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Enhancing Students' Mathematical Creative Problem Solving Ability Through Situation-Based Learning

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Abstract

Learning activities which emphasize more on answering questions than presenting questions have caused students' lack awareness to encounter some problems. The situation of the students' weak problem finding competence leads to their weak idea finding and problem solving. As a result, Creative Problem Solving (CPS) ability necessarily has to be developed in learning mathematics. There are six aspects of CPS competence as parts of thinking process stages, namely: objective finding, fact finding, problem finding, idea finding, solution finding, and acceptance finding. In this case, to learn mathematics is about to explore the ability to present and to solve the problems emerged by the students themselves, applying Situation-Based Learning (SBL). This research used quasi-experimental design with experimented and controlled groups. The experimented group was examined using SBL learning while the controlled one using conventional learning. Based on the research result, it can be concluded that the enhancement of students' mathematical CPS ability who were taught under SBL learning is higher than those who were taught under conventional learning. Fact finding is the highest aspect of the students' mathematical CPS ability, and the lowest aspect is acceptance finding.

Keywords: Mathematical situation, Mathematical problems, Mathematical creative problem solving, Situation-based learning

1. Introduction

Thinking has become a part of humans' mental activities whether they face problem or certain situation which needs to be solved. However, not all people possess similar point of view to encounter some problems in that certain situation. The cause is that someone's knowledge background may really influence his/her point of view on particular situations. One situation could be crucial for him/her, but not for other people who do not realize that it may become big problem for them. In the other words, one situation may become someone's complicated problem or not.

One situation will be identified as a problem for someone if he/she realizes the existence of the situation, admits that the situation needs action and then immediately figures out that the situation is unsolved (Newell and Simon, 1972); (Yee, 2002); (Hamzah, 2003); (Dindyal, 2009); (Kaur and Yeap, 2009). Problem is thing that needs action, but difficult or confusing (Schoenfeld, 1992). Hayes supports the previous opinion by stating that problem has created gap between recent condition and goal to achieve when we do not know exactly what should be done to reach the goal (Hamzah, 2003). In this case, problem can be defined as question that must be answered exactly at that time while we do not have any fixed solution plans.

Treffinger, Isaksen, and Dorval state that problem is '… any important, open ended, and ambiguous situation for which one wants and needs new options and a plan for carrying a solution successfully' (Steiner, 2009). A problem is known as open ended since it gives so many various options, or in the other words, the answer is not figured out in singular option or one solution only, but also in many ways. Therefore, it does not rely on true answers but on how the process to answer the problem goes. And, all answers may be possibly true. While one situation is stated here as ambiguous, it can be interpreted that the situation is not meant singular but consists of much understanding. So, it needs various solutions to solve the problem in order to interpret the situation significantly.

Someone will be able to solve a problem if he/she has adequate ability to do so. According to Utari-Sumarno, the importance of students' mathematical problem solving competence becomes objective of teaching Mathematics, even becomes the heart of Mathematics (Soekisno, 2002). In Education-Unit-Based Curriculum (a.k.a. *Kurikulum Tingkat Satuan Pendidikan* or KTSP for short) (Depdiknas, 2007), it states that objective of learning mathematics is to develop problem solving competence.

During teaching-learning activities in the classroom, however, teacher frequently asks his/her students too many

questions with low level. Learning method used commonly emphasizes on answering instead of presenting problems. So, the method is not proper to develop the students' awareness on problem and competence on problem solving. Therefore, Creative Problem Solving (CPS) competence needs to be developed in learning mathematics. In this case, mathematical CPS ability consists of: 1) objective finding; 2) fact finding; 3) problem finding; 4) idea finding; 5) solution finding; and 6) acceptance finding. For every aspect of competence, students start their learning by divergent thinking activities and end by convergent ones (Ellyn, 1995); (Mitchel and Kowalik, 1999); (Proctor, 2007); (Isrok'atun, 2012a).

In order to develop the competence, learning mathematics has to explore the students' competence on presenting and solving the problems creatively proposed by the students themselves. One of learning methods used to overcome the problems is Situation-Based Learning (SBL). SBL learning process can be applied through a set of designing materials based on situation-based learning so that the students are able to develop their creativity and thinking productivity further. Teacher's roles here are merely as motivator and facilitator.

1.1. Research Question

The problem proposed in this research: Is the enhancement of students' mathematical CPS ability who were taught under SBL learning is higher than those who were taught under conventional learning?

1.2 Situation-Based Learning

Situation-Based Learning is a strong, flexible and new learning approach intended to develop constructive learning paradigm (Tarek, Thomas, Hermann, and Maja, 2000). Lave; Lave and Wenger; Greeno, Smith, and Moore assume that there are many things student learns from a situation, like where he/she studies (Anderson, Reder, and Simon, 1996). The objective of SBL is to develop students' ability on problem posing, problem understanding, and problem solving through mathematics point of view.

Situation-Based Learning consists of four learning process stages, namely: 1) creating mathematical situations; 2) posing mathematical problem; 3) solving mathematical problem, and 4) applying mathematics, being described as follows (Xia, LÜ, Wang, and Song, 2007); (Xia, LÜ, and Wang, 2008); (Isrok'atun, 2012b); (Isrok'atun, 2012c).

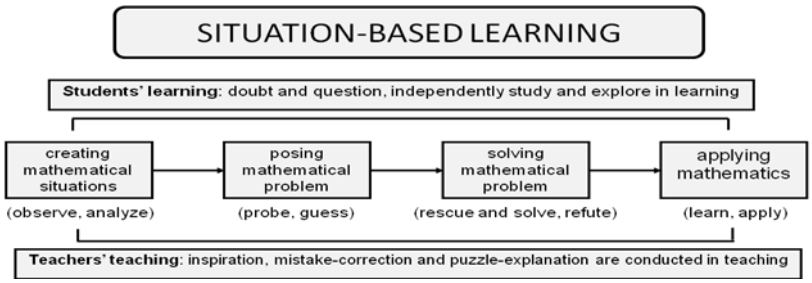

Figure 1. Situation-Based Learning

Creative mathematical situations are prerequisite. Posing mathematical problem is core. Solving mathematical problem is goal. Meanwhile, applying mathematics is the application of learning process to new situation.

There are four SBL learning strategies, such as (Isrok'atun, 2012d):

(1) Teacher creates situation

Teacher creates mathematical situation. It is expected that there are some mathematical questions asked by students through activities of observing and analyzing. Here, the situation starts from firstly simple one to more complex one.

(2) Students pose mathematical problems

By investigating and guessing, students implement mathematical problem posing. It is intended to increase their awareness on problems of situation they have faced. Teacher's role here is to place problems proposed by students at certain levels based on difficulty grades.

(3) Students practice mathematical problem solving

At the second learning step, teacher and students sort existing problem levels, whether the problems need to be followed up or not. Solved problems start from simple ones to complex ones. As learning materials, the main objective here is to emerge problems that require problem solving with mathematical CPS competence. In this strategy, teacher's roles are to guide, to direct, and to stimulate students by implementing scaffolding techniques.

(4) Applying mathematics

The strategy of applying mathematics is hoped to become students' positive habit so that they can find out the way to solve every mathematical problem. After students conduct SBL strategies in the classroom, it does not mean the end of everything. In daily life, every student is obliged to continue applying the strategies as part of his/her character whatever, wherever and/or whenever he/she faces certain situation or problems. The students become more critical to view a problem which exists in every situation.

1.3 Conventional Learning

In this research, conventional learning is teacher's learning model which limits students' roles during the process of teaching-learning activities. Teaching method is teacher-centered and learning process emphasizes more on expository method.

1.4 Mathematical CPS Ability

The ability of mathematical CPS has six aspects, each of aspect begins from divergent activity and ends by convergent activity. The aspect of mathematical CPS ability such as (Ellyn, 1995); (Mitchell and Kowalik, 1999) ; (Proctor, 2007); (Isrok'atun, 2012a). Osborn-Parnes creative problem solving process:

(1) Objective finding
Effort to identifying the situations to become more challenging form.

(2) Fact finding
Effort to identifying all the data which is still related to the situations context, finding and identifying an important information that didn't contain in the situation, but it is important.

(3) Problem finding
Effort to identifying of all possible problems, and then sorting which are important.

(4) Idea finding
Effort to identifying several solutions which is possible for the statement problem.

(5) Solution finding
Using a list of solutions that have been on the stage of idea finding, and selecting the best solution to resolve the problem.

(6) Acceptance finding
Effort to increase the capacity, planning an action, and implementing the solutions.

For further explanation about CPS thinking process, see on picture below (Isaksen and Treffinger, 1985):

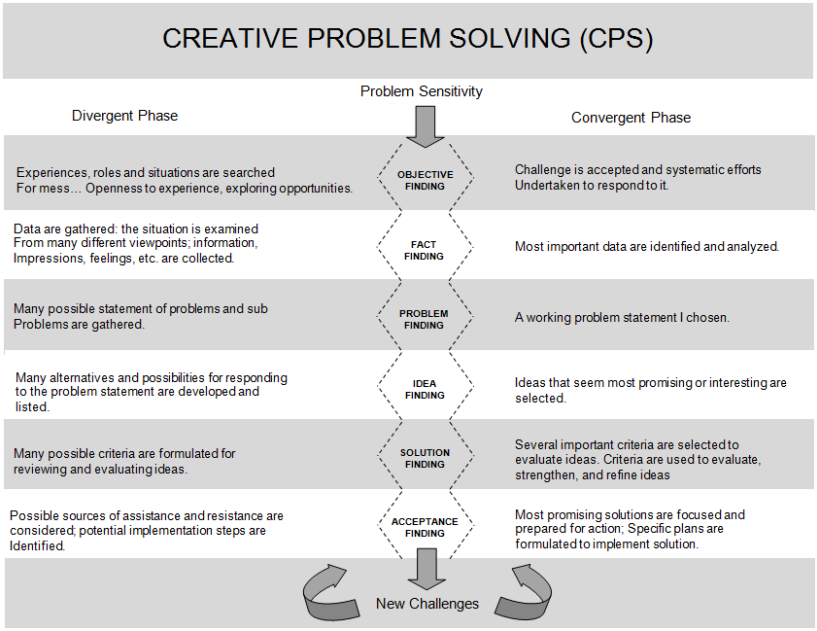

Figure 2. The Flow of CPS Thinking Process

2. Experiment

2.1 Purpose

The research aims to figure out whether students' mathematical CPS ability using SBL learning is more improving than those ones' using conventional learning.

2.2 Sample and Population

Research population was all SD (elementary school) students in the Province of Banten, Indonesia with medium-leveled elementary school category. Based on the category, SD Negeri 9 Kota Serang was chosen as the research subject. The sample were grade 5 because grade 5 can be deemed to have been invited to think more highly (high-order mathematical thinking skills, is the mathematical CPS ability) than previous classes, and are not preoccupied with preparations for the National Examination (UN).

Two classes were randomly selected among all classes of Class 5. One class was treated as experimented group (Class 5A, with 47 students were examined using SBL learning) and the other one as controlled group (Class 5B, with 47 students were examined using conventional learning).

2.3 Research Design

The research was quasi-experiment using experimented and controlled groups recognized as pretest-post test control group design (Fraenkel and Wallen, 1990); (Ruseffendi, 1998); (Sugiyono, 2011). The experimented group was treated using SBL learning and controlled group was treated using conventional learning. The research design is described as follows:

O X O
O O

Note:

O = pretest = post test on mathematical CPS ability
X = SBL learning

3. Research and Discussion

After two classes had been treated differently, one group using SBL learning and the other one using conventional learning, the research result of students' mathematical CPS ability was performed as follows.

Table 1. Mathematical CPS Ability

Learning	*n*	Pretest		Post test		Gain		Gain Category
		Average	S.D	Average	S.D	Average	S.D	
SBL	47	16.32	11.58	32.91	14.38	0.24	0,16	low
Conventional	47	16.21	7.82	24.66	9.56	0.12	0,12	low

S.D = standart deviation

Based on pretest result, two groups started from significantly same mathematical CPS ability (after examined statistically). The students' mathematical CPS ability average treated with conventional learning (16.21) and than ones' with SBL ability (16.32). Though post test was later conducted, the student group's average of mathematical CPS ability treated with SBL learning was highly achieved, 32.91.

Both groups experienced improvement (gain) of significant mathematical CPS ability. The student group's average of mathematical CPS ability treated with SBL learning (0.24) was more improving than one's with conventional learning (0.12). So, the group with SBL and conventional learning was determined as low-categorized.

3.1 Hypothesis Testing and Statistical Significance

To prove which group is better, whether the student group with SBL learning or the other group with conventional learning, statistical test is urgently required. The statistical test result is as follows:

Table 2. Statistical Test Summary on Mathematical CPS Ability Gain

Learning	*n*	Gain		Statistical test		Mean Difference Test (Mann-Whitney)
		Average	S.D	Normality	Homogenity	
SBL	47	0.24	0.16	Normal	Varians not same	Both means were different
Conventional	47	0.12	0.12	Not normal		

Note: $\alpha = 0.05$

The table above explained that the student group with SBL learning was more significantly improving than the other one with conventional learning.

Therefore, it can be concluded that the student group examined using SBL learning got more exceeding result than the controlled group though the experimented group had got lower result at the beginning. It clarifies that students' mathematical CPS ability with SBL learning is better than ones' with conventional learning.

The explanation acquisition of student's score in experimental class if viewed each aspect, which one is strongest or weakest of student's mathematical CPS ability, describe as:

Table 3. The Students' Mathematical Ability CPS in Experimental Class
Viewed each individual aspects

Aspect of mathematical CPS	O	F	P	I	S	A
Frequency	5	5	3	5	4	2
The maximum score	3	3	4	4	4	4
The score for item:	-	-	-	-	-	-
1	51	49	-	51	42	36
2	36	20	23	23	-	-
3	56	56	66	59	54	-
4	41	38	-	38	24	22
5	10	73	6	45	45	-
Sum	194	236	95	216	165	58
% for CPS aspect	28	33	17	23	22	15

Information:
The strongest aspect : *Fact finding*
The weakest aspect : *Acceptance finding*

The table above explained that the percentage gain scores on students' mathematical CPS ability viewed per aspect. The strongest aspect is the fact finding aspect (33%). Fact finding is an effort to collection of the data which related the problems and to exploring facts of situations, it's indicates an to be able to relating; to connecting about the problems and to exploring; to organizing; to caring the hiden information of situation. The weakest aspect of mathematical CPS mathematical CPS ability is the acceptance finding aspect (15%). It's an effort to increase the capacity of the answers obtained, planning an action to solve it, and implementing a solutions. It indicates the ability to acting the completion, considering the support acquisition the previous answers, and expressing the plan of the support answers.

4. Conclusion

SBL learning is a kind of learning consisting of four learning process stages, namely: 1) creating mathematical situations (prerequisite); 2) posing mathematical problem (core); 3) solving mathematical problem (goal), and 4) applying mathematics (application).

This SBL learning can be one of learning alternatives in order to improve students' mathematical CPS ability. Deriving from problems proposed by students, teacher plays role to guide them solving problems by applying mathematical problem solving techniques. Therefore, students' problem posing and problem solving are well put in balance.

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