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Inquiry Learning and Lesson Study Activities on Improving Mathematical Critical Thinking Ability of Madrasa Students

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ABSTRACT

Learning mathematics requires students to always be active in the learning process because mathematics is a field of science that prioritizes high intellectual quality and not just knowledge that is informative and theoretical. One of the intellectual qualities can be seen from the ability to think critically and is one of the needs of students in learning mathematics. But the fact is that currently, learning is still dominated by the lecture method and rarely facilitates students to develop their critical thinking skills. Appropriate teaching and learning strategies approaches, and models are needed to train mathematical abilities. Therefore, teachers are expected to be able to determine the right strategy so that learning objectives are more optimal. In this study, researchers analyzed how the results after applying inquiry learning strategies and Lesson Study activities affected students' critical thinking skills. The study population was students of class XI Madrasah Aliyah Mu'allimat NW Pancor, and the sample was determined by purposive sampling technique as many as 38 students. Research data were collected using documentation, questionnaires, observation sheets, and math substance tests. This research was conducted through four Lesson Study cycles. After carrying out this process, it was found that there were positive results from the application of inquiry learning strategies and Lesson Study activities to improve student's critical thinking skills in mathematics.

A. INTRODUCTION

In learning mathematics, students are expected to always be active in the learning process because mathematics is a field of science that prioritizes high intellect and not only fields of knowledge that are informative and theoretical. One of the abilities needed in learning mathematics is thinking critically. Critical thinking is the cognitive ability to decide on a decision or conclusion based on logical reasoning and empirical evidence (Wibowo et al., 2022; Yaumi, 2012). This ability is a higher-order thinking skill that directs students to be more active when asked to analyze, evaluate, and create (Conklin, 2011). In addition, Kalelioglu and Gulbahar (2014) emphasized that critical thinking is needed to examine the truth of information so that students can decide which information is correct (Amnia'ul, 2021; Kalelioğlu & Gülbahar, 2014).

Appropriate strategies, approaches, and teaching and learning models are needed in teaching a subject such as mathematics. Therefore, the teacher must choose the right method to facilitate the achievement of the learning objectives that have been formulated. The teacher's selection of teaching approaches and methods is difficult because each class has heterogeneous students' academic abilities. One of the efforts that the teacher can make in learning mathematics is to encourage students to be more actively involved and think critically in finding concepts in the teaching and learning process, especially by conducting learning using the inquiry model and lesson study activities.

Inquiry learning is a part of learning that involves a lot of students in the teaching and learning process. The inquiry learning model is one of the learning activities that define the process of thinking analytically and critically to seek and find answers to a problem in question. The thinking process is usually done through debriefing between the teacher and students (Wina Sanjaya, 2011). The implementation of the inquiry model

is expected to be able to improve students' critical thinking skills. Learning will be combined with lesson study activities to maximize the results of the process.

Lesson study is anchored on jugyokenkyu, which came from the Japanese words jugyo (lesson) and kenkyu (study) or simply Lesson Study. Lesson Study was originally a Japanese practice of enhancing teaching, where teachers systematically inquire into their pedagogical practice by closely examining their lessons (Fernandez, 2002). A lesson Study is a collective work of a group of teachers with students or lecturers. Making lesson plans (planning) can be done together, implemented by appointing one member as a model teacher, and other teachers and experts act as observers. The results of these observations are analyzed (through the reflecting stage) together. Teachers can adopt learning methods, techniques or strategies, use of media, and so on that are raised by display teachers to be imitated or developed in their respective classes. Other teachers/observers need to analyze to find the positives and negatives of the learning class from minute to minute. The results of this analysis are needed as input material for display teachers for improvement, or through this learning profile, teachers/observers can learn from learning innovations carried out by other teachers (Suhaili & Shahrill, 2015). Based on the previous descriptions, in this study researcher will analyze the improvement of critical thinking ability after implementing an inquiry learning model and lesson study activity.

B. RESEARCH METHODS

This research is a qualitative descriptive analysis where the activities that occur will be analyzed, described, and summarized into various conditions and situations from various data collected in the form of interview results or observations regarding the problems studied that occur in the field (Winartha, 2006). The research activities were conducted in Madrasah Aliyah Mu'alimat NW Pancor. The sample was determined by a purposive sampling technique of 38 students. Sugiyono (2013) states that purposive sampling is a sampling technique with certain considerations (Sugiyono, 2013). The consideration for choosing this sample was because the characteristics of the students were heterogeneous and represented the characteristics of madrasa students in East Lombok in general. Research design implementation is in the form of cycles. Each cycle consists of three phases, namely: (1) planning (plan), (2) implementation and observation (do), and (3) reflection (see).

1. Planning (plan)

At this stage, the class's problems were identified for lesson study activities and the planning of alternative solutions. Identification of problems in the framework of problem-solving planning relates to the subject matter (subject matter) that is relevant to class and lesson schedules, student characteristics and class atmosphere, learning methods/approaches, media, teaching aids, and evaluation of learning processes and outcomes.

The identification results were discussed (in the lesson study group), the selection of learning materials, the selection of methods and media according to the characteristics of students, and the type of evaluation to be used. During the discussion, opinions and suggestions will emerge from the teachers and experts in the group to determine the options to be implemented.

2. Implementation and Observation (do)

In the do stage, a teacher who has been appointed (agreed on) by his group implements the lesson plan that has been prepared in class. Experts and other teachers make observations using observation sheets that have been designed and other tools needed. The observers recorded positive and negative things in the learning process, especially student behavior. In addition, record a video (audio visual) that closes up special events (to the teacher or students) during the learning process.

The results of these recordings are useful later as authentic evidence of events that need to be discussed in the reflection stage or at lesson study seminar results; besides that, they can be used as material for dissemination to a wider audience.

3. Reflection (see)

After the learning practice stage, then reflection is carried out. At this reflection stage, the teacher who appeared and the observers and experts held discussions about the learning that had just been carried out. This discussion is led by the principal, group coordinator, or teacher appointed by the group. First, the teacher who implements the lesson plan can express his impressions while carrying out the lesson to himself or the students he encounters. Furthermore, the observer (other teachers and experts) conveyed the results of the analysis of

the observation data, especially those concerning student activities during the learning process, which was accompanied by playing a recorded video of the lesson.

Furthermore, the teacher implementing the implementation will provide feedback on the observers' comments. It is also essential in this reflection stage to reconsider the lesson plan that has been prepared as a basis for improving the next lesson plan. Is the lesson plan appropriate, and can it improve student learning activity performance? If not, there will be adjustments to things not by the learning method, material in the student worksheets, media or visual aids, or others. These considerations are used to improve the next lesson plan

The classroom action research was conducted in four cycles, each with two meetings. The data was collected using documentation, survey questionnaires, observation sheets, and math substance tests. The survey questionnaire was adopted from Hj Suhaili and Shahrill (2015) with slight modifications to gather insights on the teachers' perception of the Lesson Study and as guide questions for the interview to verify their responses (Suhaili & Shahrill, 2015). The scoring guidelines for the observation sheet refer to the guidelines from Arikunto (2019), namely each observation indicator is given a score ranging from 1 to 5 with the provision that a score of 5 = Strongly agree, 4 = agree, 3 = quite agree, 2 = disagree, 1 = Strongly disagree. Observation sheet scoring results are calculated using the formula:

$$\mu = \frac{\sum x}{a}$$

information:
μ = Score average
$\sum x$ = Total score
a = The number of assessment items (Arikunto, 2019).

The observational data (student activity, student group discussions, and implementation of learning by the teacher) was analyzed after calculating the observation data's average score. The criterion intervals from the results of these observations are:

Table 1. Interval Value of Observational Data

Criteria	Interval
Very active / Very good	$4 < \mu \leq 5$
Active / good	$3 < \mu \leq 4$
Quite active / pretty good	$2 < \mu \leq 3$
Inactive / poor	$1 < \mu \leq 2$
Very inactive / worst	$0 \leq \mu \leq 1$

A student is said to have critical thinking skills if he can analyze facts, generalize and organize ideas, defend opinions, make comparisons, draw conclusions, test arguments, and solve problems (Ariyani & Tego, 2021). Students' mathematical critical thinking skills were analyzed by analyzing data from observations of student group discussions and students' mathematical substance tests. During the mathematical substance test, the student answers math literacy questions in which students solve five contextual problems with mathematical concepts that they learn with the level of difficulty of each problem: 60% low, 20% moderate, and 20% very difficult. Every student is said to have good critical thinking skills if they can solve mathematical problems with a minimum score of 75 (classical completeness score). The formula can calculate the classical completeness score of the student's mathematics substance test

$$\vartheta = \frac{N_a}{n}.100\%$$

information:
ϑ = Classical completeness score
N_a = The number of students who get a minimum score of 75
n = The number of students

Researchers designed the inquiry learning model and lesson study activities to help students get used to comprehensive critical thinking so that they can solve mathematical contextual problems contained in the

mathematical literacy problems given. These learning activities are said to be able to improve student's critical thinking skills if at least 80% of students get a minimum mathematics substance test score of 75 ($\vartheta \geq 80\%$) and the average score of student group discussions is in very good category ($\mu > 4$).

C. RESULT AND DISCUSSION

The research was carried out by applying the inquiry learning model and lesson study activities and was carried out for two months. The implementation of activities is described in four cycles, with each cycle containing each learning activity combined with lesson study activities

1. Cycle I

Cycle I activities began with the planning stage in which the researcher, as the model teacher, compiled lesson plans and learning and research instruments such as student activity observation sheets, teacher activity observation sheets, student group discussion activity assessment sheets, and cycle I student activity sheets along with alternative solutions. The researcher then presented the lesson plan and research instruments to the observer team. In general, the notes that were the result of discussions with the model teacher and the observers were: 1) adjustment of learning objectives according to the estimated learning time, 2) division of student groups into smaller groups to make giving guidance easier, and 3) division of time on learning activities for more detail.

Furthermore, at the do stage, the researcher, as the model teacher, leads the learning process and is observed by a team of observers who are guided by the Teacher Activity Observation form, the Student Activity Observation form, and the Student Discussion Activity Observation form. The model teacher conducts learning with the inquiry learning model on mathematical sequences and series material. The model teacher facilitates learning according to the lesson plan that has been prepared. The model teacher also remembers to give students a math substance test. After the learning process was carried out, the observed data were obtained as follows:

Table 2. Observation Results of Learning Cycle I

Observed Aspect	μ	Criteria
Student Activity	3.38	Active
Implementation of learning by teachers	4.33	Very good
Student discussion activity	3.55	Good

In addition to obtaining observational data, data was also obtained from the results of the mathematics substance test given to each student with the following results:

Table 3. Mathematics Substance Test Result of Cycle I

Aspect	Value
Number of present students	37
Number of absent students	1
The highest score	92
The lowest score	60
Classroom average score	78,10
The number of students who get passing grade	28
The number of students who didn’t get passing grade	9
Classical completeness score (ϑ)	75.67%

Based on the information in the two tables above, it can be seen that the teacher has carried out learning in accordance with the lesson plan that has been prepared and gets a score of 4.33. However, student activity in participating in class learning still needs to be improved. This is because the value of student activity is still 3.38 and the value of group discussion is still 3.55. The activity data of students and teachers in learning in table 2 is directly proportional to the data on the results of the mathematics substance test in table 3 where there are 9 students who have not been able to achieve a minimum score of 75 or a classical completeness score of 75.67%. So it is necessary to improve the aspects of student and teacher activity.

In the next stage, namely the seed stage, the model teacher and observer jointly discuss and evaluate the implementation of learning. In this activity several notes of improvement were obtained including: 1) The model teacher did not convey detailed learning steps to students so that students were confused when in the

middle of learning they were asked to present the results of the discussion; 2) The model teacher still does not fully carry out the learning process in accordance with the planning at the plan stage; 3) The number of questions on student worksheets is too much, resulting in students needing quite a lot of time to complete them; 4) The time for presenting the results of group discussions was too short and not in accordance with the plan due to the time taken for students to complete their worksheets; 5) There are still groups that have not received guidance from the model teacher during the discussion process; 6) There are still many students who look passive during the learning process; 7) There are still students who seem indifferent to the learning process; and 8) Model teachers do not give appreciation to groups who dare to give presentations so that students look less enthusiastic during the presentation process. Based on these notes, it will then be considered for process improvement in the next cycle.

2. Cycle II

At the beginning of cycle II, the researcher obtained what aspects needed to be improved based on the eight notes obtained from the seed stage in cycle I. At the do stage, the researcher, as the model teacher, prepared a lesson plan that designed a plan for improving the previous learning process. The model teacher with the observer team discussed the lesson plan that had been designed and also presented a process improvement plan that was prepared based on the notes at the seed stage in the previous cycle.

At the do stage, the model teacher leads the learning process in class and implements the lesson plan that has been designed, and the observer team observes the implementation of the lesson. Unlike the previous cycle, in this cycle, the model teacher already knows what needs to be done to improve the quality of the learning process. After the implementation of the do stage in cycle II, the following observation data was obtained:

Table 4. Observation Results of Learning Cycle II

Observed Aspect	μ	Criteria
Student Activity	3.94	Active
Implementation of learning by teachers	4.50	Very good
Student discussion activity	3.73	Good

After giving a math substance test to students, the following data were also obtained:

Table 5. Mathematics Substance Test Result of Cycle II

Aspect	Value
Number of present students	36
Number of absent students	2
The highest score	100
The lowest score	60
Classroom average score	77,11
The number of students who get passing grade	28
The number of students who didn't get passing grade	8
Classical completeness score (ϑ)	77.77%

Based on the data obtained in cycle II activities, there was an increase in several aspects compared to the previous cycle (see Tables 4 and 5). Even though there was an increase in several aspects such as student activities and discussion activities, students were still in the "good" category. The same as the previous cycle, but the increase is not significant. To find out the cause of this, the see stage was carried out, where the teacher and observer team evaluated the learning process that had been carried out. In this evaluation process several notes of improvement were obtained, such as: 1) The teacher model needs to pay more attention to time management so that the learning process runs more effectively and efficiently; 2) Model teachers need to pay more attention to passive students, one of which is by asking these students to represent the group showing the results of the discussion or by giving different responsibilities; and 3) Guidance on finding mathematical concepts needs to be further improved by model teachers for each group so that all students can understand the material being discussed. After doing the see stage with the observer team, the model teacher was enthusiastic about improving the quality of learning in the next cycle.

3. Cycle III

When carrying out cycle III, the model teacher has been provided with experience from the previous cycle of learning implementations. In cycle III, the model teacher starts by designing learning scenarios and media equipment needed in the learning process. The model teacher also prepares student worksheets. These worksheets can further stimulate students' thinking skills so that they can help them find the expected mathematical learning concepts for learning objectives. The model teacher presented lesson plans and other learning equipment to the observer team at the do stage; the teacher and the observer team discussed together so that the observer team advised the model teacher so that he was better prepared to deliver learning in cycle III.

With high self-confidence, the model teacher is well prepared to carry out the do stages. The model teacher carries out learning based on the learning plan that has been designed. The model teacher also remembers to pay attention to notes on improvements in previous cycles. The observer team who observed the implementation of the learning saw that there were positive changes to the ongoing learning process. The students also enjoyed the learning process and were enthusiastic about working on the worksheets and math substance tests that were given. After the learning process is implemented, the following data are obtained:

Table 6. Observation Results of Learning Cycle III

Observed Aspect	μ	Criteria
Student Activity	4.27	Very Active
Implementation of learning by teachers	4.67	Very good
Student discussion activity	4.10	Very Good

In contrast to the two previous cycles, the improvement cycle occurred in the activeness of students in class. In another assessment, data on the results of the mathematics substance test were also obtained as follows:

Table 7. Mathematics Substance Test Result of Cycle III

Aspect	Value
Number of present students	38
Number of absent students	0
The highest score	100
The lowest score	65
Classroom average score	83.28
The number of students who get passing grade	35
The number of students who didn’t get passing grade	3
Classical completeness score (ϑ)	92.10%

Based on the data in table 6 and table 7, there has been an increase in student activity, student assessment of group discussions, and scores on the mathematics substance test results. In this cycle, we can see a consistent relationship between the quality of learning activity and the results of the mathematics substance test. The results of the assessment of student activity, the implementation of learning by the teacher, and the assessment of student group discussions have achieved a score of $\mu \geq 4$ or are in the "very active or very good" category. The results of the mathematics substance test were no less satisfactory, where the classical completeness score was 92.1%. It is expected from the learning process with the inquiry learning method and lesson study activities.

During the see stage, the observer team and the model teacher evaluate the implementation of the learning process together. The observer team explained that the results of implementing the learning plan in this cycle were very good. It can be seen from the active and enthusiastic students in the learning process and the results on the mathematics substance test, which have exceeded the minimum standard of 80% of the minimum classical completeness score. The observer team also explained that the learning media stimulated students to think critically and discover concepts independently. It is what is expected from the purpose of this research.

From some of the positive results obtained in cycle III learning activities, there are several notes of suggestions that will be taken into consideration in improving further learning, namely: 1) There are still groups that have not received optimal guidance, so there are still some students who are confused about learning material, especially in the cycle this has entered the new chapter material; and 2) Due to high enthusiasm with learning, model teachers and students do not pay attention to spare time so that better time

management is expected. Some of these suggestions come to the model teacher's attention to continue improving the quality of the learning process that he leads in the next cycle.

4. Cycle IV

In cycle IV activities, the model teacher tried to maintain performance like the previous learning activities and made improvements in aspects that were suggestions for improvement in the previous cycle. The model teacher designs lesson plans and prepares learning media with the same methods and models as cycle III. The model teacher also presented his preparation to the observer team. The observer team supported the model teacher and felt happy with the high enthusiasm shown by the model teacher in preparing his lesson activities.

During the do stage, the same as before, the model teacher leads the lesson enthusiastically, and the observer team observes the ongoing learning process. This time the model teacher carried out the learning process by the planned time estimate and provided guidance evenly to the entire group with each planned time duration. Students also look enthusiastic about participating in learning, completing all learning stages well, and answering all questions given by the teacher and other students. At the end of the fourth cycle of learning, the teacher asked students to fill out a form of feedback on implementing the learning they had participated in for four cycles. From all the series of doing stages in cycle IV, the following data is obtained:

Table 8. Observation Results of Learning Cycle IV

Observed Aspect	μ	Criteria
Student Activity	4.55	Very Active
Implementation of learning by teachers	4.67	Very good
Student discussion activity	4.26	Very Good

It can be seen that the observed data is as good as the data in the previous cycle. In addition to the observational data, data on the results of the math substance test obtained increased from the previous cycle, which can be seen in the following table:

Table 9. Mathematics Substance Test Result of Cycle IV

Aspect	Value
Number of present students	35
Number of absent students	3
The highest score	100
The lowest score	67
Classroom average score	88.88
The number of students who get passing grade	33
The number of students who didn’t get passing grade	2
Classical completeness score (ϑ)	94.28%

Based on the data obtained from the do stage, it was found that the quality of the learning process was getting better. It is evidenced by the observation scores, which continued to improve and reached $\mu \geq 4$ or are in the "very active or very good" category. The results of the mathematics substance test also experienced an increase, where the classical completeness score was 94.28%.

In the see stage of cycle IV, the model teacher and observer team evaluate the implementation of learning in this cycle. The observer team explained that the learning activities led by the model teacher went well according to the learning objectives. Students actively carry out group discussions and discover the basic mathematical concepts being studied. Model teachers are actively involved in guiding students to think critically to find mathematical concepts and ways to solve mathematical problems that students get. It was also reinforced by the results of the students' mathematics substance tests, which achieved the target classical completeness score.

Furthermore, the lesson study team also assessed all lesson study activities carried out by the researcher as a model teacher. The inquiry learning model designed and implemented by the model teacher through lesson study activities was implemented very well and achieved the research objectives. The increase in student activity scores evidences this, the implementation of learning by the teacher, the assessment of student group discussion activities, and students' math substance test scores which increased convincingly in each cycle. The increase in the score of the observation aspect and the results of the mathematics substance test can be seen in the following figure:

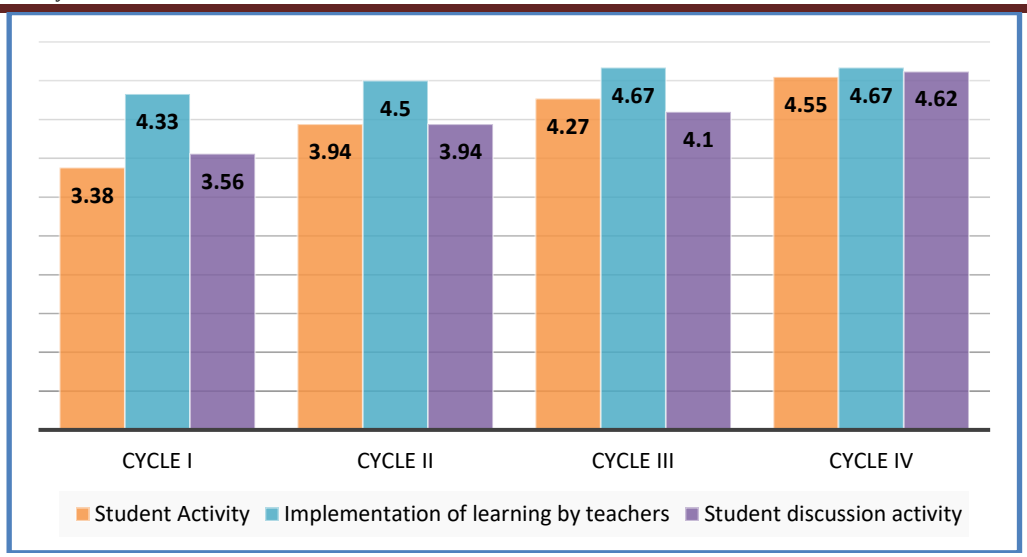

Figure 1. The Score Average of The Observations (μ)

The increase in the results of the mathematics substance test in this study can also be seen in the following figure:

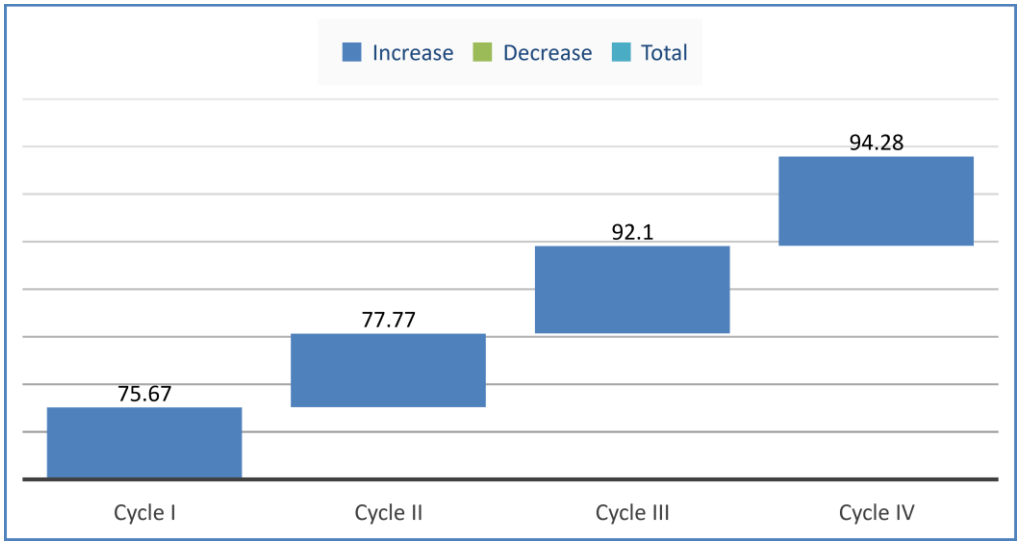

Figure 2. Classical Completeness Score (%)

The implementation of inquiry learning models and student lesson study activities can improve students' critical thinking skills, provide an explanation of what the contribution of inquiry learning and lesson study activities in improving students' critical thinking skills. Based on Figure 1, there is an increase in student activity, learning activities by the teacher, and student discussion activities from cycle I to cycle IV. In Figure 2 it can also be seen that there is an increase in students' critical thinking skills which is indicated by the increase in students' classical math substance test results from cycle I to cycle IV. It indicates that the research carried out succeeded in achieving the target. There are several factors that have caused this to be achieved, including: 1) Good learning preparation and getting input from other people's perspectives contributes to producing perfect planning; 2) The implementation of learning activities that are observed and assessed by other people can provide an overview to the teacher regarding what aspects need to be improved; 3) The selection of the inquiry learning model is considered to be able to improve students' thinking skills because students are required to find concepts and ways to solve the problems they get; 4) The active involvement of the teacher in guiding students according to the principles of the mathematics learning model plays an important role in improving learning outcomes because the teacher can stimulate students' critical thinking skills through creative guiding by the teacher; 5) The teacher's good ability in designing and choosing the right learning media so that students more easily achieve learning goals; 6) Teachers who are very enthusiastic in

preparing and leading learning and students who are enthusiastic about participating in learning can create a positive learning climate and can produce good learning outcomes.

Based on the results of the research that has been done, when reviewed with the results of previous studies that have been carried out by several researchers, there are results that are directly proportional. As research has been conducted by Aziz (2016) which also applies Lesson Study activities in the learning process and can improve students' critical thinking skills (Aziz et al., 2016). Another study conducted by Ahmatika (2017) showed that after applying the inquiry learning approach, there was an increase in students' critical thinking skills (Ahmatika, 2017).

Based on the results of the activities from cycle I to cycle IV in this study, students continued to practice solving mathematical problems given through good and intense student-student and student-teacher interaction activities so that in the end students' critical thinking skills could develop. This is in line with the cognitive theory by Jean Piaget where learning does not only involve the relationship between stimulus and response. But more than that, learning involves a very complex thought process. Learning involves the basic principles of psychology, namely active learning, learning through social interaction and through one's own experience (Al Rasyidin; Wahyudin Nur Nasution, 2011).

D. CONCLUSION AND SUGGESTIONS

Based on previous data reviews, the inquiry learning model and lesson study activities can improve the critical thinking skills of madrasah students. This was proven by the researcher as the model teacher and the seven lesson study teams as observers applying the inquiry learning model through lesson study activities which were carried out in four lesson study cycles. The researcher chose Madrasah Aliyah Mu'allimat NW Pancor students as research subjects because the school is one of the schools that represents the character of madrasa students in Lombok. After conducting research, it appears that there is an increase in the quality of learning in each cycle where at the beginning of the cycle, the average score from the aspect of student activity, the implementation of learning by the teacher, and the implementation of student group discussions is only in the "good or active" category and the classical completeness score still "< 80%".

After going through several cycles of lesson study, there was a significant increase in all aspects of the assessment so that all aspects of the assessment reached the "very active or very good" category and classical completeness "> 90%". This is not only because the inquiry learning model can improve students' critical thinking skills as has been proven by several previous researchers, but also this increase is reinforced by lesson study activities which provide opportunities for teachers to develop the best lesson plans, implement them accompanied by observers, and can evaluate the implementation of learning with various perspectives of people. The teacher's enthusiasm to continue to improve the quality of learning based on the evaluation results in each cycle with the observer team also plays an important role in the success of this research.

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