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Mathematics, Informatics, Science and Education International Conference (MISEIC) 2018

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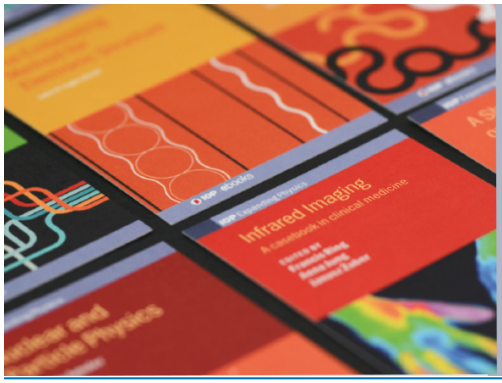

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2nd Mathematics, Informatics, Science and Education International Conference (MISEIC).

PREFACE

The 2nd Mathematics, Informatics, Science and Education International Conference (MISEIC) is organized by Faculty of Mathematics and Natural Sciences Universitas Negeri Surabaya. This international conference aims to bridge the scientists, education experts and practicioners, and students in the scientific forum through sharing ideas and issues about theoretical and practical knowledge in mathematics, informatics, science and STEM education. The theme for this conference is **"Emerging Trends of Research in Mathematics, Informatics, Sciences, and Education"**.

This conference hosted by the Universitas Negeri Surabaya is considered to accommodate discussion among researchers in the field of mathematics, informatics, science and education as a scientific forum. Therefore, the invited speakers in this conference are experts in the field of mathematics, informatics, science and education.

The 2nd MISEIC took place in Surabaya, Indonesia, on 21 July 2018 involving more than 300 papers are participated from various topics including pure and applied mathematics, science and technology innovation, computer science, and innovation in mathematics, science, and computer science education. There are 129 selected papers that go through a strict peer reviewed process, and these papers will be published in the present conference proceedings.

We would like to thank the organizing committee and the members of reviewers for their kind assistance in reviewing the papers. We would also extend our best gratitude to keynote speakers for their invaluable contribution and worthwhile ideas shared in the conference.

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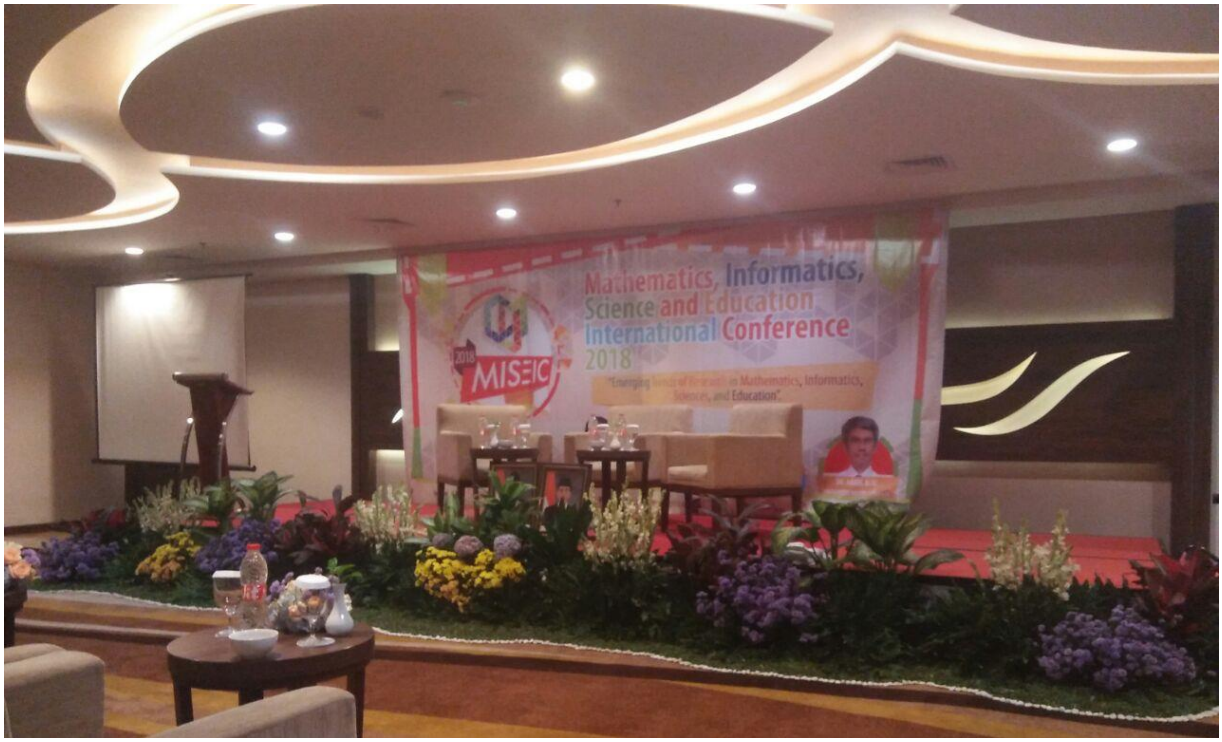


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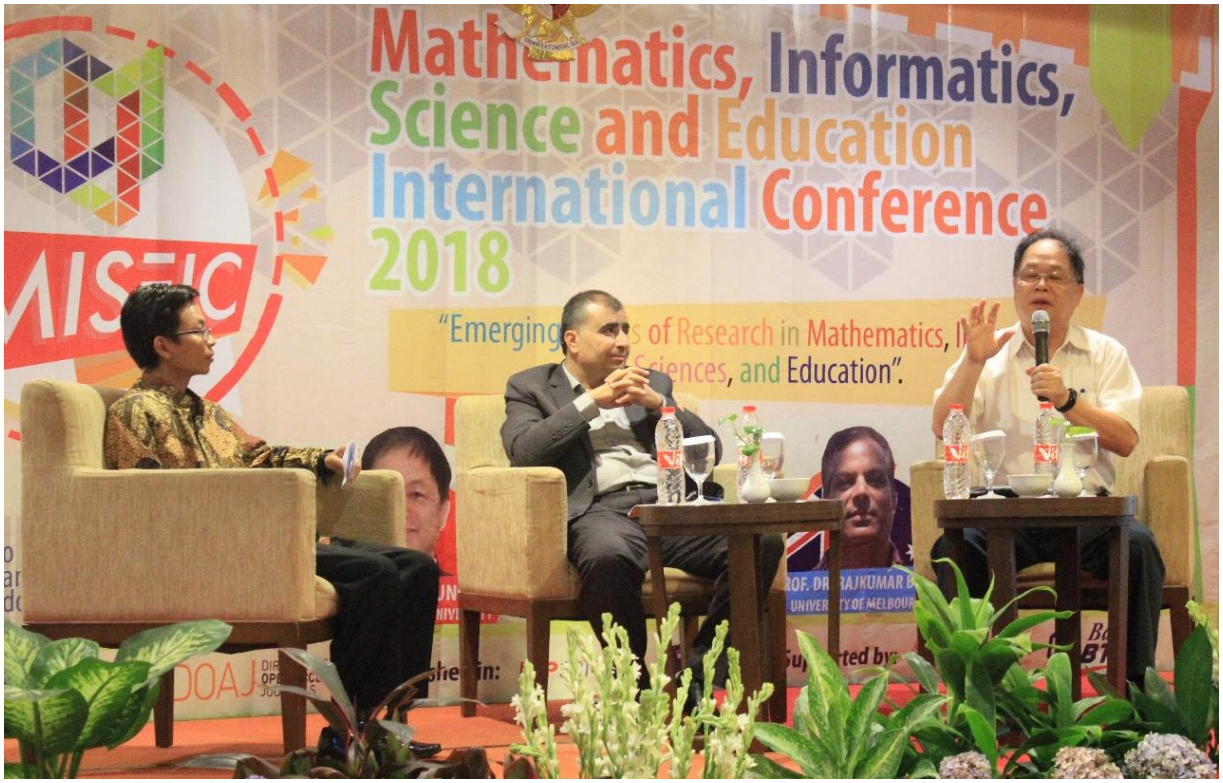
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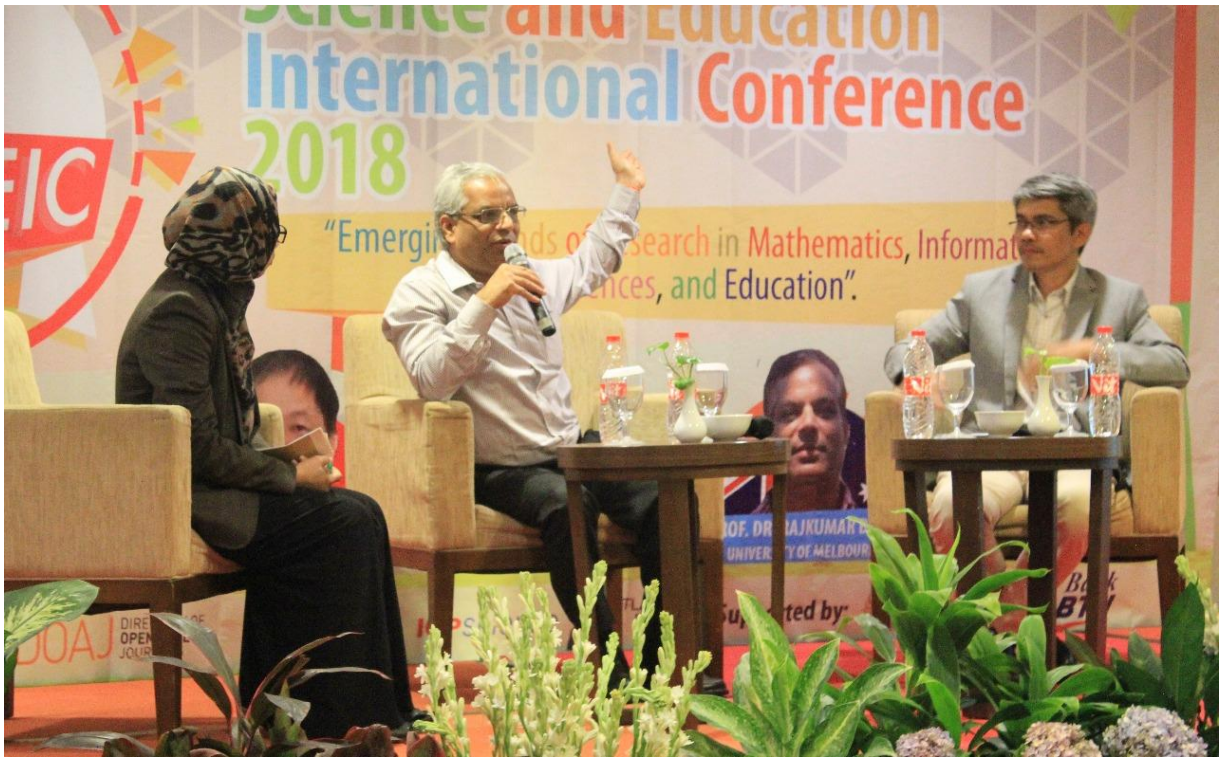
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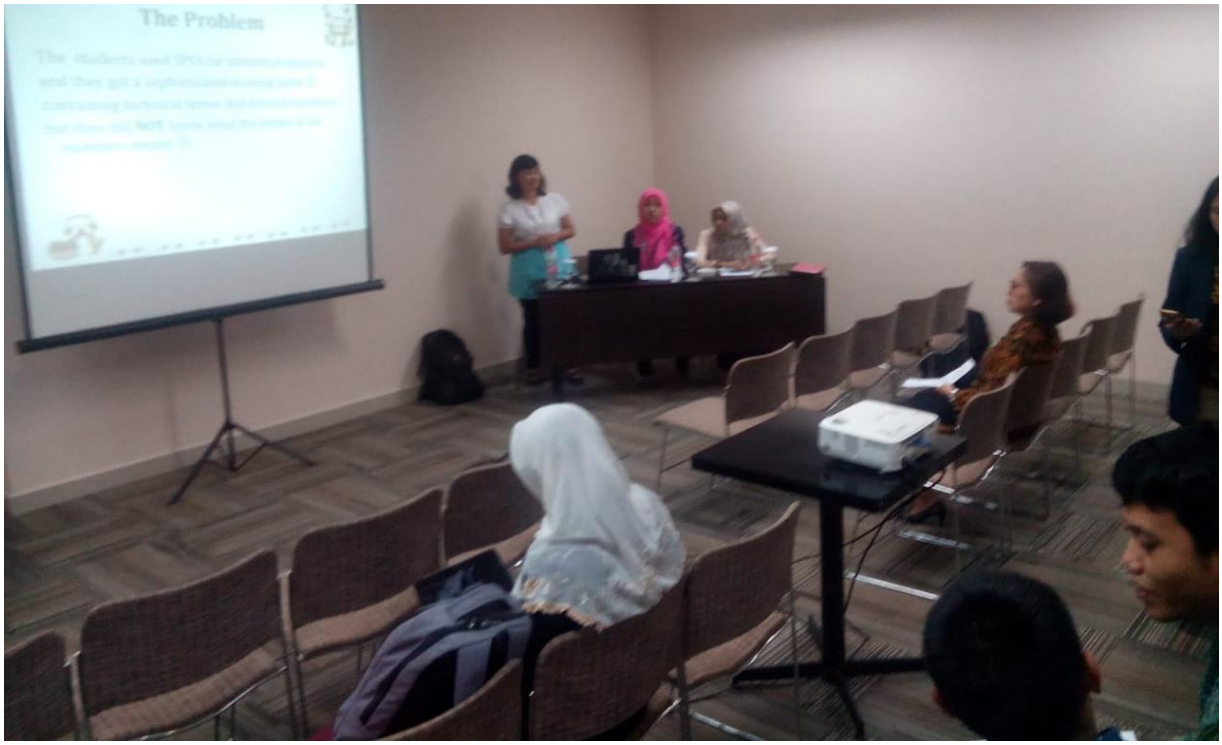
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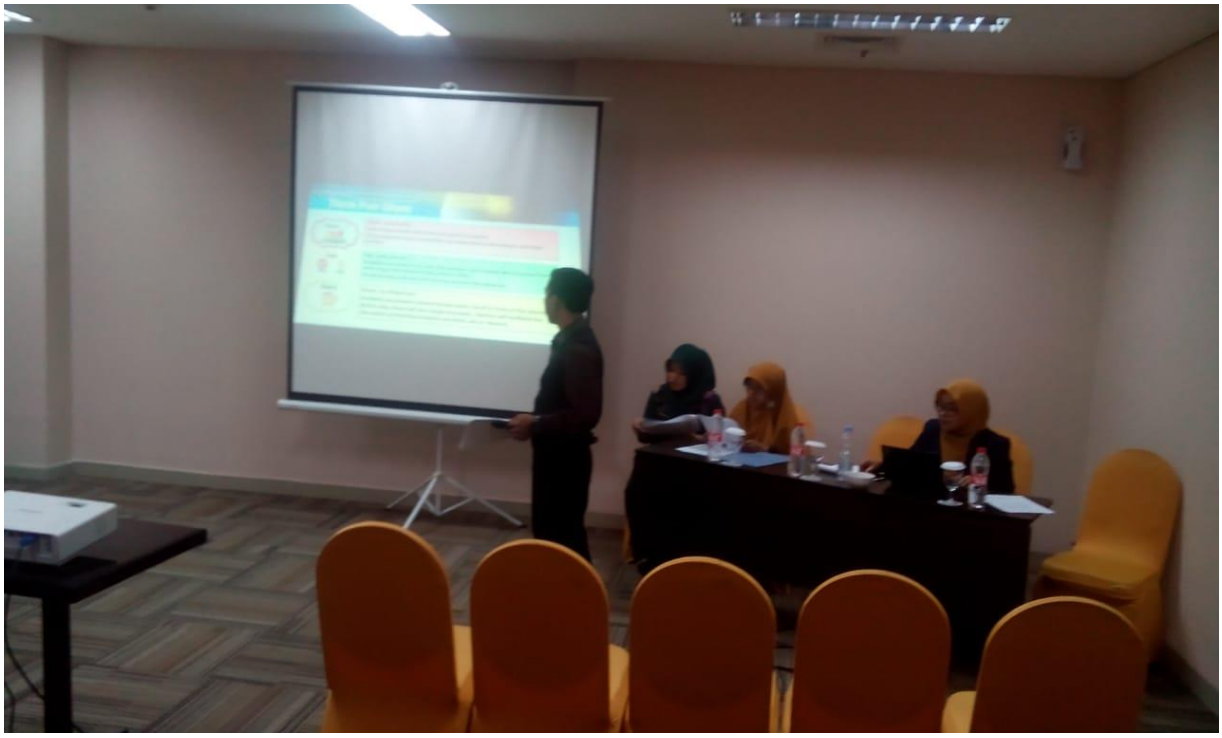

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Suryanti

as Paper Presenter

entitled

Application of Inquiry Learning to Exercise Critical Thinking Skills in Light Material of Elementary School Students

in Mathematics, Informatics, Science, and Education International Conference (MISEIC) 2018
with theme :
"Emerging Trends of Research in Mathematics, Informatics, Science, and Education"

at Best Western Papilio Hotel,
Jl. Jendral Ahmad Yani no. 176-178,
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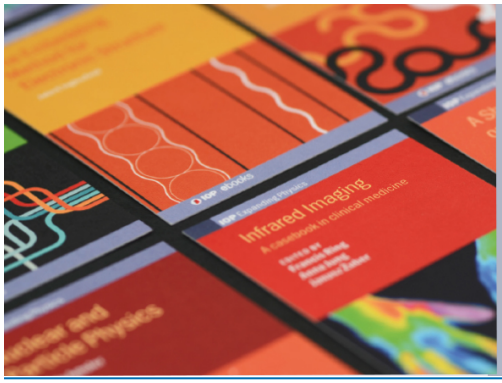

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The Application of Inquiry Learning to Train Critical Thinking Skills on Light Material of Primary School Students

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Abstract. Critical thinking skills are seen as important skills for survival and have become one of Indonesia's educational goals. The results of initial observation of critical thinking skills in Kemangsen 2 primary school involving students of grade V, revealed that 95% students possessed score 2 (with the scale, ranging from 1 to 4). Therefore, critical thinking skills of students need to be improved by applying hands-based learning of Hands on Science; one of which is through inquiry learning. The purpose of this study is to determine the effectiveness of inquiry learning model in trained critical thinking skills of elementary students (n = 22). This research was conducted by One Group *Pretest-Posttest* Design. Data were analyzed using t-dependent tests for overall critical thinking skills and descriptive analysis for critical thinking skills for each indicator. The critical thinking skills trained in this study include evaluation, explanation, interpretation, and inference based on the results of data analysis. To sum up, inquiry learning is classified as effective in terms of training students' critical thinking skills. The critical thinking skills of students should be continuously trained on appropriate materials or topics.

1. Introduction

Critical thinking is seen as an important skill for the survival of the 21st century [1]. The skills to think critically is not only necessary in analyzing the various information but also important in the individual and social aspects [2]. Critical thinking helps to decide about a person's way of life. In everyday life, we need to have high selection skills in dealing with different situations in life [3]. All these capabilities make it possible for greater success at school, at work and at home [4]. The skills to think critically will form a critical attitude is actually meant to invite us to think clearly to help ourselves get the right knowledge and understanding [5].

Critical thinking is seen as an essential skill for 21st century survival and education experts agree that encouraging students to think critically is an essential requirement of the educational system [6]. Rahma [7] critical thinking skills are one of the most important educational goals in all levels of education. Critical thinking skills is unnatural innate in every human being since birth so it can be taught to the students [8]. Critical thinking can be taught, and not just for "talented" students but for all students [9]. The skills to think critically can be improved and developed by way of practice [10]. Students may not be able to think critically when their teachers are unable to integrate sufficient critical thinking into the practice of daily learning [11]. Teachers in this case have an important role in trained skills to think critically to students at every level of education. [12] the skills to think critically should be developed from an early age. In elementary level, critical thinking skills can be taught to fourth, fifth and sixth graders because it is in accordance with students' cognitive development at the

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abstract operational stage [13]. Critical thinking skills is not only a skill that needs to be taught in schools but has become one of the goals of Indonesian education should be trained.

Science is concerned with a systematic way of finding out about nature, so science is not just a collection of knowledge in the form of facts, concepts, or principles but also a process of discovery [14]. Filsaime [15] argues that critical thinking skills are needed in digging and getting to know the science so that students can master the workings taken in studying nature and solving problems related to daily life. Contextual thinking skills are contextual so that their application in science education includes a focus on tasks, problems, and issues that exist in the curriculum that require critical thinking skills [16]. From the above description, it shows that critical thinking skills can be developed on the materials that have been available in the curriculum that have characteristic fit with critical thinking skills.

Critical thinking must go through argumentation, reasoning, and inferences [22]. From the exposition, the trained aspects must contain elements of argumentation (argument evaluation), explanation and inference (inference and interpretation). The critical thinking indicators to be investigated include explanation, interpretation, inference, and evaluating arguments. [23] Inquiry learning is a dynamic learning approach to which involves exploring, asking, making discoveries, and testing discoveries to seek new insights. Hands-on science learning such as inquiry can help students think critically and give students confidence in their skills to solve a problem [17]. Inquiry learning is student center learning [18] to build critical thinking skills, reasoning and subsequent creativity [19]. [20] explaining that inquiry-based learning techniques can encourage students' critical thinking skills. [21] inquiry learning is a dynamic learning approach to which involves exploring, asking, making discoveries, and testing discoveries to seek new insights. The focus of this research is to describe the critical thinking skills in the topic of the properties of light by using learning inquiry mend the skills of critical thinking in students.

2. Methods

The research method used in this research is quasi experiment or Weak Experimental Design, with the basic pattern "The One Group Pretest - Posttest Design" and descriptive method. Subjects in this study are the students of grade V of Kemangsen primary school in the academic year 2014-2015. The subject of the research are 22 students, with 12 male students and 10 female students. Critical thinking skills trained using inquiry learning in light topic. This research was conducted on light material in science teaching by using inquiry model. The scoring criteria used are the modified rubric score from Facione [24] (the solo taxonomic rubric as Table 1 follows).

Table 1. Indicator of Critical Thinking Skill of Student Science through Inquiry Learning.

Indicator	Information	Score
Interpretations	Students can't make interpretations the data provided	0
	Students make interpretations of the data provided but wrong and not in accordance with the context of the problem	1
	Students interpret the data given incorrectly but in accordance with the context of the problem	2
	Students interpret the data given correctly and according to the context of the problem but not complete	3
	Students interpret the data correctly, according to the context of the problem and complete	4
Inference	Did not make any conclusions.	0
	Make inaccurate conclusions and not in accordance with the context of the question.	1
	Make inaccurate conclusions, though tailored to the context of the question.	2
	Make conclusions appropriately, according to context but not complete.	3
	Make conclusions appropriately, contextually and completely	4
Explanation	Did not make any explanation.	0
	Make an inappropriate explanation and not in accordance with the context of the question.	1

Indicator	Information	Score
	Make an inappropriate explanation even if adapted to the context of the question.	2
	Make annotations appropriately, in context but not complete.	3
	Make Explanations appropriately, contextually and exhaustively	4
Evaluate arguments	Do not evaluate arguments from statements given	0
	Provide an evaluation of the arguments of the statements given but are not appropriate and not in accordance with the context of the problem.	1
	Provide an evaluation of the arguments of the statements given incorrectly, even though they are adapted to the context of the problem.	
	Provide an evaluation of the arguments from the statements given correctly, logically but incompletely.	2
	Provide an evaluation of the arguments from the statements given correctly, logically and completely.	3
		4

Data analysis is divided into 2 parts, namely analysis of each indicator of critical thinking skills and analysis of critical thinking skills as a whole. The percentage of critical thinking skills obtained from the calculation is then categorized according to Table 2 below.

Table 2. Category Percentage of Critical Thinking Skills [25].

Interpretations	**Category**
81,25 < X ≤ 100	Very high
71,5 < X . 81,25	High
62,5 < X ≤ 71,5	Medium
43,75 < X . 62,5	Low
0 < X ≤ 43,75	Very Low

Analysis of critical thinking skills as a whole is done by using hypothesis testing using t-test. Before, performing the t-test it is necessary to test the normality to test that the sample data comes from normally distributed populations or not. Normality test used in this study using the Kolmogrov-Smirnov normality test. If the normality test obtained normal distributed data then the data calculation using parametric statistical method that is using test-t dependent sample or Paired t-Test.

3. Results and Discussion

3.1. The result of critical thinking skills of each indicator.

The result of students' critical thinking skills of class V can be known from the evaluation result done at a pretest and a posttest. The result of evaluation of students 'critical thinking skills for each indicator in Table 3 below is done by using descriptive method measured based on the scoring guidance of students' critical thinking skills.

Table 3. Frequency Distribution of Critical Thinking Skill in a Pretest

Indicator	Category	Indicator							
		Interpretations		Inference		Explanation		Evaluate arguments	
		F	%	F	%	f	%	F	%
81,25 < X ≤ 100	Very high	0	0	0	0	0	0	0	0
71,5 < X . 81,25	High	0	0	0	0	0	0	0	0
62,5 < X ≤ 71,5	Medium	0	0	0	0	0	0	0	0
43,75 < X . 62,5	Low	3	13,63	5	28,73	4	18.18	5	28,73
0 < X ≤ 43,75	Very Low	19	86,37	17	72,27	18	81,82	17	72,27
		22	100	22	100	22	100	22	100

Based on Table 3, critical thinking skills each indicator on the pretest of each indicator has a very low and low category. This result indicates that the capacity critical thinking skill student is very low. This was not attributed to the role of teachers who had not yet maximally and sustainable trying to involve the students in the activities of a critical thinking skill can even standard intellectual a basis for the capacity critical thinking skill usually not to be taught in schools. The Frequency Distribution of Critical Thinking Skill in a Posttest is shown in Table 4 below.

Table 4. Frequency Distribution of Critical Thinking Skill in a Posttest

Indicator	Category	Indicator							
		Interpretations		Inference		Explanation		Evaluate arguments	
		F	%	F	%	F	%	F	%
81,25 < X ≤ 100	Very high	16	72,73	17	77,27	18	81,82	14	63,63
71,5 < X . 81,25	High	6	27,27	5	22,73	2	9,10	3	13,63
62,5 < X ≤ 71,5	Medium	0	0	0	0	1	4,54	2	9,10
43,75 < X . 62,5	Low	0	0	0	0	1	4,54	2	9,10
0 < X ≤ 43,75	Very Low	0	0	0	0	0	0	1	4,54
		22	100	22	100	22	100	22	100

Table 4 shows that learning inquiry having a fairly significant effect to train critical thinking skill. One pf the four indicators, indicators evaluate argument having the lower in of appeals that other. Analytical capability this requires a exercise seamless and intellectual level adequate. Learning inquiry to boost the ability of investigation requires students to connect the investigation by scientific knowledge causing the students to uses reasoning scientific and critical thinking in developing concepts on the science. The data of critical thinking skills of each indicator presented in the following table 5.

3.1.1. Indicator 1: Interpretation.

Based on Table 5, it can be seen that there is a significant increase in interpretation skills after inquiry learning. In the phase of collecting and processing student data in demand to be able to do 2 aspects of interpretation are: 1) linking the results of observations and 2) finding the pattern of data relationships in observation. This is in line with the opinion of Carlson [26] which states that inquiry learning applied in the learning process can improve students' skills in making observations and put forward answers to a problem through data interpretation to obtain conclusion. Inquiry learning not only requires students to be able to conduct the investigative process independently, but also requires students to be able to understand the implications of an experimental result. The Percentage of critical thinking skills of each indicator is shown in Table 5 below.

Table 5. Percentage of critical thinking skills of each indicator

Indicator critical thinking skills	Pretest		Posttest	
	Percentage (%)	Category	Percentage (%)	Category
Interpretations	36,36	Very Low	85,27	Very high
Inference	38,59	Very Low	86,37	Very high
Explanation	39,02	Very Low	84,06	Very high
Evaluate arguments	34,45	Very Low	78,02	High

3.1.2. Indicator 2: Inference.

Based on these data it can be concluded that students' critical thinking skills of inference increases significantly after inquiry learning is done on the students. Inference is one of the activities needed in inquiry learning especially in phase IV collecting and processing data. [27] which states

that inquiry learning requires direct experience of inquiry and practice on an ongoing basis so that students are not limited to understanding questions by learning words like "hypothesis" and "inference" or with memorize procedures but students gain a deep understanding of the characteristics of the steps of the scientific method.

3.1.3. Indicator 3: Explain.
Based on the data it can be concluded that the skills Student's critical thinking indicator improved significantly after inquiry learning was conducted on the students. The high critical thinking skills of students in this indicator is not separated from the role of inquiry learning in the fifth phase of presenting the results of the investigation. In this phase students are given the opportunity to explain the results of their inquiry directly by presenting in front of the class or indirectly by using the question, given the opportunity to obtain a meaningful understanding of the concept [27] reveals that the inquiry learning model develops understanding skills.

3.1.4. Indicator 4: Evaluate the argument.
The indicator evaluating the argument is an indicator of critical thinking skills that obtains the lowest percentage of skills compared to other indicators trained in both pretest and posttest. Based on these data it can be concluded that students' critical thinking skills to evaluate arguments increased significantly after inquiry learning was done on the students. The teacher provides some statements or arguments related to the investigation that have been done then the students are instructed to be able to evaluate the given argument whether the argument whether the argument is the 2000 National Research Council (NRC) in Olson and Horsley [27]. Inquiry learning model can train students to build answers and think smartly in finding various alternative solutions to the problems posed by teachers.

3.2 Outcomes of overall critical thinking skills
Overall critical thinking skills were analyzed using N-gain and t-test. In table 6 can be concluded there is improvement of critical thinking skills of student before and after conducting inquiry study. This finding is in line with Estes [28] explaining that inquiry learning is capable of developing critical thinking skills and abilities in science literacy. Martin [29] which states that students who are taught science by using inquiry in primary school can develop literacy skills in science, independent thinking, critical thinking, and problem solving. In improving students' critical thinking skills. The Data Paired Samples Test critical thinking Skill is shown in Table 6 below.

Table 6. Data Paired Samples Test critical thinking Skill.

Paired Samples Test

	Paired Differences					T	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1 pretest – posttest	-46,30591	7,95090	1,69514	-49,83114	-42,78068	-27,317	21	,000

4. Conclusion
Inquiry learning can be used to train students' critical thinking skills. Inquiry learning students will be actively involved in learning both physically and mentally (hands on activity) through experimenting activities, observing, asking, analyzing data, and making conclusions. Student centered inquiry learning has been shown to improve students' critical thinking skills. Critical thinking skills of the students to continue to develop should be to trained critical thinking skill continuously adjusted with the characteristics of learning that one of them using inquiry learning.

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