

Where Exactly for Enhance Critical and Creative Thinking: The Use of Problem Posing or Contextual Learning

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Keywords: Critical Thinking, Creative Thinking, problem posing, contextual learning.

Abstract: Critical and creative thinking are the two essential competencies of the four competencies required in the 21st century. However, both are still difficult to achieve well by students due to lack of training during the course of mathematics learning. This study was conducted to determine what model of learning is appropriate to develop students' critical and creative thinking skills. The study used three class samples from class VIII. First class is given problem posing lesson, second class is given contextual learning and third class as control class. The results of the study indicate that improving students' critical and creative thinking skills are included in the moderate category for classes using contextual and contextual classroom posing problems. In addition, it is also found that contextual learning is more effective for improving critical thinking skills when compared with learning posing and exposure problems. Meanwhile, learning problem posing is more effective to improve creative thinking skills compared with contextual and expository learning.

1 INTRODUCTION

Critical and creative thinking is very important for students in school and life going forward. Thinking of this is necessary to face the 21st century (Center. Pacific Policy Research, 2010; Koetzsch, 1997), as the objective of mathematics learning (Mahmuzah, 2015), analyzing problems and synthesizing (McCormick, Clark and Raines, 2015), make decisions and make judgments (Paul and Linda, 2006). Both are essential for solving everyday problems (Apino and Retnawati, 2017).

Results of the 2015 TIMSS Review show Indonesian students are still weak in the content and cognitive domains of mathematics. In line with the findings of Indah Nurul Faizah and Budi Murtiyasa which states that UN questions are still minimal in the domain of cognitive reasoning such as generalize and justify (Faizah, Budi and M., 2017). Lack of linkage between creativity in the curriculum and creativity taught by teachers (Aizikovitsh-Udi and Diana, 2015), Feeling less ready to teach creativity (Mullet *et al.*, 2016).

The various notions of critical thinking are presented by experts and researchers. Trend and skills to engage in activities with reflective skepticism (McPeck, 2016). A rational-reflective

thinking to decide what to believe or do (Ennis, 2015), a metacognitive process involving analysis, evaluation, and inference (Dwyer, Hogan and Stewart, 2014).

In this study, the critical thinking that we use is adopting from Ennis with 4 indicators: 1) formulating the main issues, 2) analyzing arguments, 3) determining the strategy, and 4) concluding.

Creative thinking refers to Torrance containing 4 cognitive processes, fluency, flexibility, authenticity, and elaboration (Almeida *et al.*, 2008), stated creative thinking contained innovative creativity (fluency, originality), and adaptive creativity (flexibility, the abstractness of titles, and Resistance to Premature Closure).

In this study, the creative thinking that we use is adopted from Torrance with 4 aspects: 1) fluency, 2) flexibility, 3) originality, and 4) elaboration.

Various efforts were made by teachers and researchers to develop students' critical and creative thinking in mathematics learning. Problem posing is central to the nature of mathematical thinking (Silver and Cai, 1996). Strategies for questions asked by teachers in discussions and play roles in real-life problem solving very well for developing critical thinking (Abrami *et al.*, 2015). Problem-based learning affects the students' mathematical thinking

skills (Widyatiningtyas *et al.*, 2015). At the same time, Rifaatul Mahmuzah suggests Problem Posing as an alternative to improving critical thinking (Mahmuzah, 2015). State the importance of effective learning so students become critical thinkers and how students learn effectively, the role of students, teachers and the context in teaching critical thinking. In line with the traditional paradigm shift and the transfer of information toward constructivism of student activities for more meaningful learning (Bonney and Sternberg, 2016). If the teacher consistently and systematically encourages critical thinking in their class by applying mathematics to real-life problems, encouraging debate, and planning investigative lessons, students tend to practice critical thinking skills and develop critical thinking languages (Aizikovitsh-Udi and Diana, 2015).

Creative thinking can be developed through problem posing and problem-solving (Suastika and Wahyuningtyas, 2017), MEAs with realistic problems (Wessels, 2014).

According to Ranak Lince revealed that NHT is more suitable to enhance students' creative thinking mathematically (Lince, 2016). Apino and Retnawati suggest the importance of providing a variety of non-routine issues that enable students to practice asking "why and How" (Apino and Retnawati, 2017). Huang, Ricci, and Mamikon Mnatsakanian suggested that Students be taught how to: identify the steps; evaluate; choose a troubleshooting strategy; identify possible conclusions; choosing logical conclusions; explains how solutions are obtained; and shows how the solution can be applied to wider mathematical problems (Huang, Ricci and Mnatsakanian, 2016). The importance of student and context analysis, the setting of learning objectives, differences in strategy development or assessment techniques in designing learning steps on problem-based learning approaches to develop students' critical and creative thinking (Birgili, 2015).

Another approach that teachers can use as an effort to optimize students' critical and creative thinking skills is a contextual approach called Contextual Teaching Learning (CTL). Contextual Teaching and Learning (CTL) is a learning strategy that emphasizes the full process of student involvement in order to find the material learned and relate it to real life situations that encourage students to apply it in their lives (Sanjaya, 2006). Johnson that in Contextual Teaching and Learning (CTL) requires a more empowering approach to students in the hope that students are able to construct knowledge in their minds rather than memorizing facts (Johnson, 2002).

This study uses learning posing and contextual problems given to students with the aim of developing critical thinking (analyzing arguments, being able to ask, able, answering questions, solving problems, determining strategies and making conclusions) and thinking creatively (thinking fluently, thinking flexible, thinking original, and detailed thinking) students.

2 METHODS

The quantitative approach is done by quasi-experimental method (Campbell and Stanley, 2015) with Nonequivalent Control Group Design (Bryk and Weisberg, 1977) in sample 3 class VIII MTs N 1 Cirebon-Indonesia. This research was conducted to see the learning of the mathematical problem of posing and contextual in improving critical and creative thinking skill.

2.1 Procedure

The research procedure is done through the determination of 3 class samples, where 2 classes are given treatment and 1 class as a control. Class 1 is treated by learning problem posing, second class is given contextual learning treatment, and third class is controlled by traditional learning. Prior learning was given preliminary tests with students' critical and creative thinking skills for the three groups.

Implementation of learning problem posing for experiment class 1 refers to pre-positioning posing activity (Leonard, 2017) with the learning stages adopting Mathematical education research. While contextual learning for experimental class 2 refers to Elaine B Johnson which describes the stages of Contextual Teaching Learning with student activity and teacher activity (Johnson, 2002). while the control class is given expository learning.

After the implementation of the learning, each group is given a final test related to students' critical and creative thinking skills related to the topic of the circle in accordance with the competencies contained in the 2013 curriculum at the topic of the circle and their parts.

2.2 Data Collection

The technique of data collecting using description test which amounted to 9 item, where 5 items about which to measure a student's critical thinking ability and 4 remaining matter to measure student's creative thinking ability. The test will be done before

(pretest) and after learning (postest) in experiment and control class. both of tests have similar indicators, but are different in the question The scoring to calculate the results of the description test is by using Holistic Scoring Rubrics criteria (Mertler, 2001).

Critical thinking tests using instruments with indicators cover four aspects (Ennis, 2013), details of this including at the table below;

Table 1: Instrument of critical thinking

Aspects	Indicator
analyzing arguments	Determining a problem and identify reasons that match the question
formulating problems	Digging information by asking and answering through various alternative answers to solve a problem
determining strategies	Determining an alternative action that is possible to solve the problem
concluding	the giving a meaningful idea

Examples of pretest and post for determining strategies can be seen in the following figure 1 and 2 below;

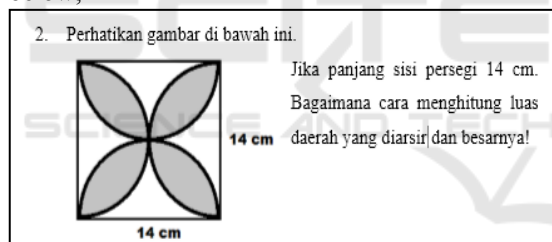


Figure 1: Sample Pre-test of critical thinking

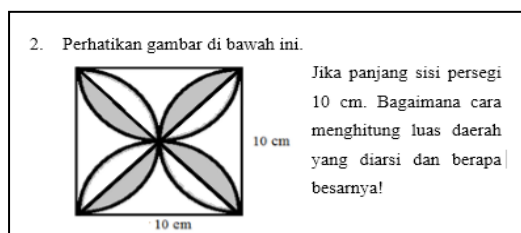


Figure 2: Sample Post-test of critical thinking.

The creative thinking test uses instruments with indicators, including: 1) fluency, 2) flexibility, 3) originality, and 4) elaboration (Torrance, 1972), details of this including at the table below;

Table 2: Instrument of creative thinking

Aspects	Indicator
Fluency	Students can provide relevant ideas to solve problems
Flexibility	Students can express various ways or approaches to a problem
Originality	Students can provide unique answers to solve problems
Elaboration	Students Able to develop ideas or ideas and explain in detail the problems resolved so that they are more interesting

Examples of pretest and post for elaboration can be seen in the following figure 1 and 2 below;

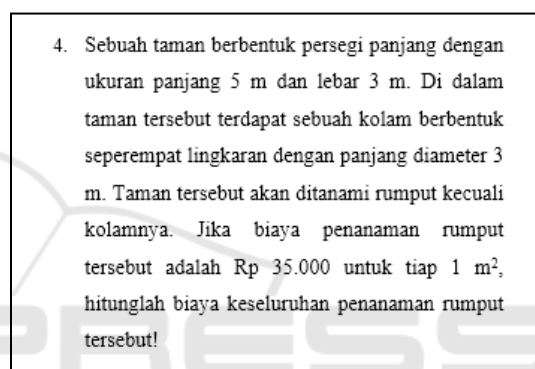


Figure 3: Sample Pre-test of Creative thinking

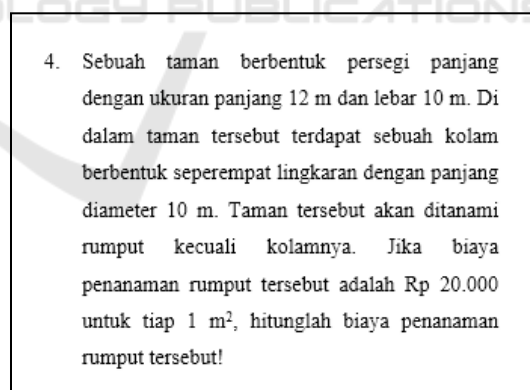


Figure 4: Sample Post-test of Creative thinking

This instrument is analysed in advance to see the validity, reliability, indices of difficulty (easy and middle) and distinguishing power (good and very good) previously tested by experts.

2.3 Data Analysis Technique

Data analysis techniques used to describe the learning approach (problem posing, contextual, and expository approach) in terms of students' critical and creative thinking ability include normality test by using Kolmogorov Smirnov test, homogeneity test, and N-gain calculation for both thinking variables (Creswell and Creswell, 2017). To test the hypothesis done through One Way ANOVA (Kim and Kohout, 1975). which compares the N-gain of critical and creative thinking to the three groups. Data analysis is continued by using the Scheffe Test to determine which variable is better. All data analysis is done by using SPSS software version 20.

3 RESULTS AND DISCUSSION

Overall, the critical and creative thinking for the three groups can be presented in the following table;

Table 3 : Mean value of creative and critical Thinking

	Critical Thinking		Creative Thinking	
	Pretes	Postest	Pretes	Postest
Eks. 1	38,82	77,37	35,36	79,44
Eks. 2	37,57	77,30	35,47	75,17
Control	36,25	65,14	33,85	63,19

The data in table 3 shows all groups have an average increase from pretest to posttest. This increase occurs in students' critical and creative thinking skills in mathematics, especially with regard to the topic of circle and their parts.

To achieve the intended objectives in this study, the research findings will be presented in 3 sections, namely: the difference in the increase of critical and creative thinking, the best improvement of critical thinking, and the best improvement of students' creative thinking.

3.1 Differences in Improving the Critical and Creative Thinking Skills of Students

The students' critical and creative thinking skills improved in the medium category as measured by N-gain. This increase is experienced by all students in experimental 1 (Problem Posing), experiment 2 (Contextual Problem), and the control group. However, the N-gain value varies for both capabilities and the three groups as shown in table 2 below.

Table 4: N-gain value of students' critical and creative thinking skills

Class	N-Gain		Interpretation	
	Critical	Creative	Critical	Creative
Exp. 1	0,63	0,68	Moderate	Moderate
Exp. 2	0,64	0,61	Moderate	Moderate
Control	0,45	0,44	Moderate	Moderate

The data in Table 4 shows that the N-gain of experimental group 1 (who studied with probing problem) and experiment 2 (who studied contextually) were greater than the control group either critical thinking or creative thinking in mathematics. For critical thinking, the n-gain value of the posing's problem group is greater than the contextual group. Conversely, n-gain creative thinking posing problem groups are lower than contextual groups. Although, all of treatment give as same as criteria about n-gain.

The involvement of students in learning posing and contextual problems is the cause of the development of critical thinking (Abrami *et al.*, 2015; Widyatiningtyas *et al.*, 2015) and creative students (Ayllón, Gómez and Ballesta-Claver, 2015). The existence of mathematical problems presented in learning posing and contextual problems make learning more meaningful (Yen and Halili, 2015).

3.2 The Differences in Increasing Critical Thinking

To answer the second question, first analysis used by anova. The differences in critical thinking between groups can be seen in Table 5 below;

Table 5: Anova the ability of creative thinking

	Sum of Squares	df	Mean Square	F	Sig
Between Groups	1,127	2	,564	22,128	,000
Within Groups	2,751	108	,025		
Total	3,879	110			

Furthermore, we founded significant differences in students' critical thinking skills between classes in the learning process using problem posing, contextual problem and expository approaches. The

analysis used Scheffe test which is 95% significant level to know the difference of significance at treatment. The output results of this analysis can be seen as follows:

Table 6: Scheffe test of critical thinking skill

Multiple Comparisons						
Dependent Variable: Learning approaches Scheffe						
(I) Learn . App.	(J) Learn. App.	Mean Diff. (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Exp. 1	Exp. 2	-,00753	,0335	,975	-,090	,0756
	Exp. 3	,15240*	,0338	,000	,0686	,2362
Exp. 2	Exp. 1	,00753	,0335	,975	-,075	,0907
	Exp. 3	,15994*	,0340	,000	,0756	,2442
Exp. 3	Exp. 1	-,15240*	,0338	,000	-,236	-,068
	Exp. 2	-,15994*	,0340	,000	-,244	-,076

Table 6 shows significant differences in students' critical thinking skills between classes using problem posing approaches (Experiments 1) and those using a contextual approach (Experiment 2) with a class using an expository learning approach. However, there is no significant difference in students' critical thinking skills between classes using the problem-posing approach (Experiment 1) with those using the contextual approach (Experiment 2). Nonetheless, classes that acquire a contextual learning approach are better than classes using problem posing approaches the inability of critical thinking.

Real issues related to the student's daily life in contextual learning trigger student activities to identify and analyze information logically, find solutions and present them argumentatively. Discussions of small groups and large groups trigger them to argue with each other and reasoning that train them to be more critical. As Sanjaya and Hassoubah argue that Contextual Teaching and Learning (CTL) is a learning strategy that emphasizes the full process of student involvement in order to find the material learned and relate it to real life situations that encourage students to be able to apply it in their lives, to empower students with the hope that students are able to construct knowledge in their minds, rather than memorizing facts (Sanjaya, 2006; Paul and Linda, 2006).

This is in line with what suggests, Bonney and Sternberg state the importance of effective learning so that students become critical thinkers and how students learn effectively, the roles of students,

teachers and the context in critical thinking teaching (Bonney and Sternberg, 2016). Contextual learning is a constructivism approach to student activity for more meaningful learning (Yen and Halili, 2015).

The students who learn through contextual have excellent abilities in identifying, formulating things that are known and asked correctly and the results of calculations are correct. However, the aspect of determining the strategy for problem-solving is less systematically and logically even though the results are correct.

The aspects of critical thinking to analyze and conclude are good. They can identify 5 to 6 elements contained in a circle. They were able to provide a good explanation of the results from the right calculations, although in concluding there were still a few mistakes.

3.3 Differences in Enhancing Creative Thinking

Differences in creative thinking between groups can be seen in table 5 below.

Table 7: Anova the ability of creative thinking

	Sum of Squares	df	Mean Square	f	Sig.
Between Groups	1,127	2	,564	22,128	,000
Within Groups	2,751	108	,025		
Total	3,879	110			

Table 7 shows that there is a significant difference in students' creative thinking ability between classes which in their learning process use posing, contextual and expository approaches.

The next analysis used Scheffe test which is 95% significant level to know the difference of significance at treatment.

Table 8, shows significant differences in students' creative thinking ability between classes using problem posing approach (Experiment 1) and using contextual approach (Experiment 2) with a class using an expository learning approach. However, there is no significant difference in students' creative thinking ability between classes using the problem-posing approach (Experiment 1) with those using the contextual approach (Experiment 2). Nonetheless, the class that acquired the problem-posing learning approach is better than the class using the contextual approach in ability of creative thinking.

Tabel 8: Scheffé test-the ability of creative thinking

Multiple Comparisons						
Dependent Variable: Learning approaches Scheffe						
(I) Learn. appr.	(J) Learn.a ppr.s	Mean Differen ce (I-J)	Std. Erro r	Sig.	95% Confidence Interval	
					Low er Boun d	Upp er Boun d
Exp. 1	Exp. 2	,068	,0369	,189	-,0237	,1593
	Exp. 3	,240*	,0371	,000	-,1482	,3325
Exp. 2	Exp. 1	-,068	,0369	,189	-,1593	,0237
	Exp. 3	,173*	,0374	,000	,0798	,2653
Exp. 3	Exp. 1	-,240*	,0371	,000	-,3325	-,1482
	Exp. 2	-,173*	,0374	,000	-,2653	-,0798

*. The mean difference is significant at the 0.05 level.

This findings reinforce the results of Ayllón's, Gómez and Ballesta-Claver research, who argue that posing problems can develop students' creative thinking (Ayllón, Gómez and Ballesta-Claver, 2015), supporting also the results of Silver and Cai's research that posing problems are at the core of mathematical thinking, a problem that implies students train to ask " why and how "through a variety of problems, so students have various ways, arguments, alternatives in identifying ways to solve problems at hand (Silver and Cai, 1996).

The exercises to make sub-questions from the main problem make them accustomed to finding ideas, ideas in finding alternative solutions. Students are also trained to complete their ideas so that they are triggered to find new ideas or strategies for finding more effective solutions. Sharing ideas in posing problems is an important medium in finding new ideas and revised old ideas.

Students who learn through problem posing have excellent abilities in aspects of flexibility and elaboration. This is characterized by the ability to provide answers in more than one way, the calculation process and the results are correct, and resolve problems accompanied by reasons or explanations in detail correctly and the results are correct.

4 CONCLUSION

Based on the results and discussions conducted in this study can be concluded that learning posing and contextual problems more effectively used to improve the ability of critical thinking and creative

thinking of students compared with expository learning. Problem posing learning enables the development of creative thinking better than contextual learning. In line with the findings that learning problem posing and problem-solving can develop creative thinking (Ayllón, Gómez and Ballesta-Claver, 2015). Conversely, contextual learning is more instrumental in developing students' critical thinking than learning problem posing. In parallel with the traditional paradigm shift and the transfer of information toward constructivism from student activities for more meaningful learning (Yen and Halili, 2015).

Critical and creative thinking can be improved through thinking exercises during the learning process (Bostic, Pape and Jacobbe, 2016). This practice of thinking will be formed through the context of problems that are close to their lives, questions that have many ways to be solved.

To provide opportunities for them to share ideas or opinion, give one or two trigger questions by the teacher when they are deadlocked. Teachers should make instruction how to talk or use talk to ask questions, to explain their thinking, to analyze and solve problems, explore and evaluate ideas, argue, reason and justify (Gillies, 2016).

5 RECOMENDATIONS

Furthermore, the study needs to be done to see which aspects of critical thinking and creative thinking can be developed through learning of posing and contextual problems. In addition, the study also needs to be done through a mix method approach to obtain more complete data again. Innovations in learning posing and contextual problems by utilizing technology and collaboration with other subjects need to be done in order to comprehensively the students can develop specially to face the century 21 ahead. Teachers can implement this method for any topic in mathematics. Further studies can be conducted to identify 21st-century character quality through contextual learning and problem posing.

ACKNOWLEDGEMENTS

The authors wish to thank Faculty of Tarbiyah and Teacher Science (FITK) IAIN Syekh Nurjati Cirebon-Indonesia.

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