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Effect of Inquiry Model on Mathematical Critical Thinking Ability of Primary School Students

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Abstract. This study aims to analyze the differences between students' mathematical critical thinking under the model of inquiry learning model and those under the expository model. The experiment was conducted in an elementary school in Sukabumi, academic year 2018/2019. The sample were 42 of fourth graders, which were divided into two groups, namely experiment group and control group. Each group consist of 21 students. This type of research was a quasi-experimental with pretest-posttest control group design. The data were collected by using mathematical critical thinking tests. The data analysis technique used was the difference of means of results of tests from both the experimental group and the control group at the significance level a = 0.05. The results show that there are differences between students' mathematical critical thinking under the inquiry model with those under the expository model. Further analysis show that the students' mathematical critical thinking under the inquiry model is better than those under expository model.

Keywords: Inquiry, Expository, Mathematical Critical Thinking

INTRODUCTION ~ Mathematics courses should be offered to all learners from primary schools to equip students with the ability to think logically, analytical, systematic, critical, and creative, as well as the ability to cooperate. The competence needed so that learners can have the ability to acquire, manage, and use information in order to survive in a state that is always changing, uncertain and competitive. This all requires that we have the ability to think critically and creatively.

So that well-educated people in the future have the ability as stated earlier required education system oriented problem solving, critical thinking, creative, systematic and logical (MONE, 2003). It is very likely appear in mathematics because considering all these capabilities are part of the goal of learning mathematics (MONE, 2003). Therefore math needs to be given to each student since elementary school.

The purpose of learning mathematics in schools by Ministry of Education (2006) are: (1) Understanding the concepts of mathematics, describes the relationship between concepts and apply concepts or algorithms, are flexible, accurate, efficient, and precise, in problem-solving; (2) Using the reasoning in the patterns and nature, perform mathematical manipulation in making generalizations, compile evidence, or explain mathematical ideas and statements; (3) Solve problems that include the ability to understand the problem, devised a mathematical model, solve the model and interpret the obtained solution; (4) Communicate ideas with symbols, tables, diagrams, or other media to clarify the situation or

problem; and (5) Have respect usefulness of mathematics in life, which is curious, attention, and interest in studying mathematics, as well as a tenacious attitude and confidence in solving problems. Thus, mathematics as part of the basic education curriculum, play a strategic role in improving the quality of human resources in Indonesia.

However, facts on the ground have not been in accordance with what is expected. Based on a report by The Trends in International Mathematics and Science Study (TIMSS) reported that for one problem associated with mathematical reasoning only about 7% of Indonesian students sampled able to answer that question. While students from Singapore about 44% were able to answer the same question. In the TIMSS reports in different years, for the same types of problems that only about 17% of Indonesian students into the sample was able to answer, while about 59% of Singapore students. Conclusions from the TIMSS study report, not much different from the PISA (2015) results. Mathematics achievement of students in Indonesian from the PISA Indonesia only ranks 62 out of 70 participants with an average score of 386, while the averages score of 500 (Suhartini & Martyanti, 2017).

Education International is a mathematical one part is to analyze the process of critical thinking mathematically. The importance of teaching and developing critical thinking skills must be seen as something urgent and cannot be underestimated again. Mastery of critical thinking skills are not sufficiently serve as educational purposes only, but also as a fundamental process that enables students to cope with future uncertainties. It is very naive when critical thinking skills are ignored by teachers.

Critical thinking is the human ability of a general nature, which is always used in the daily activity of thinking. What is meant by the ability to think according to this description and are widely used in a variety of research on critical thinking mathematically comparing, contrasting, making conjectures, using inductive reasoning, to generalize, making a specialty, classify, to categorize, using deductive reasoning, using visualization, sort (ordering), stringing (sequencing), predict, validate, demonstrate, connect, analyze, evaluate, and look for patterns.

Krulik and Rudnick (NCTM, 1999) that included critical thinking in mathematics is thought that tested, questioned, connect and evaluate all aspects that exist in a situation or a problem. For example, when a person is reading a text or listening to a mathematical explanation of the mathematical expressions or she should be trying to understand and trying to find or detect the presence of things

that are special and the need or importance. Likewise, from a data or information he will be able to make conclusions that are true at the same time see a contradiction or whether there is consistency or discrepancies in the information. So the critical thinking that people analyze and reflect on the results of thinking. Of course necessary to have a clear observation and exploration activity, and the inquiry in order to collect accurate information that makes it easy to see whether or not there is an order or something striking. In short, someone who thinks critically always be sensitive to the information or situation at hand, and tend to react to situations or information. Teachers should not ignore the students' critical thinking skills.

Given the very central role in the process of improving the quality of human resources, the efforts to improve mathematics learning process, especially at the primary level, there should be continued. This effort is very important given the lack of results achieved in the national evaluation of mathematics, indicates that the quality of the students' understanding of mathematics is still low.

Accordance with Armanto (2002) Conventional mathematics learning activities are usually centered on the teacher, using the lecture method (chalk-and-talk), students are passive, questions from students rarely appear, oriented in the correct answer, and class activities are dominated by activities recorded or copied. The learning activities like this do not accommodate the development of students' skills in problem solving, reasoning, connections and mathematical communication. As a result, high-level cognitive abilities of students are very weak because they are accustomed to be trained to think a low level.

To answer the above problems, the government, in this cases the Department of Education and Culture, the recent renovations of the school curriculum. Changes were made not only in the restructuring substance being studied mathematics, yet very fundamental is the paradigm shift of how teachers teach to how students learn. Learning is no longer regarded as the transfer of knowledge to be stored in the memory system of students through repeated practice and construct their knowledge based on the prior knowledge.

Student learning outcomes are often associated with how many students are able to memorize the material, which was then poured in workmanship matter and measured by value. Students are easy to memorize then it will get a good value, and vice versa. The usual tests only measure students' cognitive ability and ignore affective and psychomotor abilities. Based on the experience of the test results indicate that there are still

some students who have not completed KKM (75) so that they have to make improvements so that they reach KKM value.

In connection with the ability of teachers to enable students, of course, begins with the ability in designing the learning of the various aspects and forms a system that leads to the activation of the students find their own facts and concepts, so that learning is effective. At this stage specified learning objectives to be achieved, tools and learning resources are needed, as well as learning scenarios was going to do to achieve those goals.

Therefore, a teacher in providing learning must prepare carefully and pay attention to various conditions of the students, the ability and intelligence of students, so the teacher does not see students as objects that accept whatever is given by the teacher. Usually teachers convey information about the learning material in the form of verbal explanation and narrative, known as lectures, speeches, and lecture.

According to Milyawati (2014) learning is a process that resulted in the change of potential or actual behavior and relative permanently as a result of training and experience. While learning activity is an activity of interaction between educators and learners with learning resources in a learning environment. In learning activities students are required activeness. Active in question is an active student asked, questioning, ideas and actively engaged in learning activities, because learning is an active process of the students in building their knowledge. Thus, if learning does not give students the chance to play an active role, then the learning is contrary to the nature of learning.

In learning activities of students not only required but also creativity activeness, because creativity in learning to create a new situation, not monotonous and interesting so that students will be more engaged in learning activities. In the wake flat comprehensive learning students often find it difficult to learn, but it is not yet meaningful student learning, so that students' understanding of the concept is wrong. As a result, student achievement, both nationally and internationally has not been encouraging. Poor performance of students caused by factors that are having problems comprehensively or partially. While the teacher who served as the manager of learning are often not able to convey the subject matter to the students was significantly reduced, and delivery is also monotonous without regard to the potential and creativity of the students so that students feel bored because students are only considered as empty bottles ready to be filled with the subject matter. This shows that in broad flat wake learning teachers should use a variety of learning methods and adapted to the conditions of students so

that students better understand the material presented and the students more memorable by learning that has been delivered and the students will remember and do not easily forget things learned.

According to Psychology Bruner (Bruner, 1966) learning will be more meaningful and more quickly achieve the goal if it starts from the stage of concrete (enactive), which uses the object indeed, then semi-concrete (econic) the object replaced the image, and the last abstract (symbolic) the grain only in the form of the emblem / symbol the only form of letters only, or numbers only. According to Bruner if students experience math learning for each topic is treated as the third stage, the students will be able to develop knowledge far beyond what they receive from the teacher. In connection with this, the teacher was instrumental in encouraging the optimal learning process so that students learn actively. In order to maximize the learning process and learning outcomes of mathematics, teachers should encourage students to engage actively in discussions, ask and answer questions, think critically, explains each answer given and give reasons for any proposed answer.

In connection with the problems, it can be affirmed that the learning process improvement efforts through the efforts of the appropriate model selection and innovative learning in mathematics in elementary school is a very important requirement to do. One model of learning that allegedly can be used to improve the quality of the process and result of learning is inquiry learning model. Inquiry model is a series of learning activities that emphasize the process of thinking critically and analytically to seek and find their own answers to be sure of a problem in question (Sanjaya, 2009). The thinking process itself is usually done through a question and answer between teachers and students.

Thinking involves two main aspects namely critical and creative. Thinking occurs in every human mental activity that serves to formulate or solve problems, make decisions, and seek understanding. Through think humans were able to obtain the meaning or understanding of each case that it faces in life. The main activity of the thinking done in a conscious state, although it is possible with regard to something that is acquired unconsciously. Although the activity of thinking occurs personally and individually, but in reality is not an isolated activity. Activities are closely related to factors or other parties who interact. Thus, the activity of thinking it is actually closely related to the social context, and influenced by cultural and environmental aspects. As a result, learned thinking cannot occur optimally in an isolated situation of the other party or the environment.

In the process of learning to think, Piaget (in Fisher, 1995) suggests the following three factors: (1) the need to pay attention to why a child to think a certain way, (2) keep in mind that thinks it is doing and thus is an active process, and (3) the need for children to conduct exploration on certain key concepts that can reveal their full potential.

According to Abdullah, et. All. (2012) the process of thinking strategy is an important factor to make learning to think. Because it is a deeper discussion about the views and the results of a study in this respect need to be disclosed further. One view suggested by psychologists such as Fisher conveyed is that the human brain is a place or part of the process of information or idea (idealist processing).

The theory of critical thinking is rooted in the concept of Benjamin Bloom on the classification of thinking in the cognitive domains (Bloom, 1969). Bloom classify the behavior learned in 6 levels starting from memory focused on recitation and facts to evaluation requires a high level thinking, hereinafter known as Bloom's taxonomy. Critical thinking occurs when students think on the zone-evaluation analysis of Bloom's Taxonomy. In this mental zone students are required to process information related to the problems faced among them by thinking activities such as classify, categorize, combine, test, construct, formulating, debating, justify, and conclude.

Based on the above concepts, learning to think critically view that learning is not just a transfer of knowledge from teacher to student, but more than that, learning is an activity that allows students to build their own knowledge.

Based on the opinions of the above, it can be concluded that a person's critical thinking with the main features: (1) resolving a problem with a specific purpose, (2) analyze, generalize, organize ideas based on facts / information, and (3) draw conclusions in a systematic way to resolve the issue with the correct arguments.

One part in learning mathematics is to analyze the process of critical thinking mathematically. This is consistent with the goal of school mathematics learning. Critical thinking is a very common human capabilities so that it touches almost every activity of everyday thinking.

Based on the synthesis of the results of relevant research, critical thinking is defined as a process to effectively use thinking skills that can help a person create, evaluate, and take a decision.

According to Ennis (in Costa, 1985), critical thinking, there are two components, namely the disposition and ability, which can be considered as the nature and characteristics of critical thinking. Furthermore, according to

Langrehr (2006), to train students' critical thinking should be encouraged to answer the questions relating to the following matters: (1) determine the consequences of a decision or an event; (2) Identify the assumptions used in a statement; (3) Formulating the problem issues; (4) Finding a bias based on a different angle; (5) Disclose the cause of an event; (6) Choose factors that support the decision.

The view that mathematics is a science that is arranged in a structured include elements that are not defined, elements that are defined, postulate and theorem or postulate, a static view because it does not involve the process. A dynamic view of mathematics put forward by Schoenfeld (in Henningsen & Stein, 1997), namely that mathematics is an active and generative processes performed by actors and users of mathematics. The active mathematical process contains the systematic use of mathematical tools to find patterns, frame the problem, and establish a process of reasoning. The process that no other is the foundation for developing the ability to think critically and creatively.

Henningsen & Stein (1997) uses the term to think and reason mathematically high level (high-level mathematical thinking) for high-level mathematical thinking. He described the activities of high-level mathematical thinking and reasoning as mathematical activity (doing mathematics) are active, dynamic and exploratory. Dynamic task is characterized by activities such as: search and find patterns to understand the structure and mathematical relationships; using resources and tools to effectively formulate and solve problems; understand the idea of mathematics; mathematical thinking and reasoning like, generalize, using inference rules, make conjectures, reasoning, communicating mathematical ideas and to set or check whether the results obtained or answer math makes sense. Due to the high level of mathematical thinking as described above, then the task of mathematics (mathematical task) in the process of learning to be a very important part. In other words, the mathematical task is a means to promote critical thinking, logical, rational and systematic.So that it can be achieved, it is necessary to design a mathematical learning process that requires critical thinking skills. One is through the implementation of inquiry learning model.

Gulo (in Trianto, 2009) said inquiry means a series of learning activities that involve maximally throughout the student's ability to search and investigate in a systematic, critical, logical, analytical, so that they can formulate their own findings with aplomb. The main target is the inquiry learning activities (1) The maximum

student involvement in the process of learning; (2) directional activities logically and systematically on the learning objectives; and (3) develop confidence in students about what was found in the proceedings.

Referring to Piaget's (in Fisher, 1995) stages of cognitive development, the child at the time of primary school age is in the concrete operational step lasting approximately 7- 11 years of age. At this stage, logical thinking replaces intuitive thinking. The concept initially vague and unclear is now becoming concrete. Children are able to think rationally and logically perform certain activities, although it is still limited to concrete objects and in concrete situations. Kids have been able to demonstrate the conversion skills, classification, addition, subtraction, and several other capabilities that are needed in the children learn basic skills in school.

According to Camenzuli and Buhagiar (2014) implemented of inquiry model learning in classroom can affected to good students interpersonal, social face emotional, and behavioral difficulties. In particular mathematical learning, the students have to understand the concepts and then mastered the concept. in order to more effective mathematical learning. Efforts can be more effective in learning mathematics is to apply the inquiry model in solving difficult problems in doing individually, so that the difficulties will be solved together. And by using this model of inquiry learning students are more active in the process of gaining knowledge, not just listening to the teacher. Students also learn to listen and respect the opinions of others, especially the opinion of their peers in the learning process. Furthermore, Asnidar et. Al. (2018) inquiry model learning model effectively implemented for mathematical learning. The research showing that inquiry based learning supports student's learning of mathematics and leads to the improvement of students' learning achievement.

Model inquiry learning emphasizes the process of searching and finding. The subject matter is not given directly. The role of students in this is to find and locate the subject matter, while teachers act as facilitators and mentors students to learn. So expect the inquiry model of learning can affect students' mathematical ability of critical thinking. This is in line with research conducted Duran, et. al. (2016) showed that the students able to get the better of critical thinking with their inquiry learning treatment.

According background of the above, the research question was "Is there any difference students' mathematical critical thinking under inquiry model and those under expository model?"

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METHOD

The design research was a quasi experiment is a pretest-posttest control group design. The sample were 42 fourth graders of a Elemtary School in Sukabumi, which were divided into two groups, where 21 students as experimental and 21 students as control (Sugiono, 2015)

Data analysis techniques used in this research was the analysis of quantitative data using statistical techniques based on the assessment results pretest and post-test in both study groups.

RESULTS

Data of students' critical under inquiry and those under expositoryare as follows.

Table 1. Students' Mathematical Critical Thinking Under Inquiry

Count of Data	21
Average	78.29
Standard Deviation	5.86
Minimum Value	70.00
Maximum Value	90.00

Table 2. Students' Mathematical Critical Thinking Under Expository

Count of Data	21
Average	68.05
Standard Deviation	6.26
Minimum Value	55.00
Maximum Value	78.00

Based on the above data, students' mathematical critical thinking under inquiry got average score as 78.29 with the standard deviation as 5.86; whereas those under expository got average score as 68,05 with standard deviation as 6,26.

Based on the above data, if it is classified in the Benchmark Reference Rate (PAP) the average score of students' mathematical critical thinking under the inquiry at 78.29. Meanwhile, those under expository is relatively lower at 68.05. This fact indicates that the achievement of students' mathematical critical thinking under inquiry gives better results than thoseunder expository.

Based on mean analysis using the Mann-Whitney test in Table 3, the valueis at 31.5 and significance p-value of 0.000. By using a significance level a = 0,05. Due to the significant p-value of 0.000 is smaller than the significance level used is 0.05. H0 which states that "there are significant differences

between students' mathematical critical thinking inquiry model and those under expository model", was rejected. In other words, the alternative hypothesis (Ha) states that "there are significant differences between students' mathematical critical thinking under inquiry model with those under expository model" was accepted. This means that there are differences in the enhancement of mathematical critical thinking bentween students who study mathematics under inquiry model with those under expository model.

Table 3. Mean Testing

KELAS	N	Mean Rank	Sum of Ranks
Expository	21	12.5	262.5
Inquiry	21	30.5	640.5
Total	42		

Table 4. Test Statistics[a]

	Value
Mann-Whitney U	31.5
Wilcoxon W	262.5
Z	-4.791
Asymp. Sig.(2-tailed) *p-value*	0.000

CONCLUSION

The conclusion obtained in this study is that there is difference between students' mathematical critical thinking learn under inquiry model and those under expository model. Further analysis show that the students' mathematical critical thinking of students under inquiry model is better than those under expository model. Based on these results, it can be recommended to readers that the study should be followed by further study to answer why the inquiry model give more benefit to students rather than expository model.

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