MATHEMATICAL CRITICAL THINKING ABILITY THROUGH CONTEXTUAL TEACHING AND LEARNING APPROACH

Kurniati[1], Yaya S. Kusumah[2], Jozua Sabandar[2], Tatang Herman[2]

[1]Pakuan University, Jl. Pakuan PO Box 452 Bogor 16143 Indonesia
[2]Indonesia Education University, Jl. Dr. Setiabudi No. 229 Bandung 40154
e-mail: kurniati_unpak@yahoo.com

Abstract

This research aimed to examine the effect of the application of contextual teaching and learning (CTL) approach to the enhance of mathematical critical thinking ability (MCTA) of Primary School Teacher Students (PSTS). This research is an experimental study with the population of all students PSTS who took algebra subject matter of one university in the city of Bogor. The results showed: (1) the increase of MCTA of student who receive CTL better than students who receive TTL; (2) There are differences in the increase MCTA between students in groups of high MPA, medium MPA, and low MPA, both the student who received the CTL and TTL; and (3) There is no interaction between learning factors (CTL and TTL) with MPA (high, medium and low) toward the enhance of MCTA.

Keywords: Critical Thinking Ability in Mathematics, Contextual Teaching and Learning Approach, Prior Mathematical Ability

Abstrak

Penelitian ini bertujuan untuk mengkaji pengaruh penerapan pendekatan pembelajaran kontestual terhadap peningkatan kemampuan berpikir kritis matematis (MCTA) mahasiswa Pendidikan Guru Sekolah dasar (PGSD). Penelitian ini adalah penelitian eksperimen dengan populasi seluruh mahasiswa PGSD yang mengambil Mata Kuliah Aljabar pada suatu universitas swasta di Kota Bogor. Hasil penelitian menunjukkan bahwa: (1) Peningkatan MCTA mahasiswa yang memperoleh CTL lebih baik daripada mahasiswa yang memperoleh TTL; (2) Terdapat perbedaam peningkatan MCTA pada kelompok KAM tinggi, KAM sedang dan KAM rendah, baik pada mahasiswa yang memperoleh CTL maupun TTL; dan (3) Tidak terdapat interaksi antara faktor pembelajaran (CTL dan TTL) dengan KAM (tinggi, sedang, dan rendah) dalam mencapai peningkatan MCTA.

Kata Kunci: Kemampuan Berpikir Kritis Matematis, Pembelajaran Kontekstual, Kemampuan Awal Mahasiswa.

Mathematical thinking skills are essential given to students ranging from the beginning of its development, especially when the child was in elementary school. Mathematical skills required so that learners can think logically. Mathematics needs to be mastered elementary school students to help digest the sciences in higher education (Wimbarti, 2012). The statement means that the most important thing was learning mathematics at the elementary level because it occurs early during the development of cognitive abilities in students. Early cognitive development of learners in mathematics will affect further development of mathematical thinking and mastery of subjects affecting the others. Thus, mathematics education in primary schools should be able to provide the basic mathematical thinking skills in order to develop the critical thinking skills of learners. Given the

importance of the role of mathematics education in primary schools in developing critical thinking skills mathematically, the role of mathematics in primary school teachers to be very meaningful. Thus by elementary school teachers can be built basic high-level mathematical thinking skills in learners. This is in line with the opinion Ruseffendi (2006, p. 1) that one of the factors that influence the success of students in learning is the ability possessed by the teacher. Until now, the ability of elementary school teachers in Indonesia is still cause for concern. As one indication of the low ability of teachers indicated from the results of the Initial Competency Test (ICT) which was first held as a condition in following The Education and Training of Professional Teacher (ETPT) in 2012. Known that the average value of ICT about 40 for all materials tested (Modul Pendidikan dan Latihan Profesi Guru Rayon 135, 2012). Based on preliminary research conducted on teachers ETPT Rayon 35 participants in 2012, the majority of primary school teachers assume that mathematics problems are the most difficult questions are found in the matter of ICT.

Mathematics problems in ICT included into the matter of the type of problem solving that are considered difficult by elementary school teachers because they are not a matter of routine problems that can be solved only by using a formula that is already known, but must use mathematical thinking skills higher, such as analysis, synthesis and evaluation. Mathematics problems that are considered difficult by participants are questions concerning patterns of reasoning in mathematics, to determine the extent, converting the unit of length, area, weight and volume, and a matter of comparison. As one example of reasoning about ICT is similar to the question: determine the sum of $1 + 2 + 4 + 6 + ... + 200$. Required to resolve this issue on sequence pattern formation capabilities to do with the way the investigation. Conditions such as these indicate that elementary school teachers in Indonesia have not been used to solve the problems in a problem-solving type. The teachers just used to finish and make the routine questions that will be given to the learners in primary schools. Therefore, the critical thinking skills of primary school teachers are not trained. As a result, the ability of critical thinking mathematically elementary school teachers is low.

Teachers in mathematical reasoning difficulties occur because teachers do not have experience in conducting investigations (inquiry). This fact is very ironic, considering the elementary school curriculum requires that teachers are able to use contextual learning approach to learning in the classroom. In contextual learning, inquiry is one important principle, because through inquiry activities of learners are expected to construct their own knowledge (constructivism). As the founder of the ability to think critically mathematical learners, primary school teachers should have the ability to think critically and creatively in order to develop both the ability of the learners. The low critical thinking skills and creative teachers in primary schools thought to be one factor that causes low critical thinking skills and creative learners Indonesia.

As known based on the research Programme for International Students Assessment (PISA) in 2006 showed that the mathematical ability of Indonesian students is 391 (Munger, 2012) and the results of the study Trends in International Mathematics and Science Study (TIMSS) in 2007 showed

that the average score Indonesian students only 397, in 2011 decreased to 386 on a scale of 500 international average (Mullis, Martin, and Arora, 2012).

Improving mathematical critical thinking skills of mathematical teachers in primary schools can be done by training the critical thinking skills during the student teachers enrolled in college. Should, mathematical critical thinking skills possessed by teachers before implementing learning in elementary school. One way that is expected to improve the ability of critical thinking mathematically is to implement contextual learning mathematics. In contextual learning mathematics, there are several principles that could be expected to develop critical thinking skills mathematical student teachers. Some principles of contextual learning can increase students'critical thinking skills are mathematical principle: constructivism, inquiry, questioning, learning community, modeling, reflection and the authentic assessment.

Application of the principles of constructivism in learning requires learners to be able to construct their own knowledge. This knowledge is built through real experience with how to solve problems, find something and grow ideas. The ability to solve problems, discover, and grow the ideas included in the critical thinking mathematically skills.

Application of the method of inquiry is expected to develop the ability of inquiry (inquiry) on the learner. Capabilities include the ability to investigate in mathematics: identify problems, make predictions, formulate hypotheses (search for solving strategies), tested the hypothesis (carry-solving strategies), check back solving, look for other alternative solutions and develop theory (conclusion). Thus, investigation of the activities require higher order thinking skills such as the ability: analysis, synthesis, evaluation, and problem solving, as well as generalization. These abilities include the ability of critical thinking mathematically.

The principle of contextual learning that can enhance of mathematical critical thinking skills is questioning. Activities undertaken by educators ask is to encourage, guide and assess the thinking skills of learners. Open questions can teach learners to give an answer that requires the ability to think critically. The learning community principle encourage for students to learn and learning activities in a community. An understanding of the formation of knowledge can be gained through sharing ideas among learners, from those already familiar to learners who do not understand. In order to make sharing ideas, learners must master the concepts, analyze, synthesize and evaluate the issues being discussed. Therefore, the principle of learning communities can enhance the ability of critical thinking mathematically.

Principles of modeling in contextual learning requires the provision of examples that can be done by educators, learners or experts should come to class. To be a model of the necessary ability to master concepts, demonstrate skills and concepts communicating a procedure smoothly. It is therefore necessary mathematical critical thinking skills.

The principle of contextual learning requires reflection on the activity of thinking about what students have learned or that have been conducted to determine what is good and what needs to be

fixed. Reflective thinking requires high mathematical critical thinking skills such as analysis, synthesis and evaluation to find the other alternative mathematical problem solving. Thus, the application of the principle of reflection is expected to develop critical thinking skills mathematically.

Authentic assesment principle in contextual learning requires educators to collect data about student learning progress to determine whether learners experiencing learning process in earnest. The assessment was conducted covering all activities undertaken learners during the learning process, such as: tasks, projects, discussions, presentations, quizzes, pretest and posttest. Such activities require the ability to think mathematically low and high, including the ability of critical thinking mathematically.

Based on these descriptions, contextual learning in theory can increase the ability to think critically mathematical student. Therefore, it is necessary to do research on the application of contextual learning in student teachers to prove these guess.

The research was conducted on two groups with different treatments. The first group is the group that obtaining contextual learning approach, while the second group is the group that received conventional learning approaches. In the first group, elementary school student teachers acquire contextual learning approach. In the early stages of the study, the group using guided inquiry methods that matter (in the form of contextual questions) given by educators and students are given guidance during the inquiry process, further intervention educator reduced (modified method of inquiry), namely by reducing the guidance during the inquiry although questions remain given by educators. At the end of the free inquiry method used, that is a matter made by students and educators provide little guidance. In the second group, learners acquire conventional learning.

Based on the study has been described previously, contextual learning approach can increase students'critical thinking skills mathematically elementary school teacher candidates better than the conventional learning approaches. Research on the improvement of students'critical thinking skills mathematical education of primary school teachers have done. The results of the study were then written in the form of a report titled the article "The Enhancement Mathematical Critical Thinking Ability of Primary School Teacher Students through Contextual Teaching and Learning Approach".

METHOD

This study is a experimental with design pretest-postest control group (Ruseffendi, 2005) described as follows:

A	O	X	O
A	O		O

Information:

A: The selection of a random sample of classes at population

X: The application of Contextual Teaching and Learning (CTL)

O: MCTA test (pretest-postest).

The research sample is determined by the cluster random sampling technique (Ruseffendi, 2005) in students of Primary School Teacher Students (PSTS) who took algebra subject matter of one university in the city of Bogor. The sample consist of 70 students who devided as two groups. The first group consist 30 students as the experimental group, while the second group consist 40 students as the control group. The experimental group was given a contextual teaching and learning (CTL), while the control group was given traditional teaching and learning (TTL). Every goups are given the same pretest and postest.

The instrument used in this study are: (1) Mathematical Prior Ability Test (MPA Test), (2) pretest and posttest of Mathematical Critical Thinking Ability (MCTA), (3) instruction observation sheet, and (4) the guideline for interview.

MPA test is a test that aims to measure the ability of students before the beginning of learning. MPA test contains questions about the concepts of integers and operations on integers as a prerequisite to follow the material will be provided. MPA test results are used to classify students into groups of students with high ability, medium and low.

Pretest and posttest of Mathematical Critical Thinking Ability (MCTA) is a test that is intended to measure students'critical thinking skills. Mathematical critical thinking skills are abilities that include the ability to perform the analysis, synthesis, evaluation, and problem solving. Pretest used prior learning, while the posttest used after learning. Problem MCTA a pretest and posttest questions containing the equivalent concepts: linear equations and quadratic equations, linear inequalities and quadratic inequalities, sequences and series arithmetic, geometric sequence and series.

RESULTS AND DISCUSSION

Enhancement in Overall MCTA

Results of the normality test on the data MCTA pretest and posttest using the Kolmogorov-Smirnov note that the data are not normally distributed experimental groups. Thus, to determine the difference in the average value of the experimental group and the control group at pretest and at posttest using a nonparametric test, the Mann-Whitney test. Based on the similarity of the two trials against average pretest MCTA using the Mann-Whitney test is known that the average value of the experimental group did not differ from the average value of the control group at the 0.05 significance level. The average value of posttest MCTA shown in Table 1.

Table 1. Pretest Average Value of MCTA for Experiment Group and Control Group

Type of Ability	Group	
	Experiments (n=30)	Control (n=40)
The average pretest value ($\bar{x}$)	2.333	2.450
Standard Deviation (s)	1.709	1.738
Ideal Maximum Score	100	100

Given that the similarity of the two test results mean pretest MCTA between the two groups showed no difference in average values, to compare MCTA improvement between the two groups, then test the equality of two average on posttest results MCTA. Results of Mann-Whitney test to post-test shows that there is a difference average MCTA posttest values between the two groups at the 0.05 significance level to be reviewed as a whole. The average value MCTA posttest experimental group was higher than the control group as shown in Table 2.

Table 2. Posttest Average Value of MCTA for Experiment Group and Control Group

Type of Ability	Group	
	Experiments (n=30)	Control (n=40)
The average pretest value ($\bar{x}$)	34.000	26.875
Standard Deviation (s)	14.557	11.277
Ideal Maximum Score	100	100

Increased MCTA Be Reviewed by MPA

Based on the post-test data analysis using two-way ANOVA with interactions obtained an average value for the group posttest MPA high, medium and low in the experimental group and the control group, as presented in Table 3.

In Table 3 it is shown that there are significant differences in the average value of MCTA between students with high MPA, medium MPA and low MPA. This means that the MPA factors affect MCTA. MCTA for high MPA group of students who received CTL better than high MPA group of students who get a TTL. The same thing is true for the medium MPA group of students, the increase of MCTA for students who receive CTL better than the group of students who received TTL. Similarly, the low MPA group, MCTA students who received CTL learning have a better than low MPA group of students who received TTL.

Table 3. Postes Average Value of MCTA by MPA

MPA	Learning	
	Contextual	Traditional
High	50.313	37.045
	s = 13.591	s = 7.401
Medium	30.000	26.806
	s = 10.377	s = 9.541
Low	24.688	16.818
	s = 7.611	s = 7.833
Ideal Maximum Value	100	100

Interaction between learning approach with MPA based on testing using two-way ANOVA with interaction in mind that there is no interaction between the factors of the learning approach with MPA as can be seen in the Table 4.

Table 4. Results of Treatment Value Average Postes MCTA by MPA

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
LEARNING	1059.388	1	1059.388	11.675	0.001
MPA	5116.341	2	2558.170	28.192	0.000
LEARNING * MPA	298.902	2	149.451	1.647	0.201
Error	5807.371	64	90.740		
Total	74675.000	70			
R Squared = 0 .515 (Adjusted R Squared = 0.477)					

The results of calculations using two-way ANOVA with interactions presented in Table 4 show that the learning factor and MPA factors significantly influence the increase MCTA. Note also that there is no interaction between the factors given learning approach with students to MPA factor. Figure 1 shows that the gain of average value of high MPA group of student who obtained CTL learning higher than the average value for high MPA group of students who obtained the TTL, the gain of average medium MPA group of students who obtain CTL higher than the group of medium MPA group of student who received TTL learning, as well as the gain of average value of a group of low MPA group of student who obtained CTL learning higher than the low MPA group of students who obtained the TTL.

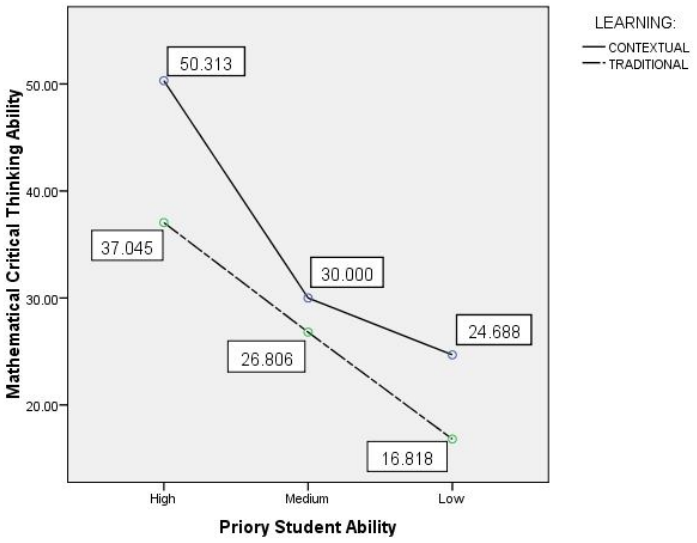

Figure 1. Interaction Between Learning And Priory Student Ability To MCTA

Improved Classification of MCTA

Based on the calculation of the gain on the acquisition of the average normalized values obtained results as shown in the Table 5.

Table 5. Classification Acquisition Gain Average Value normalized <g> on MCTA

INDICATOR	CTL		TTL	
	Gain Value	Classification	Gain Value	Classification
Analysis	0,37	Medium	0,12	Low
Synthesis	0,671	Medium	0,514	Medium
Evaluation	0,04	Low	0,129	Low
Problem Solving	0,24	Low	0,173	Low
Average	0,33	Medium	0,234	Low

The results of an analysis of the increase in the indicator MCTA using the average value of the normalized gain shows that students who obtain a category of CTL have better enhancement in the indicator analysis abilities. Students who receive CTL have a medium classification, but than the students who earn TTL has a low classification.

At indicators synthesis and problem-solving abilities, students who receive CTL has a gain value higher than the value of the learning gains of students who earn ordinary. Even, the both of ability have the same classification for student of group who obtain CTL and student of group who receive TTL. Only the indicator of the ability of the evaluation, a group of students who obtain CTL

did not show a better ability than the group of students who received TTL. As whole, students who receive CTL in medium category, while students who receive regular lessons will be in the low category.

The facts show that the increase of MCTA in students who received CTL better than students who obtain TTL can be caused by the application of the principles of the CTL. One of the principles that play a role in the formation of MCTA is the principle of inquiry. The results are consistent with the opinion of Suchman (in Bell, 1978, h.6) which suggests that inquiry learning can develop cognitive skills. This is supported also by the opinion Schafersman (1991) that critical thinking can be obtained by thinking correctly that is thought to use the scientific method. In this study, the methods used to conduct an inquiry into inquiry learning models that are applied to the CTL on the scientific method.

Besides inquiry principles, principles that led to students who obtain CTL better than students who received TTL is the principle of learning communities, in accordance with the opinion of Vygotsky (in Komalasari, 2010, p. 22) that the formation/development of social interaction that occurs as better than individually.

These results are also consistent with the theory of free discovery learning of Bruner (Komalasari, 2010, h.21) which means that the learning process will go well and creatively if educators provide opportunities for learners to find a concept, theory, rule by example which can be found in life, as embodied in the principles of constructivism on the CTL.

CONCLUSIONS AND SUGGESTION

Based on the analysis, findings and discussions that have been described in the previous section, it is concluded as follows increasing student MCTA CTL obtain significantly better than students who obtain the TTL as a whole, the gain of average value of high MPA group of student who obtained CTL learning higher than the average value for high MPA group of students who obtained the TTL. The same result for the gain average medium and low MPA group of students, there is no interaction between factors of learning with the students of the MPA factors for MCTA, the increase in the average value MCTA students who obtain CTL medium acategory, whereas students who obtain TTL is low.

Based on the results of research and analysis has been conducted on the research results, the suggestions of the results of this study are contextual learning in order to be used as one approach used at the college level to improve student teachers MCTA and research on the application of CTL in improving the ability of high-level mathematical thinking such as problem solving, reasoning, communication, and connection to the student teachers need to be investigated.

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