycle I | Cycle II |
|---------------------|---------|----------|
| Average initial test scores | 22      | 26       |
| Average final test scores      | 53      | 59       |
| N-Gain                    | 0.4     | 0.45     |

From table 1 the percentage of the initial average test scores of critical thinking skills of students with Low Skills (LS) in the cycle I of the equation and gradient graph material of 22 (very low) to 53 (low) with an N-gain of 0.4 (medium). While the initial average value of the percentage of LS in the cycle II material linear function equation of 26 (very low) to 53 (low) with an N-gain of 0.45 (moderate). From the average value of the final tests of Cycle I and II, as well as the change in N-gain from 0.4 to 0.45 after applying the guided inquiry model with a lesson study pattern, shows an increase in students' critical thinking skills.

### Table 2. The Percentage of N-Gain Students' Critical Thinking Skills MS.

|                     | Cycle I | Cycle II |
|---------------------|---------|----------|
| Average initial test scores | 27.5    | 31.5     |
| Average final test scores      | 70.5    | 76.5     |
| N-Gain                    | 0.59    | 0.66     |
From table 2 percentage of the initial average test scores of critical thinking skills of students with Medium Skills (MS) in the cycle I of the equation and gradient graph material of 27.5 (very low) to 70.5 (high) with an N-gain of 0.59 (moderate). While the percentage of the initial average value of MS in the cycle II material linear function equation of 31.5 (very low) to 76.5 (high) with an N-gain of 0.66 (moderate). From the average value of the final test of cycles I and II, as well as the change in N-gain from 0.59 to 0.66 shows an increase in students' critical thinking skills.

**Table 3. The Percentage of N-Gain Students’ Critical Thinking Skills HS.**

|                | Cycle I | Cycle II |
|----------------|---------|----------|
| Average initial test scores | 40      | 45       |
| Average final test scores    | 80.5    | 87       |
| N-Gain                      | 0.68    | 0.76     |

From table 3 percentage of the initial average test scores critical thinking skills of students with High Skills (HS) in the cycle I of the equation and gradient graph material of 40 (very low) to 80.5 (high) with an N-gain of 0.68 (moderate). While the percentage of the initial average value of HS students in the cycle II material linear function equation of 45 (low) to 87 (very high) with an N-gain of 0.78 (high). From the average final test scores of Cycle I and II and the change in N-gain from 0.68 to 0.76 it affects increasing students' critical thinking skills. This increase can be seen in Figure 1.

**Figure 1. The Percentage Increase In Students' Critical Thinking Skills**

Based on Figure 1, critical thinking skills of LS, MS, and HS cycle I always increase in cycle II. The N-Gain LS value increased by 5%, MS increased by 7% and HS increased by 8%. Demonstration after the application of the guided inquiry model with learning patterns shows an increase in students' critical thinking skills. Based on the results of tables 1, 2, 3 and figure 1, after applying lesson learning using the guided inquiry learning model, it affects the improvement of students' critical thinking skills. Supported by [15], improving critical thinking skills can be done during the learning process by implementing guided inquiry with scaffolding strategies based on the stages of lesson study (planning, doing, and seeing).
Table 4. Indicators of Critical Thinking are Based on LS, MS, and HS Average Student Skills and Improve Each Test.

| Critical Thinking Indicator | Percentage of LS students | Percentage of MS students | Percentage of HS students |
|-----------------------------|---------------------------|---------------------------|---------------------------|
|                             | Pretest | Posttest | Improvement | Pretest | Posttest | Improvement | Pretest | Posttest | Improvement |
| Focus                       | 1       | 6        | 5           | 1       | 9        | 8           | 2.5     | 9.5      | 7           |
| Clarity                     | 7       | 10       | 3           | 7.5     | 10       | 2.5         | 10      | 10.5     | 0.5         |
| Reasons                     | 0       | 2        | 2           | 2       | 6.5      | 4.5         | 2       | 9        | 7           |

Based on Table 4, the three indicators of critical thinking based on low, medium and high student skills by using lesson study using guided inquiry learning models have increased from all aspects ranging from focus, clarity, and reasons have increased as expected. Supported by [16], the teacher acts as a guide and motivates students to present the proposed problem based on several considerations so that the guided inquiry model can improve critical thinking skills. Supported by [17], when the learning process using guided inquiry models significantly influences students' critical thinking skills. According to [18], the presentation of varied problems in inquiry learning can motivate and stimulate students to seek alternative answers and think deeper. Supported by [19], the Lesson Study approach is one of the solutions in solving learning problems.

4. Conclusion
The results of the study based on the discussion can be concluded that the implementation of lesson study using guided inquiry models can improve students' critical thinking skills in mathematics with low, medium or high skills. Judging from the final results LS students showed that the existence of critical thinking skills in the medium category with an N-Gain score of 0.4 to 0.45. Students who have MS have increased critical thinking skills in the medium category with an N-Gain score of 0.59 to 0.66. Students who have HS have increased critical thinking skills from the moderate to a high category with an N-Gain score of 0.68 to 0.76. Judging from the learning process in class also shows that there are changes in student learning patterns to be more skeptical. This is supported by students' critical thinking skills based on low, medium and high skills to analyze various kinds of problems.

Acknowledgments
This paper compiled to meet the requirements to obtain a master's degree in the mathematics study program, the University of Lampung, the author would like to thank the supervisor lecturer, teacher in mathematics studies at a public junior high school 1 Kota Agung, family and friends who have given support and assistance for this research.

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