SCIENCE TEACHING IMPROVEMENT IN JAPAN:

THE THREE STEPS OF CONSTRUCTIVIST LEARNING

Slamet Suyanto[1], *Yoshisuke Kumano*[2]

Abstract

Constructivist learning (CL), although the basic principles of the theory have been developed for years, has recently become a prominent approach in teaching and learning science. The implementation of the theory in schools, however, is still problematic: how to implement the constructivist learning theory into practice? What are the results of the implementation of CL? This paper reflects the practices and the results of the constructivist learning approach in Japan as a part of the JICA training experiences.

Keywords: constructivism, constructivist learning

Japan and Indonesia have similar education system. Therefore some teaching and learning strategies and any educational innovation in Japan would likely be applicable in Indonesia. One of the similarities is that the schooling system in both countries is run under the national curricula. The government assigns the same curriculum for a certain school level so that the students in the same level learn the same topics of science.

[1] Lecturer of Biology Education, Faculty of Mathematics and Science, Yogyakarta State University (UNY, Indonesia, JICA Trainee

[2] Associate professor of Shizuoka University, Japan

School level system in the both countries is alike: Primary School for six years, Junior High School for three years, and Senior High Schools for three years. Primary schools mostly stand separately from Junior and Senior High Schools.

The main educational problem is also similar, specifically in the decrement of the science education quality. The quality of science education in Indonesia seems to decrease as Japan does because of the distortion of the curriculum goals and objectives. In Indonesia, teachers tend not to teach students to achieve the national curriculum goals and objectives but to drill their students with tests in order to pass and to get good scores on the national examination. Japan has similar problem as it is clearly depicted by Kumano (1995:20):

> "Standardized examination …is still another reason for designating the current situation as one of the crisis for science education in Japan. For many the main goal is merely to get better scores on standardized examinations. The major purpose, then, is drill and practice in order to learn science concepts by rote memorization and to review questions likely to appear on the examination."

To solve the problem, Japan at least assigns three major strategies. The first strategy is reorganizing the contents of the science curriculum. The contents of the curriculum will be reduced in order to give more opportunities for students to acquire the whole areas of development by doing real and meaningful science activities. The contents would also be adjusted to local conditions in order to meet the needs of local society and the need of advanced science and technology.

The next strategy is promoting authentic assessment. Japan assigns the national level examination twice during school periods: after Junior Secondary School and after Senior High School. In school levels, however, there will be authentic assessment to

promote students' development. Those two strategies will be widely applied starting in the year of 2002. The last strategy is fostering constructivist learning, which has been widely implemented in schools, to replace the traditional science teaching which is mainly relied on recitation, memorization, and rote learning.

This paper discusses the implementation strategies of the constructivist learning developed in schools attached to Shizuoka University, Japan as results from a three-month JICA training in Japan.

Constructivist Learning

Constructivism explains the nature of how human beings learn. According to the constructivism learning is constructing understanding or knowledge by fitting the new phenomena, ideas, or activities to the existing knowledge and believe that already learned (Canella & Reiff, 1994; Jong & Groomes, 1996; Kaufman, 1996; Richardson, 1997; Wolfe & McMullen, 1996). Thus the key word for constructivism is to "construct". Therefore, in learning the learners should really construct understanding of the content or meaning in the sense of meaningful learning, rather than recitation, memorization, or imitation.

Piaget, in theory of cognitive development (1972), notified that in learning children construct knowledge through their interaction with objects and society as well. Piaget also noted that learning has dialectical process within individuals causing disequilibria between the new phenomena and the existing knowledge or believe that end up with new schemes. According to Piaget, learning is organizing and structuring schema through accommodation and assimilation. Assimilation is fitting the new scheme into the previous scheme learned.

Concordance with Piaget, constructivist learning assumes that students come to the classrooms with ideas, believe, and knowledge (Richardson, 1997). The students may add, revise, or modified their knowledge, ideas, and believe, while they are learning in school. This process is called construction process. The teacher facilitates the construction process by inciting problems that encourage students to think about, by promoting inquiry mind, sharing ideas, communication, and by providing appropriate learning resources.

There are at least four characteristics of constructivist learning class according to Richardson (1997). The first characteristic is problematic. Learning is solving a real problem. Even in social constructivist learning, the problems to learn are come and related to societal issues from the students' daily living.

The second is discovery and inquiry process. Students solve the problem by using scientific, inquiry-, and discovery-based processes. Students may conduct observation or experiment to get data and review references in order to solve the problem.

The next characteristic is that the science class enables students to do individual and group sharing. They may work individually and in small groups to share their ideas or finding to the whole class. The last is that a constructivist learning class promotes students to make reflection and revision to their existing knowledge or understanding based on what they learn.

Brook and Brook (1993) distinguish traditional teaching from constructivist teaching in a broader school environment. The distinction can be seen in the following table (Table 1).

Table 1. Contrasting School Environments[3].

Traditional Classrooms	Constructivist Classrooms
Curriculum is presented from part to whole, with emphasis on basic skills.	Curriculum is presented from whole to part with emphasis on big concepts.
Strict adherence to fixed curriculum is highly valued	Pursuit of student questions is highly valued.
Curricular activities rely heavily on textbooks and workbooks.	Curricular activities rely heavily on primary sources of data and manipulative materials.
Students are viewed as "blank slates" onto which information is etched by the teacher.	Students are viewed as thinkers with emerging theories about the world.
Teachers generally behave in a didactic manner, disseminating information to students.	Teachers generally behave in an interactive manner, mediating the environment for students.
Teachers seek the correct answer to validate student learning.	Teachers seek the students' points of view in order to understand students' present conceptions for use in subsequent lessons.
Assessment of student learning is viewed as separate from teaching and occurs almost entirely through testing.	Assessment of student learning is interwoven with teaching and occurs through teacher observations of students at work and through student exhibitions and portfolios.
Students primarily work alone.	Students primarily work in groups.

The Three Steps of Constructivist Learning

Many schools attached to Shizuoka University implement constructivist learning in the three steps. Step one is guidance. The teacher assigns the topic to learn and help students to understand the topic, to make image map of the whole factors might be related to the topic, and to choose a specific problem for individual or group

3 Source: Brooks, J. G. & Brooks, M. G., (1993). In search of understanding: The case for constructivist classrooms. Alexandria, VA: Association for Supervision and Curriculum Development. (p. 17) in Henrique, L. (1997) http//www.educ.uvic.ca/depts./snsc.

investigation. In this step the teacher explains what is going to be learned and what the students should know about by exposing a problem. The students try to figure out the topic by drawing mental images about the factors that may influence the problems by using their prior knowledge and experiences.

Step two is mainly inquiry and discovery activities. Students work in groups of 4 to 5. They discuss the way they solve the problem, conduct experiment, and record the results.

Step three is communication, reflection, and value-sharing activities. Students analyze the data and share common ideas within the groups to make generalization and conclusion. Then the students communicate and share their finding with the other groups. Some students may ask questions, give some comments, or critics. This step ends up with conceptualization and book making. Students revise, adds, or change their previous concept map based on new constructed knowledge or understanding. The complete diagram of the three steps of constructivist class is presented in **Appendix 1**.

Method

Teachers from the school attached to Shizuoka University are strongly affiliated with professors from the Faculty of Education. The professors and the teachers work collaboratively to develop a school-wide plan (in sense of the whole school reform). They implement a constructivist learning approach whereas all teachers within the school use the same method of constructivist learning approach for about three consecutive years long. They make lesson plans, implement the lesson plans, and assess the outcomes in the sense of classroom action research as it is defined by Kemmis and Taggart (1988): planning, implementing and monitoring, and reflecting.

Indeed, every school has its specific philosophy or area to develop. Among those areas are social constructivist learning, developing students' dream, humanistic learning, promoting students' interest and independence. One of the most remarkable method is the threes steps of constructivist learning.

After a year of the implementation of the three step of the constructivist learning, the teachers and the lecturers present the results of their constructivist learning practices. General presentation is given to audiences (principals, teachers, teacher candidates, and educators) at the beginning of the seminar. Then the audiences observe the classrooms to see the constructivist learning in practice for each subject concerned. The teachers, then, have a separate session according to their respective subject to discuss the benefits of the constructivist learning approach implemented and how to make it better. The results of the improvement are presented annually in the subsequent two or three years.

Science class begins with problems. Teachers incite problems. For example what factors may influence the rate of your respiration, what .

Results

The three steps of the constructivist learning have several affirmative learning benefits to the students. Among those noted benefits were (1) communication, (2) generating ideas ability, (3) value sharing, and (4) concept development.

The ability of students to communicate their ideas increases since the three steps of the constructivist learning requires each student to communicate with others as well as with him/her-self. In the first step students communicate with teachers to understand the theme and the problems. Then every student chooses his/her own topics to study. She/he makes a prediction or hypothesis. He/she, then, communicates the topic along with her/his prediction. He or she also explains what he or she wants to do to study more about the topic.

During the second step students doing activities to study, observe, to experiment the problems. During this step students communicate with their peers. Sometime they communicate with the teachers when they have difficulties or uncertainty about their doing.

In the third step students have discussion within a small group to build up an understanding. In this step, every student may present her or his finding to the class and share ideas or values with the others. Then every student reflects his or her learning by judging his or her own ideas and finding with those of others. Finally students revise their

previous image (concept) map based on their new understanding. This process is called book making or developing portfolio.

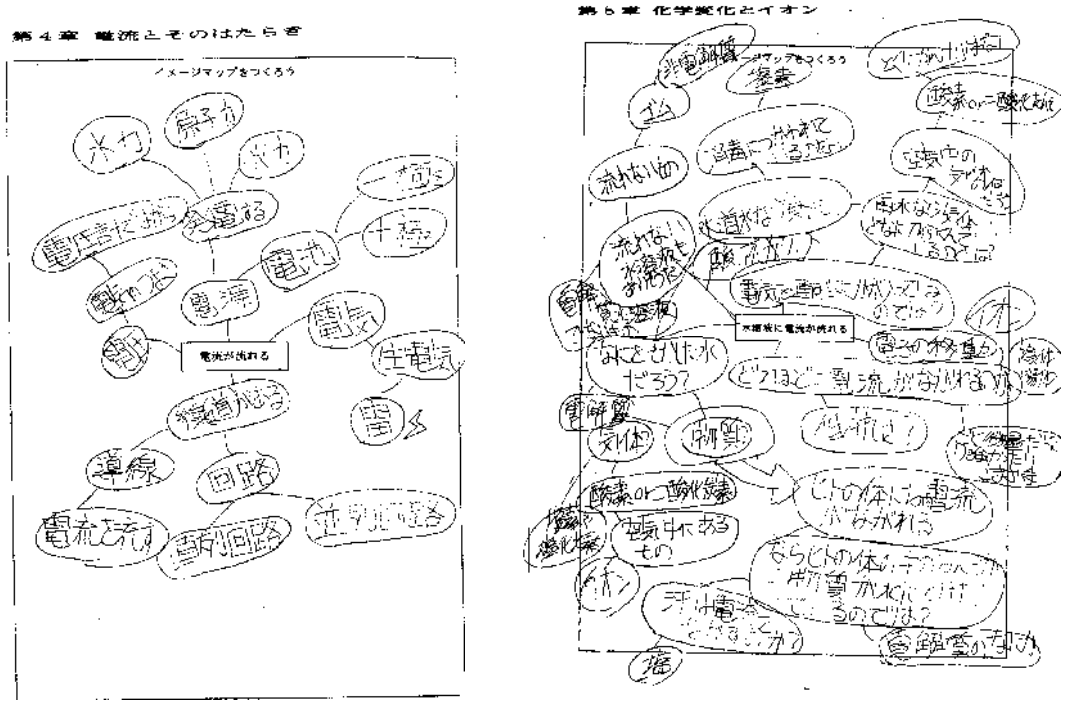
The constructivist learning approach evidently encourages students to develop new understanding based on their previous knowledge. At the end of the process students mostly add, revise, and elaborate their previous image (concept) map both on the number of concepts, the depth of the concepts, and the relation among the concepts. The new concept map looks different from the previous one and of course varies from student to the others due to his or her own learning ability and learning focus (**Picture 1**).

Discussion

There some points to highlight from the results of the implementation of constructivist learning in Japan. First, it is the teacher who does make changes in the whole school reform. The whole school reform will always remain concepts without the willingness of the teacher to change their practices. Indeed the changes of schoolteacher practices needs some supports to make the changes easier. In this case the supports from Shizuoka University, specifically from the faculty of education in terms of finance and expertise are essential. The eminent relationships between schools, university, and Education Board enable the changes even much faster. Therefore, the whole school reform and single change of teaching should be getting along in educational reform.

Second, the constructivist learning gives significant benefits to the students. Students` ability increase in sense of independence, self-esteem, and self-efficacy while simultaneously develop sense of sharing and cooperation with others as a community. By giving more opportunity to independently choosing the topic interesting to learn and the way to learn, students will be more confident. They also develop scientific process skills during the inquiry process in the second step.

Students` understanding develops clearly during constructivist learning. This development process can bee seen by assessing the development of students` mental images. At the end of the class the students revise, adding and elaborating, their previous image maps. The mental images mostly change dramatically in the number of concepts and in the organization of the concepts (See Picture 1: The development of mental images before and after the constructivist learning process)



a. **b.**

Picture 1: The changes of students` mental image **a)** before and **b)** after the constructivist learning process

Conclusion

From this reflective observation of the constructivist learning practices in Japan there are several important benefits to be notified:

1. Promoting students to draw an image map represeting what they have learn and relate what they have learned to the upcoming problems or topics
2. Accelerating students to generate ideas to solve the problems
3. Providing opportunities for the students to develop communication ability such as expressing ideas, questioning, giving presentation, and explaining.
4. Decreasing teachers' domination and increasing students` active involvement
5. Increasing students` ability to reflect their study by revising their previous image map.
6. Encouraging students` learning interests by providing choices of topics to learn
7. Providing more opportunities among students to share values and understanding

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