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Scaffolding Strategy In Mathematics Learning

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Abstract

Mathematics learning should be designed so that it is oriented to the goal which is focused on process. Learning orientation is focused on the development of ‘mathematical thinking’ and ‘mathematical disposition’. Then, the teaching-learning process is conditioned in order that student is actively to construct “meaning” through the process of self-experience, not just knowing. In such conditions the teacher's role shifted from mere "showing and telling" to be facilitators and guidance who can be responsive to students' development of thinking processes which proceed from the actual ability toward potential ability to construct mathematical knowledge. These efforts, among others, carried out by presenting a learning construction which is appropriate with the tradition of socio-constructivism. One of the most important tradition of socio-constructivism is the idea of scaffolding in practice learning. This study describe the role and strategy of scaffolding in mathematics learning.
Key words: Scaffolding Strategy, Mathematics Learning.

I. INTRODUCTION

Improving the quality of learning mathematics from time to time has always received attention from various parties. The concern is inseparable from the awareness of the importance of mathematics itself. Mathematics has an important role both as a science that is in addition and a tool (Hudoyo, 2003; Suherman, et al., 2003). As the science, mathematics can be viewed as knowledge acquired through reasoning that are hierarchical, deductive axiomatic, accurate, formal and abstract. While as a tool, it can be viewed as the language of mathematics as well as a means to develop ways of thinking which is needed in everyday life to deal with and explain the phenomenon of mathematical science itself also the science outside of the area as well as in coping the progress of science and technology in the future. Thus, it can be understood that the implementation process of mathematics learning at every level of education requires attention in a comprehensive manner. The focus of attention would not be separated from the three inter-related aspects of the aspects; teachers, students and materials/content.

In the process of teaching and learning of mathematics, teachers play a role to plan, design process, provide context and create a learning environment such that the material presented can be understood by students, develop their schemata, also giving them opportunity to construct their understanding, interacting with each other in expressing ideas so that it will produce optimal learning outcomes. Teachers should design the learning of mathematics which aims in a goal-oriented with a focus on the process. Directed learning orientation on competence development "mathematical thinking" and " mathematical disposition”.

According to Sumarmo (2008), in general, mathematical thinking can be defined as conduct or mathematical process (doing math) or mathematical tasks. When it is viewed from the complexity involved in mathematics activities, this can be classified into two types, namely low order mathematical thinking and high order mathematical thinking. Mathematical thinking is classified into five main competencies which are mathematical understanding, mathematical problem solving, mathematical reasoning, mathematical connections, and mathematical communication. Sumarmo further explains that the development of mathematical thinking competencies should also be comprehensively followed by development of a mathematical disposition of desire, awareness and a strong dedication to the student to learn mathematics and perform various mathematical activities. The learning programs designed by teachers should be oriented towards the achievement of the five core competencies in mathematical thinking and mathematical disposition. This learning orientation should be achieved through a process of teaching and learning are conditioned in such a way that students actively construct "meaning" through "experiencing" which is not only "knowing".

In such conditions the teacher's role shifted from mere "showing and telling" to be facilitators and guidance who can be responsive to students' development of thinking processes which proceed from the actual ability toward potential ability to construct mathematical knowledge. Teachers should strive to design a learning activity involving students actively to construct barns information and experience so that it can be understood as meaningful. Some of the activities that teachers can do to create these conditions include: (1) Selecting mathematical tasks so as to motivate student interest and enhance the intellectual skills of students. (2) Provide an opportunity for students to deepen their understanding of mathematics as well as product and process implementation. (3) Creating a classroom atmosphere that encourages achievement discovery and development of mathematical ideas, (4) Using and assist students'

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understanding, technology tools, and other sources to enhance the discovery of mathematics, (5) Achieve and helps students to explore the relationship between new and earlier knowledge, (6) To lead individually, in groups and in the classical style (Depdiknas, 2007).

These efforts may be performed by presenting a draft of learning mathematics in accordance with the tradition of socio-constructivism. Constructivism is a theory of cognitive development that emphasizes on the active role of students in building their own understanding of the knowledge learned. Slavin (1997) revealed that constructivism in educational history was born from the idea of Piaget and Vigotzky. Both pointed out that cognitive development occurs only if the conceptions that have been previously understood, later processed through an imbalance process in order to understand new information. Thus, individual is viewed construct knowledge when s/he could assimilate and accommodate continuously towards new and earlier information or in other words, someone studying knowledge means he is basically learning to construct science.

Viewed from the socio-cultural context, Lev Semenovich Vygotsky states that learners who are in the process of constructing a social concept need to look at the environment. This constructivism is called social constructivism. There are two important concepts in the theory of Vygotsky (Slavin, 1997), the Zone of Proximal Development (ZPD) and scaffolding. Zone of Proximal Development (ZPD) is the distance between the actual developmental level defined as the ability of solving problems independently and the level of potential development that is defined as the ability of problem solving under adult guidance or in collaboration with more capable peers. This study will present one of the most important things in the tradition of the role of socio-constructivism and scaffolding strategies into practicing the idea of learning mathematics.

II. Scaffolding Role and Strategy in Learning Mathematics

Scaffolding is a term in the world of education that exists in modern constructivist theory of learning. In learning, scaffolding takes a very important role in the development of student learning. Each time the students reach a certain developmental stage in learning which is characterized by the fulfillment of indicators in certain aspects, the students will require scaffolding. Vygotsky (Nur, 2004) suggests that the scaffolding is the concept of learning with an assistance (assisted learning). According to Vygotsky, the functions of higher mental, including memory and the ability to direct attention to specific goals and the ability to think in symbols, is a behavior that requires assistance, especially in the form of media.

When the interaction process is taking place, scaffolding might be required simultaneously and is integrated in the physical, intellectual and emotional aspect. The presence of scaffolding is closely related to the nearest development zone or Zone of Proximal Development (ZPD) of students. According to this view, a successful learning depends on when the students work on learning tasks which are in their ZPD, so the role of a teacher is very important in their development tasks. In this case, "the teacher must intervene to prevent the decreasing in learning and working together in the ZPD". Then, all forms of assistance is reduced gradually with increasing ability and confidence of students (Rodgers and Rodgers, 2004; Walqui, 2006).

Scaffolding is relevant to the view that in mathematics learning needs of multi-way interaction, teacher - student, student-student, student-teaching materials materials so that students -based on experience- can develop mathematical knowledge and strategies to respond to mathematical problem given. Scaffolding is the provision of some assistance to students during the early stages of learning, then reducing the assistance and provide the opportunity to take over greater responsibility after he or she can do it (Slavin, 1997). Teacher or other students assist students learn to master a concept or complete a math assignment, which was originally the student has not been able to absorb or understand. When students are able to figure out the problem or able to

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master a concept and solve problems, gradually the teachers let the students free to explore their ability and to solve mathematical problems.

Thus, it can be concluded that scaffolding is didactic action in the form of a measured and limited assistance and encouragement to students given by another person (teacher or other students) who have experience or knowledge and a deeper understanding of mathematical concepts or the context being studied so that students will independently be able to construct knowledge and solve mathematical problems. The aid may include illustrations, hint (clue), motivation, warnings, outlines of the problem in to more modest steps toward how to solve the problem, giving examples, and other assistance which all should be clear and relevant enabling students to reach the level of development for independent learning. In learning mathematics students interact with teachers and other students also based on students' mathematical experiences to develop strategies to respond to a given mathematical problem.

McKenzie (1999) explains that the important things in the scaffolding is a scaffolding structure framework which should be clearly and precisely on the expected goals. Teachers should provide a framework structure that is "enough" to make students become productive with no restrictions on them, that would hamper the initiative, motivation and the sense (resourcefullnes) on them. McKenzie further explained there are at least eight special features of scaffolding that must be taken into account in learning practice, which are:

1. Scaffolding provides clear direction, offering a step by step instructions to explain what the students must do to achieve their learning activities;
2. Scaffolding describes the targets/objectives, so students do not meet a gap that gives nothing. Their works must have goals which are focused entirely on the plan. Any of teachers’ actions should be intended to improve thinking processes, making a significant discovery and development of students' horizons;

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3. Scaffolding leads students continuously on a given task, by providing a kind of "AIM or route" to be followed for students completing their duties;
4. Scaffolding provides the assessment to clarify what is expected, in the form of rubrics or standards of work quality expected and delivered since the beginning;
5. Scaffolding is the starting point for students to access other sources of information useful for solving problems;
6. Scaffolding reduces uncertainty, surprise and discontent;
7. Scaffolding produces efficiency because it is focused and there is clarity of duty and time;
8. Scaffolding creates momentum, through the search process, ask, ponder, consider in stimulating inspiration.

In the context of learning there are several scaffolding strategies that can be done ie modeling, bridging, and building schema (Walqui 2006). What is meant by modeling is the strategy of scaffolding in the form of giving an example or model for solving mathematical. From the examples or models of a given student can then compare, analyze, interpret and evaluate the context of mathematical problems that it faces. Bridging is done with scaffolding strategy to revive the knowledge and students' understanding of the concept of something that already exists. Meanwhile, schema building is the scaffolding in the form of schematics, diagrams illustrate the problem situation, may also be concepts network related to problem situations.

Another form of scaffolding is also expressed by Roehlar and Cantlon (1997) in their research include: inviting student participation, offering explanation, and verifying and clarifying students' understanding. What is meant by inviting student participation is a form of scaffolding that is given with a view to inviting students to participate actively in learning through teachers' efforts to lure student participation. Offering explanation is a form of scaffolding that refers to a statement corresponding to the understanding of the emerging concept of what students are learning, why and when the concept was used and how the concept was used. While verifying and classifying students' understandings is a form of scaffolding related to the verification of the understanding that emerged from the students. If the comprehension occurring makes sense, then the teacher should verify the response, but if the comprehension does not make sense, then the teacher must also clarify to the students.

Scaffolding strategies in order to achieve the desired goals, Speer & Wagner (2009), suggested to the teachers to do the following things:

1. Recognize or figure out students' mathematical reasoning (correct or incorrect);
2. Recognize or figure out if/ how student' ideas have the potential to contribute to the mathematical goals of the discussion;
3. Recognize or figure out if/ how students' ideas (both correct or incorrect) are relevant to the development of students' understanding of the mathematics,
4. Prudently select which contributions to pursue from among all those available.

Teachers are very instrumental in planning and implementing scaffolding in teaching and learning in the classroom so that the scaffolding provided is truly functional and effective. In this case, the presence of the teachers who really have the competence and sensitivity as well as all students is required. With competence, sensitivity and good introduction to students, teachers can plan appropriate scaffolding and reduce it gradually.

III. Scaffolding Strategy Implementation Examples

Scaffolding strategies in learning activities can be designed prior to the learning process through the arrangement and presentation of materials/ materials or problems/ matter as outlined in study guides or worksheets that will be given to students. Scaffolding strategies can also be implemented during the learning process through the activities of teachers in managing learning activities in order to engage students actively in constructing and understanding the materials /contents and

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problems/ cases being faced. Similarly, scaffolding strategies can be implemented at the end of the learning process that is intended to provide reinforcement, verification and prediction of material or matter related. As an example of scaffolding strategies that can be combined with each other, among others, are presented as follows:

Example 1:

Learning Objectives: Students are able to apply the linear equation everyday life.

Context of the problem: On holiday Amir cycling toward her grandmother's house. Amir pedaling a bicycle with a fixed rate 8 KM/ hour. After pedaling for three hours, rain suddenly fell down, and Amir stopped. Amir ground shelter and rest for two hours. After the rain subsided and because the roads are very liein Amir continued his journey with speeds of 4 KM/ hour. Four hours later he arrived home to her grandmother.

1. Describe the problem into a graph
2. What is the distance that has been pursued by the Amir to get to grandmother's house?

Scaffolding Strategy:

1. Help students to create a table showing the relationship between time (hours) and distance. Ask them to complete this table:

   Table 1. Amir’s Trip

Amir’s Trip									
Hours	1	2	3	4	5	6	7	8	9
Distance	8	…	…	…	…	…	…	…	…

2. Prepare a blank transparency. Guide the students to make a Cartesian diagram and determine the sign of time (hours) on the horizontal line and mark the distance (KM) on the vertical line.
3. Ask them to determine the sign in the first hour, second and so the diagram is Cartesian.
4. Ask them to create a graph.
5. How many KM Amir traveled to his grandmother's house.

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6. Ask them to explore the question further as follows:
   - If during the trip was no rain and Amir pedaling with fixed speed without a break, how many hours he needs and at a steady pace, how he will get to her grandmother's home? Make a graph!
   - If Amir pedaling with fixed speed 8 KM/ hour, how much time he needs to get to her grandmother's home?
   - What is the distance that Amir traveled for 2 ½ hours with fixed speed 8 KM/ hour?
   - Determine a relationship between the distance (s) with time (t) of Amir's trip, if Amir pedaling a bicycle with fixed speed 8 KM/ hour, 5 KM/ hour, and *n* KM/ hour.

Example 2:

Learning Objectives: Students are able to perform arithmetic operations and able to do fractions and problem solving of the situation presented.

Context of the problem: Fractional arithmetic operations and find patterns to determine the number of fractions

*Scaffolding Strategy:*The teacher gives the task of solving the problem as follows:

The purpose of this activity is to determine your ability to perform arithmetic operations fractional form, follow these instructions:

1. Register integers -5 to 5, as a result of the operation of the two fractions. Example: -8 / 3 + 12 / 3 = - 1;
2. For each operation always consists of a positive fraction and a negative fractions. See the example above;
3. Use one of the arithmetic operations: +, -, x, : ;
4. Two fractions are involved in every single operation, should be a blend of two fractions of different types (ie, consisting of mixed types of fractions, simple fractions, and not a simple or fractional). See example;
5. Before determining the results of its operations, the results column number, first change the mixed fractions into ordinary fractions and fractions are not simple, being simple fractions;
6. Write down a list of your arithmetic operations on the table below, and specify the results of its operations in the result column number available.

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Table 2. Arithmetic Operations Fractions

Integer	The first fractions	The second fractions	Operation	Results
-5	...	...	...	...
...	...	...	...	...
...	...	...	...	...
5	...	...	...	...

At first, the students work on the problems individually, teachers observe and provide scaffolding bridging and offering some explanation and then later as students work with a friend beside him, showing each other their answers and discuss it.

In the following session, teachers assign students to complete the following task for 10 minutes.

Determine addition result of:

$$\frac{1}{2}+\frac{1}{6}+\frac{1}{12}+\frac{1}{20}+\frac{1}{30}+\frac{1}{42}+\frac{1}{56}$$

Firstly, students work individually, after 10 minutes, followed by a discussion with his/her pair for 5 minutes in order to make sure and correct answers. Teachers monitor directly, while providing scaffolding bridging and offering explanation. After that phase of activity followed by group discussions (4-5 people) for 25 minutes to discuss the task of solving the above problems. Teachers with scaffolding building scheme (depending on students' understanding of the situation at the time), watching carefully, and give directions as follows:

Teacher: Try to note the denominator of the fractions above, express the denominator as the product of two numbers the difference is 1.

Teacher: Next specify the numerator of the fraction above as a result of the difference 2 sequential numbers.

Teacher: Exploration of the phenomenon of what happened.

Teacher: Determine its addition result.

Teacher: Develop your exploration and find the pattern to determine addition result of:

$$\frac{1}{2}+\frac{1}{6}+\frac{1}{12}+\frac{1}{20}+\frac{1}{30}+\frac{1}{42}+\frac{1}{56}+\frac{1}{72}+\frac{1}{90}$$

Teacher: Do the symbols for numbers numerator and denominator, expand your exploration and find the pattern in general to determine the amount of certain fractions.

CONCLUSION AND SUGGESTION

The tradition of socio-constructivism states that learners in constructing a concept cannot be separated from the context of social environment, culture and language. On the other side, mathematics learning is an active process in an effort to help students build understanding. Management of learning mathematics that focuses on active student involvement also requires a constructive learning environment. Teachers as a major director in learning and devise strategies should provide a clear and precise scaffolding so that students can achieve the level of development potential in understanding and constructing mathematical knowledge. Scaffolding strategies that can be combined in the learning activities include modeling, bridging, schema lftuilding, inviting student participation, offering explanation, and verifying and clarifying students' understanding.

If you want to bring a clear strategy and appropriate scaffolding, it is advisable for teacher to constantly make observations and noticing to all student activities at every opportunity both in school and in class. Noticing will help teachers to be able to determine a clear strategy and appropriate scaffolding when the learning process takes place.

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