Improving Mathematical Creative Problem Solving Skill of Male and Female Students through Situation-Based Learning

Isrok'atun
Universitas Pendidikan Indonesia
isrokatun@gmail.com; isrokatun@upi.edu

Abstract: The purpose of this research was to investigate the improvement of male and female students' mathematical Creative Problem Solving (CPS) ability as a result of Situation-Based Learning. The quasi experimental design was used by involving two methods, namely Situation-Based Learning and conventional method. The population of the research was high school students in Central Java Province. The research instrument used in the study was CPS test. The data were analyzed based on the students' gender. The research resulted in the following conclusions: (1) the improvement of students' mathematical CPS ability taught under SBL was higher than those who were taught using conventional method based on students' gender, and (2) there was no interaction between learning model and gender on the improvement of students' mathematical CPS ability.

Keywords: female students, improvement of mathematical CPS ability, male students, SBL learning

Abstrak: Tujuan penelitian ini adalah untuk mengetahui peningkatan kemampuan CPS matematis siswa laki-laki dan perempuan sebagai akibat dari pembelajaran SBL. Penelitian kuasi eksperimen ini menerapkan dua model pembelajaran yaitu pembelajaran SBL dan pembelajaran konvensional. Populasi penelitian ini adalah siswa SMA di Provinsi Jawa Tengah. Instrumen penelitian yang digunakan yaitu tes kemampuan CPS matematis. Analisis data ditinjau berdasarkan gender siswa. Hasil penelitian menyimpulkan: 1) peningkatan kemampuan CPS matematis siswa yang mendapat pembelajaran SBL lebih baik daripada siswa yang mendapat pembelajaran konvensional ditinjau dari gender siswa; dan 2) tidak terdapat interaksi antara pembelajaran dan gender siswa terhadap peningkatan kemampuan CPS matematis.

Kata Kunci: pembelajaran SBL, peningkatan kemampuan CPS matematis, siswa laki-laki, siswa perempuan

In the teaching and learning process, teachers tend to ask many questions to the students in high frequency but low level. The learning process emphasizes the solving of assignment or task. The learning methods used focus on learning to answer rather than solving problems. As a result, it does not develop the awareness of the students about problem solving (Xia, LÜ, Wang, & Song, 2007; Xia, LÜ, & Wang, 2008). It affects to the students' problem solving skill, especially in converting the verbal representation to the mathematical model (Rudtin, 2013).

Creative Problem Solving (CPS) that demands more than just the usual problem solving is less understood by the students. Creative problem solving is a combination of the problem solving process and creative thinking process (Kirton, 2003; Sophonhiranraka, Suwannatthachoteb, & Ngudgratokec, 2015). Therefore, the CPS method needs to be implemented in the learning process. Mathematical CPS is mathematical ability which consists of (1) objective finding, (2) fact finding, (3) problem finding, (4) idea finding, (5) solution finding, and (6) acceptance finding. In each of the aspects, the students start with the divergent thinking activity and end with the convergent thinking activity (Ellyn, 1995; Mitchell & Kowalik, 1999; Proctor, 2007; Isrok'atun, Kusumah, Suryadi, & Sabandar, 2014). The result of Isrok'atun's research (2006) showed that even if the students had been trained with problem solving ability, generally the students were still weak in the mathematical CPS ability. The learning has not facilitated the students to think

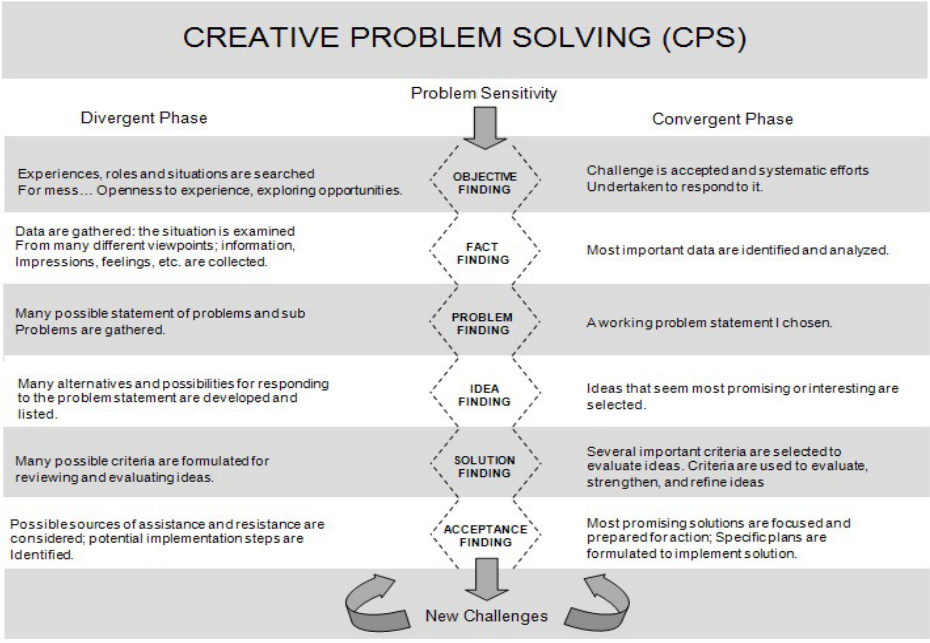
divergent-convergent and has not referred to the CPS indicators.

Creative problem solving originated from the words creative and solving to encourage the students to: (1) generating new ideas (unique, fresh, and relevant), especially in creating solution, (2) habituating the students to face challenge and opportunities, (3) training the students to plan and solve problems (Mitchell and Kowalik, 1999). Creative problem solving emphasizes on the important finding of alternative ideas and various possibilities of action in every steps from the process of problem solving. Therefore, in encoraging students to use creative problem solving, the students tend to faced a complex proble, ill-defined, or multi-interpretation, and complex solution (Helie & Sun, 2010).

According to Steiner (2009), CPS has some characteristic, they are: (1) the problem solving started from the recursively process, revised, and redifined, (2) the need of divergent and convergent thinking, and (3) initiate predicative thinking that can stimulate logical thinking. Hence, the CPS has six steps, each step started from divergent activities and ended with convergent activities (Mitchell & Kowalik, 1999; Ellin, 1995; Isrok'atun, Kusumah, Suryadi, & Sabandar, 2014; Isrok'atun & Tiurlina, 2014; Isrok'atun & Tiurlina, 2015). The steps are (1) objective finding, used to identify a challenging situation, (2) fact finding, used to identify data related to situational context and find unrevealed yet important information, (3) problem finding, used to identify all problem statement and sorting out the important one, (4) idea finding, used to identify the solution of problem statement, (5) solution finding, used to choose the list of solution from idea finding, and (6) acceptance finding, used to support and implement the solution.

For the detailed explanation of CPS process, can be seen in the Figure 1. (figure 1 adapted from Isaksen & Treffinger, 1985). It can be seen that CPS has great advantages for the students. By having the ability of creative problem solving, the students will have the ability to survive.

To develop the ability of CPS, the teacher need to have a method that will explore the students' ability to present and solve problems raised by the students creatively (Xia, LÜ, Wang, & Song, 2007; Xia, LÜ, & Wang, 2008). One of the learning method is Situation-Based Learning (SBL). SBL process can be implemented through material designed based on the characteristic of situation-based learning. Situation-based learning consists of 4 steps, they are (1) creating mathematical situations; 2) posing a mathematical problem; 3) solving mathematical problem, and 4) applying mathematics. The steps can be seen in Figure 2 (Xia, LÜ, Wang, & Song, 2007; Xia, LÜ, & Wang, 2008; Isrok'atun, Kusumah,



Gambar diadaptasi dari Isaksen & Treffinger (1985)

Figure 1. The Thinking Process Of CPS

Suryadi, & Sabandar, 2014; Isrok'atun & Tiurlina, 2014; Isrok'atun & Tiurlina, 2015).

Creating mathematical situations is a pre-requirement. Posing a mathematical problem is a core process, while solving mathematical problem is a purpose, and applying mathematics is the implementation of the process to the situation or new problems.

From the Figure 2 above, the steps of SBL can be explained as follows (Isrok'atun, Kusumah, Suryadi, & Sabandar, 2014; Isrok'atun & Tiurlina, 2014; Isrok'atun & Tiurlina, 2015):

1. The teacher creates a situation. In this step, the teacher creates a mathematical situation by observing and analyzing the material. The situation can be in the form of a story or illustration from an event that face by the students. The situation should attract and evoke the curiosity of students, so that the students will be interested to get and ask some mathematical question. The situation can be started from a simple to a complex situation.
2. The students provide a mathematical problem. Through the investigation situation, the students guess and dig up some available information. Then, from the information, it is expected that the students will ask non-routine mathematical problem. This activity can train and improve the awareness of students toward the problem.
3. The students do mathematical problem solving. From the mathematical problem, the students and teacher sort out the problem that need to be followed up. The students solve the problem by some formula or method. From this activity, it is expected that the students can find a concept, formula, or mathematic rules that are exist.
4. Applying mathematics. In this step, the students apply the concept, formula, or mathematic rules in solving the problem. The purpose of this activity is to make the students understand that the mathematical concept can be applied in daily activities.

Situation-based learnig (SBL) has some advantages. SBL improves the awareness of students toward the mathematical problem (Isrok'atun, 2012a). SBL trains the problem solving skill of the students, motivates the students, and trains the creative problem solving skill (Isrok'atun, 2012b; Isrok'atun, 2012c).

Based on the aforementioned explanation, SBL has some chances to improve the creative problem solving skill compare to the conventional learning that is teacher centered. However, there is no research that examines the effect of SBL toward the creative problem solving skill reviewed from the gender. It is strengthened by the research of Noer (2010) stated that there is no interaction between the learning approach to gender.

The result of this research is expected to give some theory related to the effect of SBL toward the students' creative problem solving skill from a gender perspective. This is important since the difference in the students' achievement in term of gender looks vague.

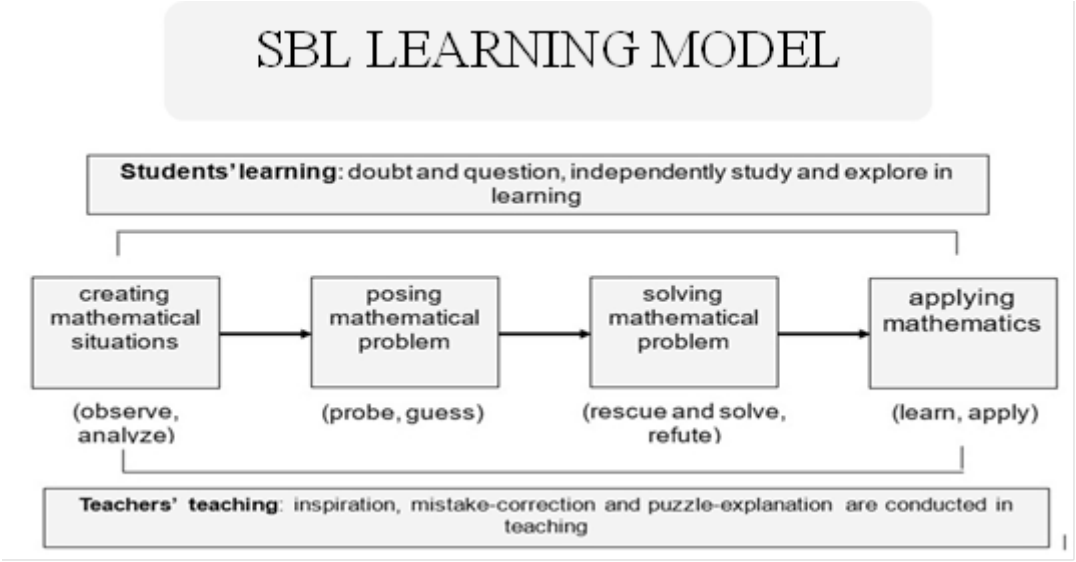


Figure 2. Situation-Based Learning Model

There are some research stated that the students' achievement of female students is better than male students. (Noer, 2010). Núñez-Peña, Suárez-Pellicioni, & Bon (2016) stated that even though female students have better score in mathematical test than male students, female students have higher anxiety too (Núñez- Peña, Suárez-Pellicioni, & Bono, 2016).

In this article, the researcher reports the effect of SBL toward the creative problem solving skill in term of gender. It is also reported about the interaction between gender differences with the learning approaches that are used.

METHOD

This research aims to examine the improvement of CPS mathematical ability of students that get SBL learning based on gender difference and the interaction of gender difference toward the learning method used to improve the students CPS mathematical ability.

The population of this research was the students of senior high school in Jawa Tengah, Indonesia. The students were around 15 – 18 years old. The research's sample was determined using stratified purposive random sampling to choose one of the high to moderate ranking senior high school, while for the sample of the class was taken randomly.

SMA N 1 Tegal was chosen as the high ranking of senior high school and SMA N 3 Brebes was chosen as the moderate ranking senior high school. Both schools have A accreditation, but they have a different competency standard for graduate (SKL). The SMA N 1 Tegal has 92 SKL and SMA N 3 Brebes has 87 SKL. The SMA N 1 Tegal is the ex-RSBI school, while the SMA N 3 Brebes is a national standard school (SSN)

The research's sample was the eleventh graders from the two schools. It was chosen because the eleventh graders were considered has passed the adjustment period and the students were not busy preparing for National Examination, so it was easy to implement the learning method. From the whole eleventh graders in the two schools, it was chosen 2 random classes. The result of sampling technique can be seen in Table 1.

Quasi experimental was used by using control and experimental group, which is known ad pretest - post test group design (Fraenkel & Wallen, 1990).

Before beginning the experiment, both groups (control and experimental) were given pre test in the form of questions that measure the aspects of CPS mathematical ability, they are *objective finding*, *fact finding*, *problem finding*, *idea finding*, *solution finding*, and *acceptance finding*. The pre test consisted of ten essay questions, as follows :

> Hitunglah C(8,6) dan C(8,2)!
> Hitunglah C(9,3) dan C(9,6)!
> Bandingkan perolehan hasil hitungan tersebut!
> Fakta apa saja yang dapat Anda ungkapkan dari kejadian tersebut?

The questions were used to test the CPS mathematical ability from the aspect of objective finding and fact finding. The indicators in the objective finding were the students should be able analyzed and identified what was known about the situation. The indicators in the fact finding aspect were the students should be able to 1) collect data related to the problem, 2) explore some facts of the situation, and 3) observe the possible problems from various issues.

After that, the experimental group got a treatment using SBL learning method and the control group using conventional learning method. The learning activities of SBL were implemented for two months by having six meetings, each meeting was 2 x 45 minutes. The material taught was the probability for eleventh graders.

Student worksheet was used to help the learning activities. The student worksheet was designed specifically to fit the SBL

Table 1. Research's Data Sample

School's Ranking			
High : SMA N 1 Tegal		Moderate: SMA N 3 Brebes	
Experiment: XI IPA 3	Control: XI IPA 1	Experiment: XI IPA 3	Control: XI IPA 1
(30 students, M: 13 & F: 17)	(29 students, M: 13 & F: 16)	(39 students, M: 10 & F: 29)	(40 students, M: 9 & F: 31)

learning. The design of student worksheet was the result of creating mathematical situation step conducted by the researcher as the prerequisite of SBL learning. From this situation, then the researcher continued to the other steps of learning based on the student worksheet. The student worksheet also used in the control group, but the learning activities were different from SBL learning. Figure 3 is the example of student worksheet. In the applying mathematic step, the student worksheet provides the enrichment questions as in the Figure 5.

After the process of learning ended, post test was given. The post test was the same questions from pre test, to find out the improvement of CPS mathematical ability that can be achieved by experimental and control group.

The purpose of this research was to examine the improvement of CPS mathematical ability that can be achieved by the students. The word improvement (gain) was normalized gain. The absolute gain (the difference between pre test and post test) cannot explain the highest and lowest gain well. Thus, to measure the improvement, the researcher used following formula by Hake, 1999 and Meltzer, 2002:

$$Gain\ (g) = \frac{post\ test\ score - post\ test\ score}{ideal\ score - pre\ test\ score}$$

The gain category based on Hake (1999) can be seen in Table 2.

Table 2. Gain Category

Gain	Category
g < 0,3	Low
0,3 ≤ g <0,7	Moderate
g ≥ 0,7	High

RESULTS AND DISCUSSION

Results

After both classes (in high and moderate ranking schools) were given a different treatment, it was gotten the result of CPS mathematical ability based on the gender differences in the Table 3.

In the female group, the experimental group had 0,43 mean improvement, while the control group had 0,31 mean improvement. In the male group, the experimental group had 0,57 mean improvement, while the control group has 0,22 mean improvement.

The mean improvement of CPS mathematical

1. Aturan Perkalian

Situasi 1:

Eka baru saja membeli 4 baju berbeda dan 3 celana panjang berbeda. Suatu hari ia ingin memakainya untuk suatu acara di sekolahnya, dengan mengkombinasikan 1 stelan baju dengan 1 celana panjang tersebut.

Probe and Guess:

Tuliskan informasi yang menjadi fokus pengamatan Anda!

1. .....
2. .....
3. .....

Dari beberapa fokus amatan tersebut, ubahlah menjadi pertanyaan matematika yang dapat diselesaikan!

1. .....
2. .....
3. .....

Diskusikan dengan teman sekelompok, pertanyaan no. berapa saja yang perlu diselesaikan? .....

Kemudian secara bersama-sama, jawablah pertanyaan-pertanyaan matematika yang telah disepakati oleh kelompok Anda sehingga diperoleh jawaban yang beragam!

.....

.....

.....

Kesimpulan apa yang Anda dapat?

.....

.....

Figure 3. Students' Worksheet

ability achieved by the four groups was in the average category. The average gain category meant that generally each student had a higher post test score than pre test score (did not reach the maximum score). Figure 4 shows the difference improvement of CPS mathematical ability in those groups.

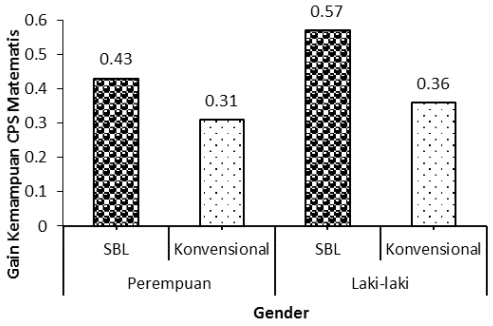


Figure 4. The improvement of CPS based on gender

The result after the statistical testing toward the mean improvement of CPS mathematical ability can be seen in Table 4.

In the female group, the experimental group had different mean improvement with the control group. The experimental group got higher mean improvement than the control group, 0.43. In the male group, the experimental group got higher mean improvement than the control group, 0.57. This result was supported by the result of observation and interview of several students. The male students in the high ranking school were more critical in answering the question. The male students liked to explore the question and change the type of question in the problem posing step of SBL learning. The example of male students' worksheet in making a question from the situation was presented as follow:

Applying Mathematics:

Diskusikan permasalahan berikut dengan kelompok Anda!

1. Maulana sedang menempuh sebuah tes yang terdiri atas 5 soal berbentuk pertanyaan B-S. Berapa banyak kemungkinan jawaban yang dapat dilakukan Maulana dengan menebak?
   Jawab:
   .....
   .....
2. Berapa banyaknya bilangan yang terdiri dari 4 angka yang dapat disusun dari angka-angka 0, 1, 2, 3, 4, 5, dan 6 tanpa pengulangan?
   Jawab:
   .....
   .....
3. Ada 3 jalur bus antara kota A dan B, dan 4 jalur bus antara kota B dan C. Tentukan banyaknya cara seseorang dapat mengadakan perjalanan menggunakan bus, jika:
   a. Dari A ke C melalui B
   b. Pulang-pergi dari A ke C melalui B
   c. Pulang-pergi dari A ke C melalui B, jika jalur pulang tidak sama dengan jalur pergi!
   Jawab:
   .....
   .....

Figure 5. Applying Mathematical Step

Table 3. CPS Mathematical Skill Gain based on Gender

Gender	Learning	*n*	Pretest		Postest		Gain		Gain
			Mean	S.B	Mean	S.B	Mean	S.B	
Female	SBL	46	9,52	8,83	56,20	22,50	0,43	0,19	moderate
	Conventional	47	11,45	5,66	44,34	18,54	0,31	0,16	moderate
Laki-laki	SBL	23	13,83	16,16	72,22	30,50	0,57	0,26	moderate
	Conventional	22	14,77	9,80	52,46	24,14	0,36	0,22	moderate

Situasi 2:

Pada saat menghadiri pesta ulang tahun temannya, Niki kehilangan motor. Polisi yang datang untuk membantu menemukan kembali motor tersebut, menanyakan nomor plat motor Niki. Tetapi Niki lupa dan tidak membawa STNK pada saat itu, yang diingat hanyalah nomor plat motornya **BD** xxxx **NK**.

Sometimes, they made their own question, which they did not sure about the answer since they make open – ended question. The male students made following question:

Berapa banyak angka-angka yang mungkin merupakan nomor plat motor dengan nomor polisi **BD** xxxx **NK**, dengan ketentuan empat angka di tengah?

They said:

"if four numbers are in the middle, how if all the number is the same ? how if three numbers are the same and one number different. How if the three same numbers are in the first, second, and fourth order. Can we have zero number? can the zero number is in the first order?"

The male students liked the challenge, they even try to answer the questions using more than one way.

The male students in the moderate ranking school also more active than female students. Even though their ability was lower that the students in high ranking school, the male students also braver to ask and try several ways in solving the questions. Compared to the female students, the male students had deep analysis and had more simple logical thinking.

Therefore, it can be said that the CPS mathematical ability is an important approach for the students in developing the solution of the problems (Sophonhiranraka, Suwannatthachoteb, Ngudgratokec; 2015).

Aanwhile, for the female students, generally they were a bit passive, did not want to try, and less to elaborate in the problem posing step. Moreover, in several open-ended questions, they were confused. This finding was different with the finding of Núñez-Peña, Suárez-Pellicioni, & Bono (2016) stated that the female students and male students did not show different ability in solving the open-questions.

The interaction between gender and learning method toward the improvement of CPS mathematical ability

The interaction between gender and learning method used toward the CPS mathematical ability was summarized in the following Table 5.

Table 5. CPS Mathematical ability Gain based on Gender and learning difference

Learning	Gender			
	Female		Male	
	mean Gain	S.B	mean-Gain	S.B
SBL	0,43	0,19	0,57	0,26
Conventional	0,31	0,16	0,36	0,22

Table 4. Statistical Test to the Gain of CPS Mathematical Ability based on gender

Gender	learning	*n*	Gain		Statictical gain		Mean difference (*Mann-Whitney*)	Mean difference (*Krus- kal-Wallis*)
			Re-rata	S.B	Normality	Homogenity		
female	SBL	46	0,43	0,19	Not Normal	Same variant	Different mean	Significantly different mean
	coventional	47	0,31	0,16	Not Normal			
male	SBL	23	0,57	0,26	Not Normal	Same variant	Different mean	
	conventional	22	0,36	0,22	Not Normal			

Note : $\alpha = 0,05$

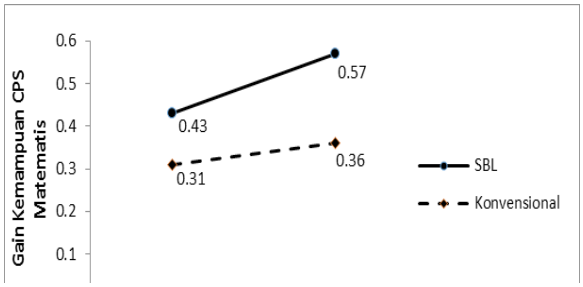


Figure 6. Interaction plot between gender and learning to the CPS mathematical Ability

The graphic above explained that there was no interaction between gender and learning method toward the CPS mathematical ability. It meant that the improvement of the CPS mathematical ability in the control group did not exceed the improvement in the experimental group, both male and female groups. The implication is the SBL learning is better in improving the CPS mathematical ability for both male and female groups.

Discussion

The most important thing to be considered is the design of learning material that fit the characteristic of SBL learning. The teachers need to design mathematical situation that can provide a creative activities, such as exploration, investigation, and elaboration activities. The students conduct investigation in clarifying the problem, on why the problem need to be provided and on why the problem is important. By exploring, the teacher gave opportunities for the students to observe and n the process in problem posing, also improve the confidence of the students in learning mathematic. The students can improve their ability in providing problem, as well as doing inquiry activities to find various solution (elaboration). In the moment when the students are exploring, investigating, and elaborating, it will be better when the teachers create a cognitive conflict. Cognitive conflict is a conflict that happened in the students' mind about the appropriateness of a new concept to the basic concept had by the students that created a conflict. From the cognitive conflict, it is expected that the students can construct their understanding (Karli & Yuliariatiningsih, 2000). In that activity, the teacher should guide, stimulate, and facilitate using scaffolding technique and the theory of The Zone of Proximal Development (ZPD) (Suparno, 1997; Oliver, 1999; Oakley, 2004; Suryadi, 2005).

Creating cognitive conflict is a way to change a concept that has possibility in shakening the misconception stability of the students to the scientific concept. This scientific concept leads to the real process of learning. In the simplest explanation, if there is a difference perception that create a contradiction, it can be called as conflict. Making a decision in answering question based on several reasons, often leads to a doubt in individual, thus it can be said that there is a conflict within themselves. Therefore, through accommodation process, the students can modify the cognitive structure to the stability step to create an assimilation process (Setiono, 1983; Suparno, 1997; Oakley, 2004; Suryadi, 2005). It is expected, if the students face open-ended question, they will not confuse in understanding the question, including believing that the various answers proposed are the answers that have analytical and rational basis.

CONCLUSION

SBL learning can be an alternative approach in improving the CPS mathematical ability, both for female and male students. It is meant to lessen the disproportion of problem posing ability and problem solving of the students. From the problems started, the students can find a concept/formula/ mathematic rules that exist. This activity can make the students aware that the concept/rule/formula is actually can be found in everyday life.

However, this research also has some weakness, the improvement of the CPS mathematical ability of the male and female students are analyzed in aggregate. It means that there should be other research that examine the effectiveness of SBL learning toward each gender separately. It should examine the improvement of the male and female students in high and moderate ranking school with the number of representative sample. Therefore, it can be known the effectiveness of SBL learning in improving the CPS mathematical ability in male and female students.

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