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The Effectiveness Of Pbl On Mathematical Creative Thinking Skills And Self-Esteem Of Junior High School Students

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Abstract

This study aims to describe: (1) the effectiveness of problem-based learning (PBL) on mathematical creative thinking skill and self-esteem; and (2) the comparison in the effectiveness between problem-based learning and conventional learning on mathematical creative thinking skill and self-esteem. This study was a quasi-experiment. The data were collected through a mathematical creative thinking skill tests and student's self-esteem questionnaire. The data were analyzed descriptively and statistically. The statistic tests were used test on one proportion and tests on two proportion. The results of the study that at the significance level of 5%, it can be inferred that (1) problem-based learning is effective on mathematical creative thinking skill, but it is not effective on self-esteem; and (2) problem-based learning is more effective than conventional learning on mathematical creative thinking skill and self-esteem.
Keyword: creative thinking, self-esteem, problem-based learning

1. Background

The problems faced by a person will become more complex as the development of age and social environment. In order to survive, one needs to have the ability to think critically and creatively, because by having this capability it will be easier to face the problem and solve it. The ability to think critically and creatively allows one to study the problems systematically, face various challenges in an organized way, formulating innovative questions, and designing original solutions (Johnson, 2002, p. 100). In addition, think critically and creatively can develop one's self in making decisions or giving an assessment of the case so he/she can solve the problem (Hassoubah, 2008, p.13).

Despite having the ability to think critically and creatively is very important, in fact both of these skill are not well mastered by Indonesian students. This can be seen in the results of the TIMSS 2011 on the domain cognitive that are presented in Table 1 below.

Table 1. Mean Percentage of Correct Answer of Indonesian Students Compared With International Students on Domain Cognitive in TIMSS 2011

Aspect of Domain Cognitive	Mean Percentage of Correct Answer (%)	
	Indonesian	Internasional
Knowledge	31	49
Aplication	23	39
Reasoning	17	30

Source: Mullis, et al. (2012, p.462)

Based on Table 1, it appears that the ability of Indonesian students is the lowest in reasoning. Average of correct answers on students' reasoning abilities Indonesian students is only 17% or 13% lower than average of International students. In addition, the reasoning ability of International students are also lower than knowledge and application.

The fact of the TIMSS 2011 result on domain cognitive that reasoning still weak can indicate that creative thinking skill still weak. This is because according to Krulik & Rudnick (1995, p.2) reasoning include basic thinking, critical thinking, and creative thinking. Therefore, the results of the TIMSS 2011 can be used as the basis that creative thinking skill of eight grade students require special attention.

The weakness of student's mathematical creative thinking skill can be caused by several factors. One of them is the learning process. Learning mathematics is expected to engage students actively and facilitate students to be able to use his creative abilities. According to Johnson (2002, p.100-101) students are given the opportunity to exercise the capacity to think, will be formed a habit to be able to distinguish between true and false, allegations and reality, fact and opinion, as well as the knowledge and belief . Thus, students will naturally be able to construct a logical argument based on evidence and reliable. In addition, students also will naturally think creatively. This is indicated by the formation of a habit to make linkages between different things, seeing the possibility of the unexpected, and think in a new way on issues that are commonly encountered.

In addition, it has become an imperative for teachers to be able to design interactive learning, inspiring, fun, challenging, and motivating students to actively participate in accordance with Permendiknas No. 41 year 2007 about Standard Process for Elementary and Secondary Education. Learning undertaken should also provide enough space for initiative, creativity, and independence appropriate with the talents, interests, and physical and psychological development of students (Depdiknas, 2007). Learning in the classroom will be more effective if teachers can combine approaches not only develop cognitive, but also affective aspects, particularly student's self-esteem.

Self-esteem be a very important thing because according to Young & Hoffmann (2004, p.87) self-esteem is associated with a number factors of lives, one of which student's success in school. Lawrence (2006 p.8-9) said that students with high self-esteem tend to be self-confident in social situations and confident in dealing with the tasks given by the teacher. In addition, students with high self-esteem will naturally retain their curiosity in learning and have passion and enthusiasm when faced with new challenges. Conversely, students with low self-esteem just avoid the situation where a situation has the potential to make him feel embarrassed in front of other people. Students with low self-esteem tend to prefer to be punished or may be viewed as a hero by his friends than look stupid.

In fact, self-esteem of eighth grade students in several schools in Bantul needs to be improved. This can be seen from the results of self-esteem questionnaire by using the "Coopersmith Self-Esteem Inventory" (1996, p.2-3). The results of the questionnaire can be seen in Table 2 below.

Table 2 Distribution of Self-Esteem Questionnaire Results Grouped by Category

School Name	Category				
	Very Low	Low	Average	High	Very High
SMP 4 Pandak	6	9	3	0	0
SMP 2 Imogiri	3	16	10	0	0
SMP 3 Imogiri	2	12	9	1	0
SMP 4 Banguntapan	1	7	14	3	0
Sum	12	44	36	4	0

From table 2 above can be seen that there are only 4 students who have self-esteem with high category. The majority of students have self-esteem with low category. In fact, there are 12 students who have self-esteem with a very low category.

Based on the descriptions that have been expressed can be taken a conclusion that is very important to be able to design and implement a learning that can facilitate mathematical creative thinking skill and self-esteem of students. One alternative that can be used in the learning process is implement the problem-based learning.

Problem-based learning is an instructional model designed and developed to developing the learner's ability to solve problems. Problem-based learning is chosen because (1) provides a problem that is close to real life and may occur in real life, (2) encourage students to engage in learning activities, (3) encourage the use of various approaches, (4) give the student opportunity to make a choice of how and what will be learned, (5) encourage collaborative learning, and (6) help achieve quality education (Delisle, 1997, p.8-13).

The exellence of problem-based learning in developing mathematical creative thinking skill is supported the existence of a previous study conducted by Sugandi (2011) that at the 5% significance level, a problem-based learning settings jigsaw cooperative learning is more effective than conventional learning in terms of the ability to think critically and creatively. Khoiri (2013) research results revealed that the average results of creative thinking skill test of students problem-based learning with multimedia better than average of conventional learning. Even research Nugroho, Chotim, & Dwijanto (2013) revealed that the problem-based learning with compact disc is more effective to develop mathematical creative thinking skill than conventional learning.

The exellence of problem-based learning to accommodate student's self-esteem is supported by one of the research results Amsikan (2009) that the problem-based learning is more effective than cooperative learning models with jigsaw type in terms of student's self-concept. This study is relevant because according to Plummer (2005, p.13) self-esteem is indicated by the difference between self-concept (what is perceived) and ideal-self (ideal self). The results of other studies conducted by Fadillah (2012) that the student's self-esteem in mathematics with an open-ended approach is better than the student's self-esteem in tradisional learning. Although in this study Fadillah not using problem-based learning, but this research is still relevant because open-ended have similarity with problem-based learning, that is open problems that allow more than one way solution of the problem. By the problem with no one correct answer gives the student opportunity to succeed in solving mathematical problems.

Based on argumentation above, problem formulation of this research is

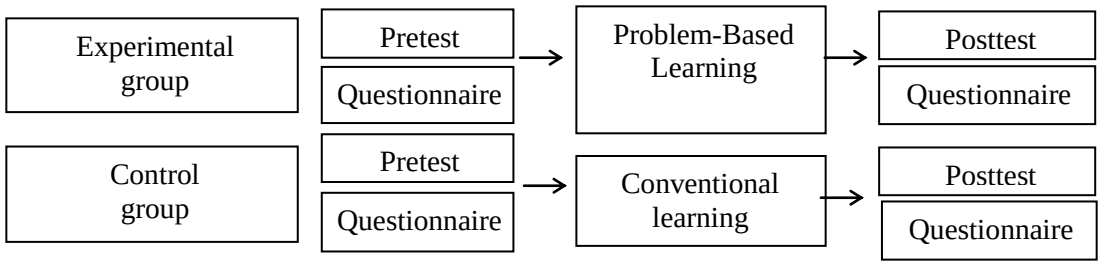
a. Does problem-based learning effective on mathematical creative thinking skill and self-esteem?
b. Compared with conventional learning, does problem-based learning more effective on mathematical creative thinking skill and self-esteem?

2. Method

This study was a quasi-experimental. Research conducted at State Junior High School 2 Imogiri on April 2, 2013 to June 8, 2013. The population in this study were all eighth grade students of State Junior High School 2 Imogiri Bantul. The students of class VIIID assigned using problem-based learning and students of class VIIIC assigned

using conventional learning were established as the sample using the random sampling technique.

The research design in the study are as follows.



Picture 1. Research Design

The data in this study were collected through pretest and posttest of mathematical creative thinking skill, and a self-esteem questionnaire before and after treatment.

In term of content validity, test instruments and questionnaires fit for use according to the reviewer. In the term of construct validity, based on the results of Confirmatory Factor Analysis (CFA), the self-esteem questionnaire showed that overall test results stating fit the model and test results for each parameter estimate also fit. The reliability tests of mathematical creative thinking skill was 0.73 with standard error measurement was 1.07. Self-esteem questionnaire reliability was 0.83 with standard error measurement was 4.33.

The data analysis technique consists of descriptive analysis and statistical analysis. Descriptively, the data are showed based on the average, standard deviation, maximum score and minimum score. Statistical analysis using test on a single proportion and test on two proportions. The data used in the statistical analysis of the data is the posttest. Test on a single proportion was used to analyze whether the problem-based learning is effective on mathematical creative thinking skill and student's self-esteem. The hypothesis to be tested is as follows.

1. $H_{01}: \pi_1 \leq 0.79$
   $H_{11}: \pi_1 > 0.79$
2. $H_{02}: \pi_1 \leq 0.79$
   $H_{12}: \pi_1 > 0.79$

with,

H_{i1} states as hypothesis for mathematical creative thinking skill.

H_{i2} states as hypothesis for *self-esteem.*

The formula used in the proportion test are

$$z = \frac{x - np_0}{\sqrt{np_0q_0}} = \frac{\hat{p} - p_0}{\sqrt{p_0q_0/n}} \qquad 2.1$$

(Walpole, et al., 2012: 362)

With,

$\hat{p}$: success proportion $\left(\frac{x}{n}\right)$

x: number of student success

p_0: hypothesized value

$q_0 = 1 - p_0$

n: number of student

The critical region is $z > z_\alpha$ so reject H_{0j} $(j = 1,2,3)$ if z falls into critical region.

Test on two proportions is used to compare the effectiveness of problem-based learning and conventional learning on mathematical creative thinking skill and students's self-esteem. The hypothesis to be tested is as follows.

1. $H_{01}: \pi_1 \leq \pi_2$
   $H_{11}: \pi_1 > \pi_2$
2. $H_{02}: \pi_1 \leq \pi_2$
   $H_{12}: \pi_1 > \pi_2$

The hypothesis was tested with the following formula.

$$z = \frac{\widehat{p_1} - \widehat{p_2}}{\sqrt{\hat{p}\hat{q}\left[\frac{1}{n_1} + \frac{1}{n_2}\right]}} \qquad 2.2$$

(Walpole, et al., 2012: 364)

With,

$\widehat{p_1}$ (success proportion of experimental group)$= \left(\frac{x_1}{n_1}\right)$

$\widehat{p_2}$ (success proportion of control group)$= \left(\frac{x_2}{n_2}\right)$

$\hat{p}$ (*pooled estimate of the proportion p*) $= \frac{x_1 + x_2}{n_1 + n_1}$

$\widehat{q}$ (*pooled estimate of the proportion q*) $= 1 - \hat{p}$

n_1: number of student in experimental group

n_2: number of student in control group

The critical region is $z > z_\alpha$ so reject H_{0j} $(j = 1,2,3)$ if z falls into critical region.

3. Research Result and Discussion

3.1. Effectiveness of Problem-Based Learning on Students' Mathematical Creative Thinking Skill and Student's Self-Esteem

The data of mathematical creative thinking skill test are presented in Table 3 below.

Table 3 Data of Mathematical Creative Thinking Skill

Value	Experimental Group		Control Group	
	Pretest	***Posttest***	***Pretest***	***Posttest***
Average	7.17	11.97	7.00	8.13
Standard deviation	1.76	1.94	1.76	2.49

From table 3, it is known that the average value of mathematical creative thinking skill before treatment in the experimental and control groups are relatively similar. Standard deviation before treatment is also relatively similar in both groups. The average enhancement of mathematical creative thinking skill before and after treatment in the experimental group is 30%. After treatment, the average value of mathematical creative thinking skill of experimental group is 23.96% higher than control group.

The success proportion of students on mathematical creative thinking skill are presented in Table 4 below.

Table 4 Success Proportion of Students on Mathematical Creative Thinking Skill

Proportion	Experimental Group		Control Group	
	Pretest	*Posttest*	*Pretest*	*Posttest*
Success	13.33%	93.33%	6.67%	23.33%
Failure	86.67%	6.67%	93.33%	76.67%

Table 4 above shows that after treatment the success proportion of students from experimental group is increased by 80%. In addition, the success proportion of students on the posttest in experimental group, which reached 93.33% indicates that the value satisfy the criteria established by researcher, ie more than 79%.

Hypothesis test results obtained values of z is 1.93 which is bigger than the value of $z_{0,05} = 1.645$ so H_0 is rejected. Therefore, at the significance level of 5% can be said that the problem-based learning is effective on student's mathematical creative thinking skill.

These results support the opinion of Arends & Kilcher (2010, p.328) that problem-based learning has contribution to improve mathematical creative thinking skill of students. These results also support the argument of Watson & Groh (2001, p.21) that the problem-based learning ensures students will be able to extand the understanding and appreciating their natural creativity.

Creative thinking skill in practice of problem-based learning many trained on visiting the problem stage and revisiting the problem stage. At this stage students explore ways or other such solutions that have been obtained previously. This is supported by the availability of some of the problems that it requires students to use some way or provide some solutions in order to solve the problem. In solving the problem is not only critical thinking skills that are trained, but also students use creative thinking skills. This is appropriate with the opinion of Ho (2004: 102) that by ill-structured problems, students are required to actively use the critical thinking skills and creative problem solving.

Another stage that provides many activities of creative thinking skills is producing a product or a performance. In this stage students are asked to prepare the results of the group discussions that have been done before. At some meetings, students are asked to produce a work that requires creativity by combining math and art. Examples of student work that needs to be made is diorama and design cereal packaging. These activities is appropriate with the criteria related problems in the theory of problem-based learning expressed by Delisle (1997: 21-24) that the problem can integrate several subjects related to the topic being studied.

The data of self-esteem questionnaire are presented in Table 5 below.

Table 5 Data of Self-Esteem

Value	Experimental Group		Control Group	
	Pretest	**Posttest**	**Pretest**	**Posttest**
Average	90.50	113.20	90.57	106.57
Standard deviation	9.59	8.80	9.52	9.66

From table 5 above found that the average score and standard deviation before treatment and after treatment in both group is relatively similar. After treatment may be seen that the self-esteem scores of students in experimental group is 4.14% higher than control group. In experimental group and control group is increase in the average score of self-esteem from before treatment to after treatment. Enhancement in the average score of self-esteem in experimental group is 14.19%, while the control group is 10%. When

viewed from the standard deviation after treatment, the control group has a higher standard deviation i.e 0.86 from the experimental group.

The success proportion of student's self-esteem are presented in Table 6 below.

Table 6 The Success Proportion of Students on Self-Esteem

Proportion	Experimental Group		Control Group	
	Pretest	Posttest	Pretest	Posttest
Success	3.33%	76.67%	3.33%	36.67%
Failure	96.67%	23.33%	96.67%	63.33%

Table 6 above shows that after treatment the success proportion of students from the experimental class is increased by 73.34%. Nevertheless, the success proportion of students from the posttest in experimental group has not satisfy the criteria.

Hypothesis test results obtained values of z is -0.31 which is smaller than the value of $z_{0,05} = 1.645$ so H_0 isn't rejected. Therefore, at the significance level of 5% can be said that the problem-based learning is not effective on student's self-esteem.

These results are not appropriate with the results of the study by Amsikan (2009) that problem-based learning is effective in terms of students' self-concept. In a study conducted by researchers implementation of problem-based learning combines theory and activity that can train some self-esteem as suggested by Lawrence (2006: 87-93). These activities include discussing the success achieved by someone, expressing the emotions of students, remembering happy events by students, and strengthening the students. The activity was carried out at each meeting either at the beginning, middle, and the end of lesson. However, these activities are emphasized at the beginning of the lesson, which is at the stage of preparation. Although these activities are carried over and over, but it is not effective enough to improve student's self-esteem. This is appropriate with the opinion of Lawrence (2006, p.28) that the process of internalization of self-esteem takes a long time.

3.2. The comparison in the effectiveness between problem-based learning and conventional learning on students' mathematical creative thinking skill and self-esteem.

Hypothesis test results on mathematical creative thinking skill obtained values of z is 5.00 which is bigger than the value of $z_{0,05} = 1.645$ so H_0 is rejected. Therefore, at the significance level of 5% can be said that the problem-based learning is more effective than conventional learning on students' mathematical creative thinking.

This is consistent with the results of the study by Nugroho, Chotim, & Dwijanto (2013) that the problem-based learning is more effective to develop a mathematical creative thinking skill.

The average enhancement on creative thinking skill in problem-based learning is higher than conventional learning. These results are consistent with the results of the study by Khoiri (2013) that the average enhancement of student's creative thinking skill in experimental group are better than the average enhancement in control group.

In problem-based learning that has been implemented is available several problems that require students to use creative thinking skill in solving mathematical problems. The problem in accordance with Delisle (1997, p.24), one of the characteristics of a good problem in problem-based learning should be ill-structured. This is give students opportunity to conduct an investigation to obtain information that might lead to solution. Students are encouraged to use information that is already known

and find additional information needed. Ill-structured problems also lead students to find a number of possible solutions.

Enhancement of mathematical creative thinking skill in conventional learning is not very significant, because in the conventional learning students are not given the opportunity to explore other ways or solutions that have been found previously. It is also expressed by van de Walle (2007, p.38) that the conventional learning assumes that students have the necessary idea that the way the teacher thinks is the best. Students used to think that way or answer the teacher is the most correct. In addition, the questions or tasks in a conventional learning is routine questions that lead to one correct answer.

Hypothesis test results on self-esteem obtained values of $z = 2.86$ which is bigger than the value of $z_{0,05} = 1.645$ so H_0 is rejected. Therefore, at the significance level of 5% can be said that problem-based learning is more effective than conventional learning on student's self-esteem.

The average enhancement on student's self-esteem in problem-based learning is higher than conventional learning. This supports the results of research conducted by Fadillah (2012) which concluded that learning by using an open problem better than traditional learning.

Enhancement of student's self-esteem in problem-based learning is quite significant because the researchers combined with the implementation of activity suggested by Lawrence (2006, p.87-93) as expressing emotions in writing, expressing the opinion on an expression, recalling events that make students feel happy, and give affirmation or reinforcement to students to better appreciate himself. In addition to these activities, students always have success stories one whose life is not completely perfect. It encourages students to realize that each individual has their own strength and weakness. Given these activities, students learn more about themselves and appreciate the circumstances and what has been achieved at this time without having to look at other people. Thus, student's self-esteem can be increased. This is appropriate with Lawrence (2006, p.83) that students who have high self-esteem will have a good self-acceptance, respect the needs of others, and have the ability to empathize.

In the conventional learning, self-esteem scores also increased substantially. It can be caused during the learning teacher gives advices which lead to character education that is being promoted in the school. Giving advices is given when students do a lot of practice questions. Giving advices is one of the activities that build students' morale. As a result, student's self-esteem will increase. This is appopriate with the opinion of Lawrence (2006, p.96) that any activity that can build morale in the school will be able to improve self-esteem.

4. Conclusions and Suggestions

The results of the study show that at the significance level of 5%, it can be inferred that

a. problem-based learning is effective on student's mathematical creative thinking skill, but it is not effective on student's self-esteem.
b. problem-based learning is more effective than conventional learning on students' mathematical creative thinking skill and students' self-esteem.

Suggestions can be submitted are

a. For teachers or researchers who want to improve mathematical creative thinking skill can apply problem-based learning. Its application can be done by integrating the stages of problem-based learning in the lesson plans.
b. Availability of problems in problem-based learning is very important and united on teaching materials. Non-routine problems with contextual issues are relevant to improve the mathematical creative thinking skill. These problems should be able to trigger the cognitive conflict within students.
c. In the process of solving problems, providing intervention to the student does not need to be done immediately so that the actual development of the students is maximum.
d. To improve student's self-esteem of students, the teaching materials prepared can be inserted strengthening student's self-esteem.
e. In the classroom, the teacher plays a very important to affect the student's self-esteem. The teacher's role is not only to maintain the quality of the relationship with the students, but also conduct a series of activities that can improve the self-esteem of students.

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