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# Measuring the Effectiveness of BLCS Model (Bruner, Local Culture, Scaffolding) in Mathematics Teaching by using Expert System-Based CSE-UCLA

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## Abstract

Many teachers experience difficulties in starting an instruction and in how to make the students learn appropriately. Meanwhile, the teacher has to make the students learn in order the teaching conforms to the four pillars of education according to UNESCO, i.e.: learning to know, learning to do, learning to be, and learning to live together in peace and harmony. In relation to this, a study was conducted to the students of primary schools in Singaraja to see the effectiveness of BLCS model (Bruner, Local Culture, and Scaffolding) in the teaching of mathematics through a measurement using Expert System - based CSE-UCLA. The effectiveness of the teaching model was seen from learning activities, learning achievement, and the students' response to the teaching. Data were collected through observation, test and questionnaire and were then analyzed descriptively. The results show that BLCS model is an effective model to be used in the teaching of mathematics.

**Index Terms:** Teaching model, local culture, scaffolding, CSE-UCLA, Expert System.

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## 1. Introduction

Why is mathematics difficult for the students? Of course it is caused by the fact that mathematics is not a lesson that can be memorized as such but it has to be understood well. In this context, NCTM in [1] states that the principle of learning mathematics states that the student has to learn mathematics by understanding, by actively engaged and by participating actively in building new knowledges based on experiences and knowledge that he or she had before. In other words, to master mathematical concepts well, the student has to understand and consider mathematics a not ready made thing that is ready to be accepted as such by the student, but it has to be reconstructed by him or her...This corresponds to what is stated in [2], which says that one of the characteristics of the acquisition of mathematical knowledges is it is acquired through a construction and is not automatically.

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The implication of the principle of learning mathematics is that the student has to participate actively in constructing the concepts being learned. That student can learn well depends very much on the learning experiences provided by the teacher daily in the classroom [3] states that to be able to provide learning that has a high quality, the teacher has: (1) to understand deeply the mathematics learning material being learned.; (2) to understand how the student learns mathematics, such as to understand such things as his or her attentiveness and misconceptions; and (3) to select tasks that make learning meaningful like when the student has been trained to think, to ask questions, to solve problems, and to discuss ideas, strategies, and solutions that he or she has acquired.

In addition, Steffe in [4] states that: cognitive theory in mathematics learning makes the teacher's role not just as the one who transfers knowledge to the student, but as mediator and facilitator in learning. Thus the roles of the teacher are: (1) to facilitate the process of constructing knowledge by making information meaningful and relevant to the student (2) to give opportunities to the student to express or apply his or her own ideas and to guide him or her to consciously use his or her own learning strategies; (3) to develop and accept the student's autonomy and initiative; (4) to provide activities that can develop the student's curiosity and help him or her to express ideas and communicate ideas to other people; (5) to write tasks by using cognitive terms i.e. to ask the student to classify, analyze, and predict; and (6) to provide the opportunities to the student to respond to the learning process, and the opportunities to think after giving a question.

In this connection, a discussion will focus on how to combine Bruner's theory, local culture (the concept *jengah*) and scaffolding in BLCS model to make mathematics teaching process effective.

## **2. Literature Review**

### *A. Bruner's Theory in Teaching*

Bruner assumes that a child's intellectual development occurs through three phases, i.e.: preoperational, concrete operational, and formal operational. Although Bruner's stages refer to Piaget's cognitive development, but he does not agree that a child's cognitive development depends on his or her age.

Bruner states that a child's cognitive development is generally related to learning. In the preoperational stage, the child's mental activity is developing a relation between experience and action and problem solving is done through trial and error. At the concrete operational stage, the child can already solve problems both directly and indirectly. Direct problem solving is meant solving a problem through manipulating concrete objects. While the indirect problem solving is done by manipulating symbols that the child has in his or her mind. However, the child cannot solve the problem easily because he or she has no experience or the cannot describe the problem solving strategy that he or she uses.

Based on the theory above, Bruner in [5] and [6] develops a learning theory that consists of three progressive stages, i.e.: (1) enactive - learning by doing/acting; (2) Iconic - learning by means of images and pictures (learning through meanings and pictures, scheme, graphics, tables, diagrams, etc.); (3) symbolic - learning by means of words or numbers.

The three modes have a hierarchical relation, which means that symbolic representational meaning is more abstract than iconic representation, and iconic representation is more abstract than enactive representation. In learning mathematics the three modes are very important. However, learning does not need to start from the lowest (enactive) but depends on the extent of the student's basic idea knowledge about what he or she will learn.

The representation modes introduced by Bruner area very important in the implementation of BLCS model as what the researchers have done at the primary school in the course of a research particularly in the teaching to find a rule in addition and subtraction of numbers. For example, in finding a relation between the addition of a positive number and a positive number and the subtraction of a positive number by a negative number.

Finding a rule through this model of teaching was done by helping the student learn through a transformation

activity from model, words, and symbols. In the model activity, the student was active through enactive mode. Then the student tried to transform it into every day words/ sentences (iconic) and finally he or she transformed it into a symbol (symbolic). Before the transformation process was done, first the teacher agreed with the students like: (i) **Positive number** means “go forward ”(ii) **Negative number** means “retreat”; (iii) **added** means “continued with” and (iv) **Subtraction** meaning “turn right”. This agreement was a modification of the agreement on addition and subtraction of round numbers as stated in [7] i.e., (i) **Positive number** means “move forward” ; (ii) **Negative number** means “retreat”; (iii) **Added** means “go straight ahead”; and (iv) **Subtracted** means “turn right ”.

### B. Local Culture (The Concept of *Jengah*)

It has already been known that teaching occurs in a cultural community and the result of learning will be applied to a certain cultural community and the result of learning will also be applied to a certain cultural community. In this context, teaching will be interesting and meaningful if it is done based on/oriented toward a culture. This corresponds to the view of Brooks & Brooks in [8] that state that a culture-based approach can give opportunities to the student to create meaning and to attain an integrated understanding of scientific information he or she acquired and to apply it in the context of his or her cultural community problems. BLCS model some Balinese cultural concepts as stated by Widja in [9] were used. Widja in [9] states that the basic concepts such as *rwabhineda*, *tri-hita-karana*, and *desa-kala-patra* can be related to the process of education to support development. Based on the opinion above, the main concepts need to be considered in the model of teaching: (1) the *rwabhineda* concept refers to the effort to keep a balance in this life through binary classification that has complementary elements (good and bad natures in a thing) This concept is very useful in this teaching model especially when the student learns in a cooperative group. BLCS model stresses mutual respect, respecting the opinion that is stated by every group member; (2) the concept of *tri-hita-karana* contains the elements of *parahyangan* (the relationship of human beings and God), *pawongan* (the relationship of human beings and themselves and their fellow human beings), and *palemahan* (the relationship of human beings and their environment). The application of this concept is generally seen in every activity which ought to be started with prayer. The same is true with a teaching using BLCS model. Besides, this concept is very useful in the learning activity especially in realizing a positive relationship among members of a group and its environment; (3) the concept of *desa-kala-patra*. The concept of *desa-kala-patra* according to [10] is the concept of space, time and human that basically contains the adaptation and harmony and ability to accept diversity in unity which is the same as the slogan of *Bhineka Tunggal Ika*. This concept provides a flexible and harmonious foundation in communication among group members without looking at strengthening differences that they have especially in their learning ability; (4) the concept of *jengah* in the cultural context has the connotation of enthusiasm. This concept needs to be developed in the student so that everything learned is relatively easy to understand. The concept *jengah* will be able to motivate it, he student in learning since the concept of *jengah* can become a motivator of every activity that will be done, can give a direction of the activity toward the objective to be attained, and is able to determine the actions to be done that are harmonious with the objective in order to achieve the objective.

The concept of *jengah* is the foundation of BLCS model, beside other Balinese cultural concepts in a cooperative activity. In this case, the student is planned to interact in order that he or she, in an interaction, can respect others and others can respect him or her, does not sharpen the existing differences and help each other, and is motivated by the concept *jengah* through sentences containing suggestions uttered by the teacher. The sentences that contain suggestions include: “You must be able to do it”, “Others can and you surely can do it”, “No problems that cannot be solved” etc. The concepts above are concepts that support the implementation of teaching in BLCS model. Thus, these concepts, especially the concept of *jengah* are maximized in BLCS model with the purpose of preventing the emergence of the concept of *nasib* (fate) that can hinder learning process. This concept of *nasib* can extremely minimize the student’s ability in learning, that can manifest as a

passive attitude and easiness to surrender.

### C. Scaffolding

Vygotsky in [11] defines Nearest Development Zone (ZPD) as the distance between actual level of development, that is determined through autonomous solution to a problem and child potential development level, that is determined through adult assisted solution to a problem or cooperation with peers. It can be thought that ZPD is a difference between what a child can do alone and what he or she can do with the help from adults (*scaffolding*). The location of ZPD stated [12] can be illustrated as shown in Fig. 1.

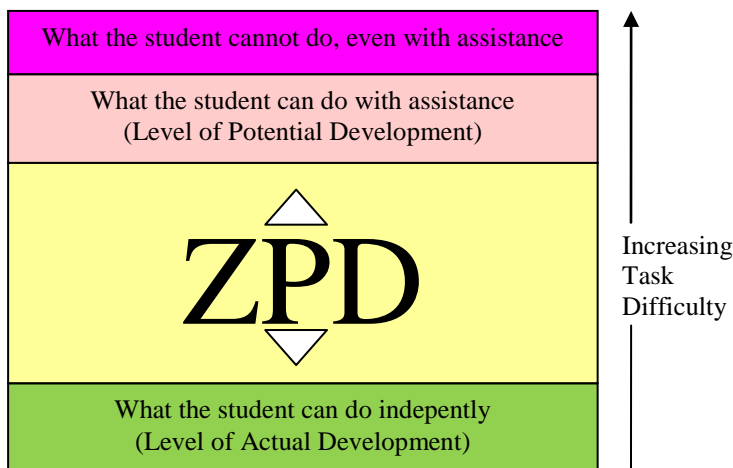


Fig.1. Location of ZPD (adopted from Teaching in the Zone: An Introduction to Working within the Zone of Proximal Development (ZPD) to Drive Effective Early Childhood Instruction; 2012)

Vygotsky believes that learning occurs at the time a child is working in his or her ZPD, since ZPD is an area between an actual level of development that is defined as ability to solve a problem by oneself and potential level of development that is defined as problem solving under adult's guidance or peers who are more able. Tasks are not things that a child can do alone but can be done with the help from peers or adults who are more competent in the form of scaffolding.

*Scaffolding* refers to help given by the peers or more able adults in [11] it is stated that to provide scaffolding means to give to the child a great amount of support during the initial stages of learning and then minimize help and chance to the child to assume responsibility which is increasingly greater right after he or she can perform the task alone. In BLCS model, if the student experiences difficulty in constructing a concept, he or she is given a necessary support until he or she can actually orient himself or herself toward the concept being learned.

### D. CSE-UCLA

CSE-UCLA evaluation model developed by Alkin in [15] has five stages of evaluation, namely system assessment, program planning, program implementation, program improvement, and program certification.

CSE-UCLA model is an evaluation model with five evaluation dimensions (system assessment, program planning, program implementation, program improvement, program certification) and are suitable to be used to evaluate service programs that help human life, such as: library program, bank, cooperative, e-government, e-learning, etc [16].

CSE-UCLA model is a model evaluation has five dimensions of evaluation, among other systems assessment

that provide information about the state of the system, the program planning which enables selection of the program particular to meet the needs of the program, program implementation that prepare information to introduce the program, program improvement that provides information of function/program performance, program certification which gives information about the benefit or usefulness of the program[17].

On the basis of some views above, a synthesis can be made that in general *CSE-UCLA* model is an evaluation model that has five evaluation dimensions, which include system assessment, program planning, program implementation, program improvement, and program certification that is suitable to be used to evaluate service programs that help human life.

#### *E. Expert System*

In [18], expert system is an artificial intelligence system that combines knowledge base with inference engine so that it can adopt the ability of the experts into a computer, so the computer can solve problems such as the often performed by experts.

In [19], expert system is a computer application program that tries to imitate an expert's reasoning in solving problems specifically.

In [20], expert system is an artificial intelligence program that combines knowledge base with inferential system or an effort to imitate an expert.

In [21], an expert system is one branch of artificial intelligence to learn how to 'adopt' an expert how to think and reason to solve a problem and make a decision or the conclusion of a number of facts.

Based on some views above a synthesis can be generally made that *CSE-UCLA* model is an evaluation model that has five dimensions which include system assessment, program planning, program implementation, program improvement, and program certification that are suitable to be used to evaluate service programs that help human life.

### **3. Methodology**

#### *A. Object and locations of the Study*

- 1) The object of the study was BLCS model (Bruner, Local Culture, and Scaffolding).
- 2) The locations were primary schools in Singaraja, Bali.

#### *B. Subject of the Study*

The subjects of the study were 71 elementary school students in Singaraja Town.

#### *C. Type of Data*

The data in this study were quantitative and qualitative data.

#### *D. Technique of data collection*

The data were collected through observation, test and questionnaire.

#### *E. Technique of Data Analysis*

The data of the study were analyzed descriptively.

#### 4. Result and Discussion

##### A. Result

##### 1. Student Learning Activity

Result that is related to student learning activity is presented as shown in Fig. 2.

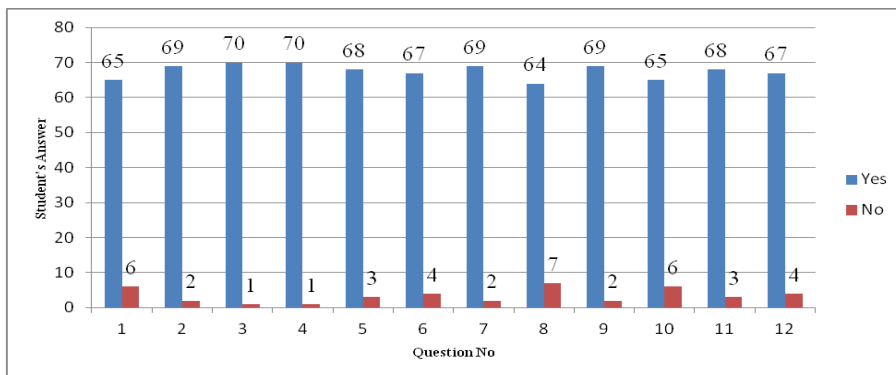


Fig.2. Student Activity in BLCS

Fig. 2 shows that for every question about student learning activity, only some students answered no (in red), and the rest answered yes (in blue). Through a computation the student learning activity average was 95.2%. This means that the students' activity in learning through BLCS model was very high.

##### 2. Learning Achievement

The student learning achievement in the implementation activity can be reported as shown in Fig. 3.

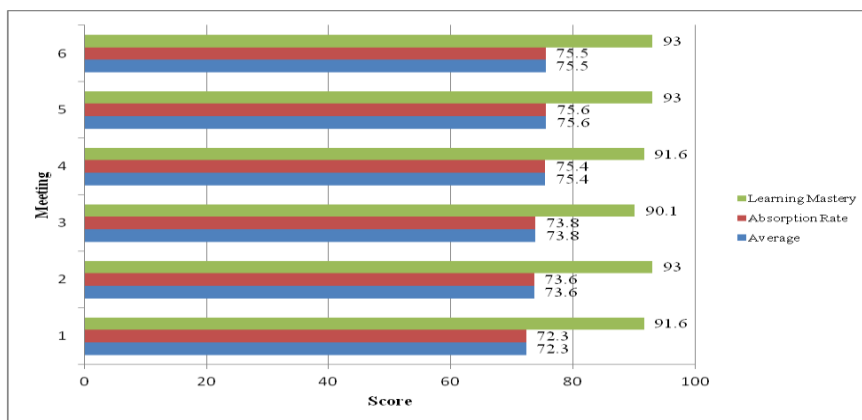


Fig.3. Average, Absorption Rate, and Learning Mastery for Each Meeting

Fig. 3 shows average, absorption rate (DS); and learning mastery (LM) have exceeded the criterion specified, namely, Absorption Rate (AR) = 65%, and Learning Mastery (LM)= 85%. Through a further computation, generally, Average = 75.8, Absorption Rate = 75.80%; Absorption Rate = 75.80%; and Learning Mastery (LM) = 93.00%, thus it can be concluded that the students' learning achievement falls into good category.

3. Student Response to BLCS Model Implementation

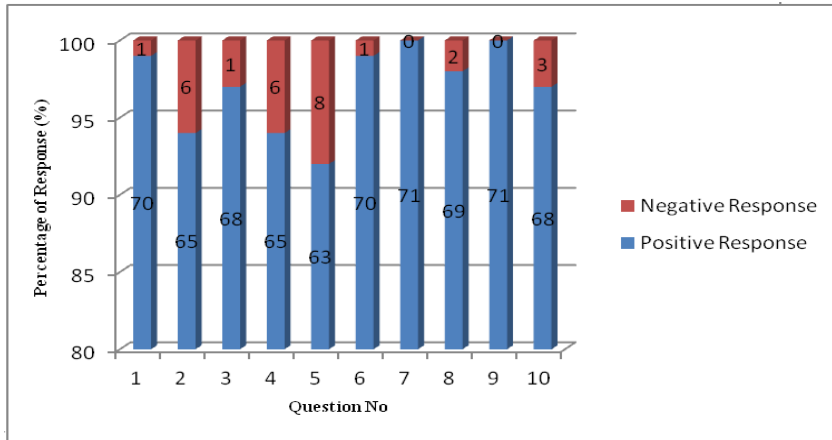


Fig.4. Student Response to BLCS Model Implementation

Fig. 4 shows that almost all students gave a positive response to each question in the questionnaire Student Response to BLCS model implementation and all exceeded 85% , thus it can be concluded that the students' response was positive to each question in the questionnaire Student Response to BLCS model implementation.

4. The result of the measurement of BLCS Model in Mathematics Teaching Using Expert System-Based CSE-UCLA

The result of the measurement of the effectiveness of BLCS model in Mathematics teaching using expert-system-based CSE - UCLA in Mathematics teaching can be shown in Table 1 as follows.

Table 1. Result of the Measurement of the Effectiveness of BLCS Teaching Model in Mathematics Teaching Using Expert System-Based CSE-UCLA

No	Evaluation Component	Aspect to be Evaluated	Model 1		Model 2	
			Conventional	CF	BLCS Teaching	CF
1	System Assessment	Learning activity	76.0	0.4	85.0	0.8
		Learning achievement	75.0	0.2	87.2	0.8
		Student response	70.0	0.2	81.0	0.8
		<b>Average</b>	<b>73.7</b>	<b>0.3</b>	<b>84.4</b>	<b>0.8</b>
2	Program Planning	Learning activity	72.5	0.2	84.0	0.6
		Learning achievement	71.0	0.2	86.5	0.8
		Student response	70.5	0.2	82.5	0.8
		<b>Average</b>	<b>71.3</b>	<b>0.2</b>	<b>84.3</b>	<b>0.7</b>
3	Program Implementation	Learning activity	72.0	0.2	90.0	0.8
		Learning achievement	71.0	0.2	91.7	1.0
		Student response	71.0	0.2	87.8	0.8
		<b>Average</b>	<b>71.3</b>	<b>0.2</b>	<b>89.8</b>	<b>0.9</b>

No	Evaluation Component	Aspect to be Evaluated	Model 1		Model 2	
			Conventional	CF	BLCS Teaching	CF
4	<i>Program Improvement</i>	Learning activity	76.0	0.4	85.2	0.8
		Learning achievement	74.0	0.2	86.7	0.8
		Student response	72.0	0.2	83.2	0.8
		<b>Average</b>	<b>74.0</b>	<b>0.3</b>	<b>85.0</b>	<b>0.8</b>
5	<i>Program Certification</i>	Learning activity	78.0	0.6	87.6	0.8
		Learning achievement	77.5	0.4	88.2	0.8
		Student response	73.0	0.4	85.5	0.8
		<b>Average</b>	<b>76.2</b>	<b>0.5</b>	<b>87.1</b>	<b>0.8</b>
<b>Total Average</b>			<b>73.3</b>	<b>0.3</b>	<b>86.1</b>	<b>0.8</b>

The result of the measurement can be made clearer through Fig.5. below

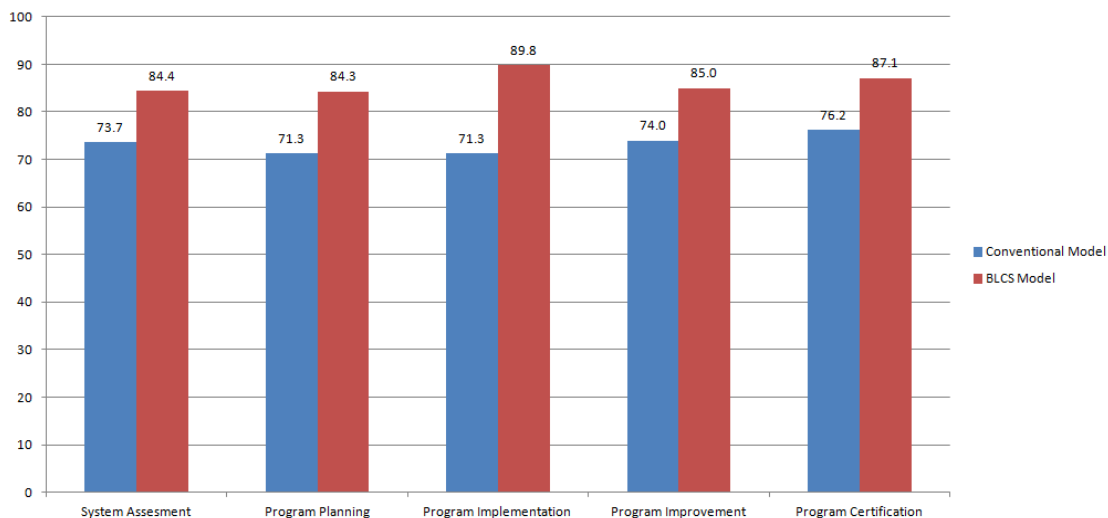


Fig.5. Result of the Measurement of Effectiveness between Conventional Teaching Model and BLCS Teaching Model by using Expert System-Based CSE-UCLA

**B. Discussion**

The syntax of BLCS model consists of 4 stages, namely Stage 1, introduction; Stage 2, Use of Bruner’s theory, local culture, and *scaffolding*; Stage 3, Presentation and conclusion drawing, and; Stage 4, Evaluation as presented in Fig. 6.



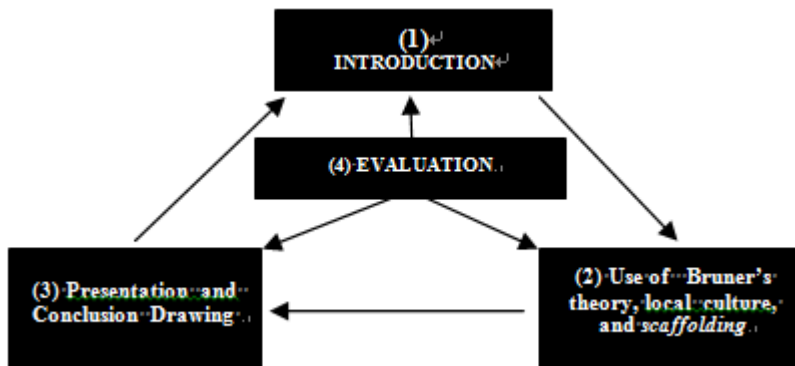


Fig.6. Syntax of BLCS Model

Ardana, in [3] states that the initial phase stresses on teaching process starting with the teacher leading the students to make a connection between the learning task that they are doing and their past experiences, in terms of academic, personal and cultural experiences. The aim is to involve the students in learning by activating their curiosity, attracting their attention to the problem they are facing, or asking some questions that make the students think. In addition, this phase gives the chance to the teacher and the students through evaluation activity to identify prior concepts that they have that are related to the new concepts that they are learning, do their prior concepts match with the new ones or not (misconceptions). In this phase the teacher identifies the strengths and weaknesses of every individual or group. This is meant for the teacher to facilitate the adjustment of the teaching activity being implemented with the learning experience of each individual or group in relation to the knowledge being learned. When the students have not been involved in learning, the teacher will dig the students' prior knowledges by giving them triggering questions that fit the students' abilities that enable them to think and at the same time activate their concept *jengah* through suggestion sentences: "I believe that you can...must be able to do it"; "others can ... You / can too"; "All things can be solved.. if we try our best", etc. With the possession of a good prior knowledge, the students are ready to communicate and will keep calm in following the lesson and their communication will be directed and will be prevented from over communication. This Activity in this phase needs to be done because Mathematics teaching can proceed well when the students' prior knowledges that are related to the material being learned are understood well so that they will facilitate assimilation in the students. In this regard, Piaget [1] states that assimilation is a process of integrating new information with the existing cognitive structure in the student's mind. It means that the student's prior knowledge is something that needs to be taken into consideration in teaching [13] states that one important factor that can influence the child's learning is what he or she has known. [2] states that to be more exact, we need to focus our attention on the student's schemata in the assimilation. [14] stresses that every teacher has to be aware first of what the students' preconceptions and experiences look like and then he or she has to adjust the lesson and the method of teaching to the "pre"-knowledges themselves. This means that in order for the students' schemata can be built and developed, the teacher needs to relate their preconceptions with the new concept that they are going to learn.

In the second phase, the teaching is conducted by grouping the students into cooperative groups with 4-5 members with different abilities and sexes. In this phase, the teacher facilitates the students at the time of investigating into the mathematical task they are doing, working to understand certain concepts and to acquire skill to solve problems and mathematical skill. In this phase, the teacher facilitates the students to learn in ZPD and makes use of Bruner's theory, local culture and provides assistance in the form of scaffolding. Bruner's theory (enactive, iconic, and symbolic) serve to facilitate learning at their pace. The students who are still learning in enactive and iconic levels can move on to representative level in the standard mathematical process.

If the students get stuck at the time of investigation, the teacher will investigate it, the teacher will facilitate them by providing a help in the form of scaffolding and activating their concept of *jengah* by using suggestion sentences such as: “nothing is impossible to be done...”; “whatever is believed and tried with our best will be accomplished”; “nothing is impossible... as long as you want to strive to get it ...”. Thus in the end, they will be able to have a deep understanding in accordance with their potentials. Scaffolding in refers to the help provided by the more competent peers or adults. [11] states that to provide scaffolding means to provide some support during initial stages of teaching and then minimizing help, giving the chance to the children to assume increasingly greater responsibility after they are able to perform the task by themselves.

The presentation and decision making activities in the third phase involve the students more than just reviewing what they have learned. During this phase, the teacher involves the students in activities and discussions that are challenging that can broaden their understanding of concepts and problem solving skill. The students apply what they have learned the students apply what they have learned about mathematical tasks and their experiences to develop, broaden and deepen their conceptual understanding. In this phase, the activation of the concept of *jengah* is done when the students have been able to communicate, no matter how simple it is done what they have accomplished.

Evaluation in the middle in Fig. 6 means that in every phase, there is a need to do an evaluation as part of reflection on the activity in that phase. In every phase, from the beginning to the end, the teacher evaluates the students' progress and asks the students to evaluate themselves. The feedback can come from quizzes, discussion with the students, or the use of other techniques. The teacher uses feedback to reflect on the effectiveness of teaching that he or she has done, and to do some corrections during the lesson.. The students use feedback to reflect on what they have understood, what they still need to learn, and what they want to learn next. With such phases of teaching above, one can expect meaningful mathematical learning to happen.

## 5. Conclusions

In the light of the results and discussion above, it can be concluded that the use of the combination of Bruner's theory, local culture (the concept of *jengah*), and *scaffolding* in the BLCS teaching model is very effective to use in mathematics teaching.

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