The analysis of learning materials implementation using inquiry based learning method to enhance student's critical thinking skills in solving two dimensional problem

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Abstract. Learning materials are the important thing that will support teaching and learning process at school. The existence of a good learning materials will help the students to understand the given subject matter. Mathematics is a subject matter which has a higher level of difficulty than other subjects. So teacher needs the right learning materials when delivering the material. a method that can be used to improve student's understanding related to mathematics learning material, especially the subject of two dimensional is inquiry-based learning. This method emphasize the active participation of students to understand the material provided. Implementing this method in learning materials are expected to develop student's critical thinking skills. Type of this research is mixed method research which combining qualitative and quantitative method. Quantitative methods are used to analyze the types of interval data on student learning outcomes while qualitative methods are used to analyze ordinal data types of student's critical thinking skills. Respondents of this research consisted of one control class and one experimental class consisting of 30 students at 4th grade class in Sawaran Kulon 02 Lumajang Elementary School. Based on the experiment result, control class was obtained 65% of interpretation, 65% of analysis, 59% of evaluation and 52% of inference. Meanwhile, the experimental class was obtained 75% of interpretation, 75% of analysis, 69% of evaluation and 82% of inference. The t-test result of independent sample shows that there is a significant difference between control class and experimental class with a sig (2-tailed) value of 0.00 (p = <0.05). It can be concluded that the implementation of learning materials using inquiry-based learning method can improve the critical thinking of elementary school students.

1. Introduction

By Indonesia's vision towards the rise of golden generation in 2045, education is expected to be more practical and support the achievement of national development goals. In an effort to achieve these goals, the vision of Indonesia gold in 2045 is supported by 4 pillars namely human resource development and mastery of science and technology, sustainable economic development, equitable development and national resilience and governance. In the first pillar, Indonesia will get a demographic bonus in 2030-2035 where as many as 52% of the population of productive age will sustain Indonesia's development so it is necessary to improve the quality of education so as to produce

Indonesian people who are religious, intelligent, productive, reliable and comprehensive through service efforts excellent education [1]. Good education services can make a positive contribution to the change of mindset and help every citizen to be able to have extensive knowledge especially with the development of an all-sophisticated era. In the era of globalization, every society especially elementary school students must be able to adapt and improve their abilities through various activities that exist in the education system in Indonesia. However, there are still various kinds of problems in the basic education system in Indonesia, especially in the framework of the 2045 gold Indonesia, one of which is the low quality of education [2].

The quality of education is determined by various factors. One of them is teacher quality [3]. The teacher quality will reflect the learning process provided. Based on [4] about teachers and lecturers, article number 10 states that the competencies that must be possessed by teachers include pedagogic competencies, personal competencies, social competencies and professional competencies are obtained through professional education. Professional competency is master of subject matter in depth and broadly. So teacher is required to arrange a good, complete and systematic learning materials that students can understand and motivated to participate actively in teaching and learning process.

Learning materials are equipment to support a teaching and learning activities. This material is used for learning process so it can carried out well [5]. The learning material becomes part of learning planning, which is preparing the media and learning materials to achieve the expected learning goals. Learning devices must be designed using appropriate methods in accordance with the character of material to be conveyed so it can help to increase student understanding.

Mathematics is a subject given in elementary school. In mathematics, students are taught to be able to solve the problems given. However, most students have low ability to solve problems related to mathematics. This is due to students difficulty in understanding the purpose of the problem, unable to explore the information provided by the problem [6]. In applying the 2013 curriculum, students are required to develop high order thinking skills starting from elementary school students. So elementary students must be able to understand until the stage of creation [7]. The 2013 curriculum demands that learning material is given to students into metacognitive stage which requires students to be able to predict, design, and estimate. This has been explained in [8], that the dimension of knowledge based on Bloom's Taxonomy is classified as factual, conceptual, procedural, and metacognitive whose mastery needs to start from the level of primary education to secondary education.

Mastery of material by students in mathematics can be supported by the development of learning materials using a scientific approach so that students actively understand and obtain information from various sources not just one direction from the teacher itself. One model that can be used for mathematics learning is inquiry learning (inquiry-based learning). Inquiry learning model is a form of active learning where students are taught to find the information needed independently. This method involves optimally the ability of students to investigate problems systematically, logically, critically so that students can better understand principles and concepts scientifically [9]. In inquiry-based learning, students are involved in a variety of activities that require thought processes such a scientist so they are motivated to produce a scientific development related to problems in more detail and sciencetifically [10]. Based on the previous research [11], it is known that inquiry learning gives a positive contribution to enhance student critical thinking skills. It is proved by the experimental class show a better learning outcome than control class.

One of the students abilities that become a part of the 2013 curriculum is critical thinking skills. Critical thinking skills are the ability of reflective thinking in depth while making a decision and solve the problem to analyze the situations, evaluate arguments, and draw appropriate conclusions. So that this critical thinking ability is related to students' cognitive processes in systematic and specific analysis of the problem so can be obtained information to solve problems [12]. The ability to think critically is important to understand and process information also develop ideas more deeply [13]. The criteria of critical thinking skill based on [14] is shown in Table 1.

Table 1. Criteria of Critical Thinking Skill

Interpretation (%)	Criteria
$81.25 < X \leq 100$	Very High
$71.5 < X \leq 81,25$	High
$62.5 < X \leq 71.5$	Moderate
$43.75 < X < 62.5$	Low
$0 < X \leq 43.75$	Very Low

To support and improve students' critical thinking skills, it is necessary to have good and effective learning methods and materials. This learning materials will be used as a guide by the teacher in directing teaching and learning activities in class so that students are expected to be able to improve their competence and understanding related to mathematics. One of the subjects in elementary mathematics subjects, especially in grade 4, is related to two dimensional problem. The material given in two dimensional subject matter consists of introduction, type, characteristic, circumference and area.

Sawaran Kulon 02 Elementary School is located in Lumajang Regency. This elementary school has 8 teachers with their qualification are bachelor degree. There are 220 students in this elementary school. In learning activities, one teacher has to handle around 30 students, so there are many shortages in transfer knowledge to students. In addition, in teaching and learning process, teachers still using conventional learning method where teacher is still become the main aspect in teaching and learning process (teacher centered learning). Because of that, the understanding of students is lack. For example in 4th grade class, it consist of 30 students and only handled by one teacher, the classroom conditions become less conducive for learning. In addition, the learning materials used have not been updated in accordance with current needs.

In this research, the learning materials that has been develop using inquiry based learning methods will be implemented into 4th grade student to evaluate the impact of it into students' critical thinking skill.

2. Methodology
This research was conducted at Sawaran Kulon 02 Lumajang Elementary School. The experiment used a quasi-experimental method which was conducted into two groups. The subjects in this study were students at 4th grade in 2019/2020 academic year that consist of 2 classes. Testing of learning materials is done by using these 2 classes. Learning materials consist of syllabus, lesson plans, worksheets and assessment instruments for two dimensional problem. The experimental group is 4A class with 30 students and the control group is 4B class with 30 students. The design of this experiment using Pretest-Posttest Control Group Design where before each group's learning was carried out, a pre-test was conducted to determine the students' initial critical thinking skills and after learning process using inquiry based learning materials, a post-test was conducted. Data processing is done by descriptive analysis to describe the learning process and quantitative data to analyze the pretest and posttest values. Quantitative analysis was carried out statistically with analysis of covariance (ancova) using SPSS 20 for Windows.

3. Result and Discussion

3.1. Student Learning Outcomes
Student learning outcomes in this study are indicated by pretest scores for both control class and experimental class. Learning outcomes are obtained from written tests. Student learning outcomes are presented in Table 2. Based on Table 2, it can be seen that the average value of the experimental class and the control class is almost the same where the experimental class is 61.8 while the control class is slightly higher at 62.43.

Furthermore, each class is given by different treatment. In the control class, learning is done by using conventional methods or using the method commonly done by the teacher in the class using the same learning materials. As for the experimental class, learning is done by utilizing learning materials that have been developed using the inquiry based learning method. The learning materials used for the experimental class have been adapted to current conditions and emphasize more on student activity in the classroom. The teacher becomes a facilitator in teaching and learning activities.

Critical thinking skills are measured by a test that involves a pretest that is used to see the initial ability of students while the posttest is used to see the effect of the use of inquiry-based learning materials on student learning outcomes. The average posttest score of students in both the experimental class and the control class is shown in Table 2. The posttest score of the experimental class showed higher that is 74.6 compared to the control class that is 65.33.

Table 2. Posttest and Pretest Score

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test Experiment	30	32	84	61.80	10.701
Post-test Experiment	30	62	90	74.60	5.840
Pre-test Control	30	36	84	62.43	11.047
Post-test Control	30	45	82	65.33	8.293
Valid N (listwise)	30				

Table 3. Normality Test

	Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig	Statistic	df	Sig
Students Learning Outcomes	Pre-test Eksperiment	.126	30	.200*	.953	30	.205
	Post-test Eksperiment	.128	30	.200*	.960	30	.310
	Pre-test Control	.116	30	.200*	.968	30	.478
	Post-test Control	.123	30	.200*	.947	30	.142

*This is a lower bound of the true significance
a. Lilliefors Significance Correction

From the students learning outcomes from both classes, normality test is performed to determine the distribution of student scores which are normally distributed or not. This was done using the Kolmorogonov Smirnov test and Saphiro Wilk test. The results using SPSS 20 for Windows is shown in Table 3. It is shown that the value of sig. for all data is 0.200 higher than 0.05 which means that the existing data is normally distributed. Then the paired t-test was conducted to determine the effect of learning using inquiry-based materials whether have an impact on student learning outcomes. The test results are shown in Table 4. Based on the results, it is known that the result from pretest and posttest conducted in both class have a sig value less than 0.05 which can be concluded that for the experimental class which using inquiry based learning materials has an influence on student learning outcomes. This also happened in the control class. But the increase in value between the two classes is different where the experimental class has a higher posttest score than the posttest score in the control class.

Table 4. Paired t-Test

	Paired Differences					**t**	**df**	**Sig. (2-tailed)**
	Mean	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**				
				Lower	**Upper**			
Pair 1 Pre-test-Experiment Post-test Experiment	-12.800	8.572	1.565	-16.001	-9.599	-8.179	29	.000
Pair 2 Pre-test-Control Post-test Experiment	-2.900	4.700	.858	-4.655	-1.145	-3.379	29	.002

Homogenity test is also needed to test the data whether have uniformity (homogeneous) or diversity (heterogeneous). Based on the homogenity test results in Table 5, it is known that the value of sig. of $0.124 > 0.05$ so that the data are homogeneous. With the data that has a normal distribution and homogeneous, then the indepence sample t-test is done to test whether the values with conventional learning in control class have differences with experimental class using inquiry-based learning materials. From Table 6, it is known that the value of sig. (2-tailed) i.e $0.000 < 0.05$ so that H_0 which stated there is no difference in students 'critical thinking skills in the experimental class and the control class is rejected, means that there is an influence of using inquiry-based learning materials on students' critical thinking skills.

Table 5. Homogenity Test

		Levene Statistic	**df1**	**df2**	**Sig.**
Students Learning Outcomes	Based on Mean	2.430	1	58	.124
	Based on Median	2.339	1	58	.132
	Based on Median and with adjusted df	2.339	1	52.529	.132
	Based on trimmed mean	2.576	1	58	.114

Table 6. Independence Sample t-Test

		Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
									Lower	**Upper**
Students Learning Outcomes	Equal variances assumed	2.430	.124	5.004	58	.000	9.267	1.852	5.560	12.974
	Equal variances not assumed			5.004	52.086	.000	9.267	1.852	5.551	12.983

Based on Ancova test results between the posttest score of the experimental class and the posttest score of the control class, the results obtained are presented in Table 7, which is the value of sig. $0.000 < 0.05$. It means that the experimental class learning outcomes have a significant difference with the learning outcomes of the control class.

Table 7. Ancova Test

Dependent Variable: Post-test Score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1288.067	1	1288.067	25.037	.000
Intercept	293720.067	1	293720.067	5709.291	.000
Class	1288.067	1	1288.067	25.037	.000
Error	2983.867	58	51.446		
Total	297992.000	60			
Corrected Total	4271.933	59			

a.   R squared = .0302 (Adjusted R Squared = .289)

3.2. Critical Thinking Skill

Critical thinking is part of cognitive skills which include interpretation, analysis, evaluation, inference, explanation, and self-regulation. Interpretation is the ability of a person to understand and express the meaning or purpose of various experiences in situations, data, events, decisions, conventions, and trustworthiness of rules, procedures or criteria. Analysis of the ability to identify true intentions and conclusions between statements, questions, concepts, descriptions based on beliefs, decisions, experiences, reasons, information or opinions. Evaluation is the ability to assess the credibility of statements or other presentations by assessing or describing a person's perceptions, experiences, situations, beliefs, decisions and using the logical power of expected inferential relationships or actual inferential relationships between statements, questions, descriptions and other forms of representation. Inference is the ability of students to identify and choose the elements needed to form reasonable conclusions or to form reasonable conclusions or to form hypotheses by paying attention to relevant information and reducing the consequences arising from data, statements, principles, evidence, judgments, opinions, description, statement, belief, and other forms of representation [15].

The results of each indicator of critical thinking skill for both experimental class and control class is shown in Figure 2. From the graph, it is shown that for all indicators (interpretation, analysis, evaluation and inference) of control class are lower than the experimental class. This shows that learning activity using inquiry-based learning materials has a significant influence on students' critical thinking skills because with the implementation of this learning materials, students are required to be more active in finding solutions to problems.
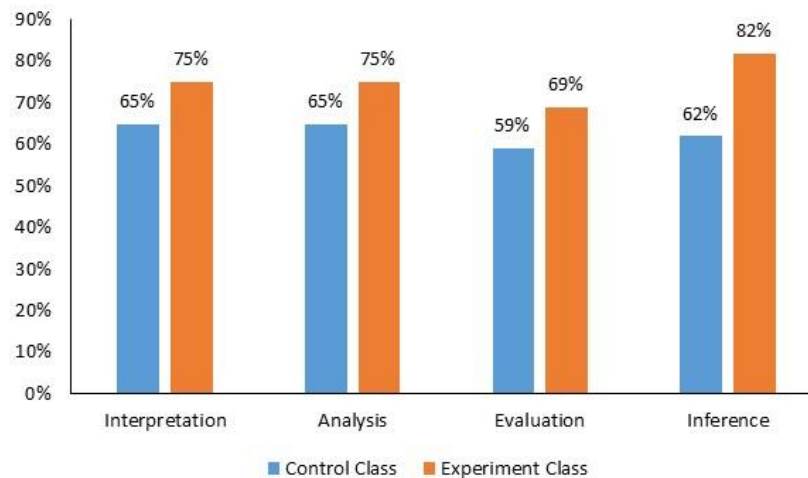
Figure 1. Critical Thinking Skill Indicator

The average of all indicator in control class is 63% while experimental class is 75%. Based on criteria of critical thinking shown in Table 1, the student's critical thinking skill of both control and experimental class shown in Table 8.

Table 8. Criteria of Critical Thinking Skill Indicator

No	Indicator	Percentage (%)		Criteria	
		Control Class	Experimental Class	Control Class	Experimental Class
1	Interpretation	65%	75%	Moderate	Moderate
2	Analysis	65%	75%	Moderate	Moderate
3	Evaluation	59%	69%	Low	Moderate
4	Inference	62%	82%	Low	High

4. Conclusion

The inquiry based learning materials have been created consist of the syllabus, lesson plans, worksheets and assessment instruments and successfully implemented in this research. Based on the result, it can be concluded that inquiry based learning materials for two dimensional problem of 4th grade was valid and can be used to enhance the critical thinking skill of students in Sawaran Kulon 02 Lumajang Elementary School. The experimental class shows better enhancement than control class. It can be suggested that the teacher should become a good facilitator to enhance the student's critical thinking skills and motivated them to improve their participation in the learning activity.

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