Lesson Study: Japanese Problem Solving Approaches

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What is the lesson study and Japanese Approach?

Figure 1. Teacher's Canon (1873)

An Origin: Japanese lesson study School (University of Tsukuba) and the Attached Elementary School (Elementary School Attached to the University of Tsukuba) were established at the same time (Isoda et al 2007). It began from the observation of teaching methods in whole classroom teaching which were firstly introduced in those Schools beyond the temple school culture on tutorial teaching methods. People observed the ways of teaching for knowing how-to. Teachers' Canon was published by the Normal School in 1873 which already mentioned the etiquette for entering classroom for observation as for avoiding troubles during observations,

The conditions: There are various understanding of lesson study. Here, the Japanese lesson study is recognized with following features.

Process: Plan (Preparations), Do (Observations) and See (Discussion and Reflection) activities (lesson study cycle) with other teachers.

Various dimensions of observation:
Personal, whole School, regional and national but systematic

Theme: Study Topics and Objective
Study Topics such as Developing Mathematical Thinking, Learning for/by themselves in relation to development, reform or improvement.
Objectives related with curriculum, such as 'Through A, Teach B'. Both learning how-to (A) and achievement (B) are objectives of curriculum.

Lesson Plan: A format is usually developed/improved depending on a study topic. Some countries recommend a set of national lesson plans as a part of curriculum but lesson study is implemented for new challenges and not necessary to keep the same lesson plan.

Teachers' mind: Lesson study is conducted by teachers for developing students in a classroom and making each student developing him/herself. Not for researchers who just observe a classroom through their telescopes prohibiting influence into the classroom and do not feel sympathy teacher's objectives and do not consider next teaching activity in each moment. In this sense, lesson study recommends that researchers are teachers who propose improvement of class, as well as teachers are researchers who analyze children's understanding.

Result:

Lesson study usually considers achievement in relation to study topic and objective. At the same time, aims of lesson study change depending on participants and are not always the same as seen below; Model teaching approach, New ideas for traditional approach, Understanding objectives, What students learned before the class, What students learned and could not learn in the class, Teachers' values, Students' values, Professional development,…., Ideas for the curriculum reform, Theory of mathematics education, and so on. One of the most sharable products is a description of model approaches. The guidebooks for teaching contents and teaching approaches have been written by teachers. In these twenty years, videos have been used for sharing good approaches by making them more visible (APEC lesson study project 2006: first announcement). In some countries, a model approach sometimes means a teaching manual with the sequence of teacher's questions and children's answers which are expected to be followed by every teacher. But in the case of lesson study, it is nature of that to work beyond a model because lesson study usually includes a proposal to develop something new in their group based on their own theme of lesson. Thus, on the context of lesson study, a model approach means an illuminating approach and major resources for adapting a model into each teacher's classroom. And sometimes it means an object of improvement for specific aims.

<u>Developing Students thinking and learning by/for themselves</u>: Sometimes, general educators and educational management researchers enhance the function of the professional development on the lesson study but do not concern preparation of subject matter and teaching approaches for improvement. If it does not have the subject and teachers'

perspective for developing children, it is not satisfying the meaning of lesson study. The history of lesson study has been described with a new theme and a new approach on lesson study for developing children because the new theme and approach themselves are the aims of study and represent the reform, improvement, or focus of study itself.

The first known lesson study guidebook for teachers in Japan which have these features is 'Reform the Methods of Teaching' (1883: see figure 2). The lesson study topic was Pestalozzi methodology of teaching approach for whole subjects but it was not same as the original version in German because it was imported from New York Oswego Normal School and adapted in the Japanese way. In those days, lesson study had been introduced in Japan in a top-down way as well as establishment of the school system with an initiative of the government.

Another important feature of the first guidebook is the establishment of model teaching approach through questioning ('Hatsumon', as we call it today) *for developing students who think by themselves*. For enhancing a dialogue style of classroom communication in whole classroom teaching, the model approach itself was described through the dialogues such as ones of Plato and Confucius. The model dialogues in order to represent the process within a limited number of pages at high cost of publication are a recommended process for enabling teachers to plan their lesson and did not develop for following the protocol to describe social phenomena by current researchers on social science. Teachers' guidebooks in Japan have been keeping the custom of the model dialog because it is much reproductive than the social-science-like protocol. From the viewpoint of teachers who are trying to reproduce his approach based on the model approach, model dialogue description style is reasonable because careful protocol as for data only describes the past as the object of interpretation and does not aim for designing new practice.

Format of Lesson Plan

Necessity of Lesson Plan

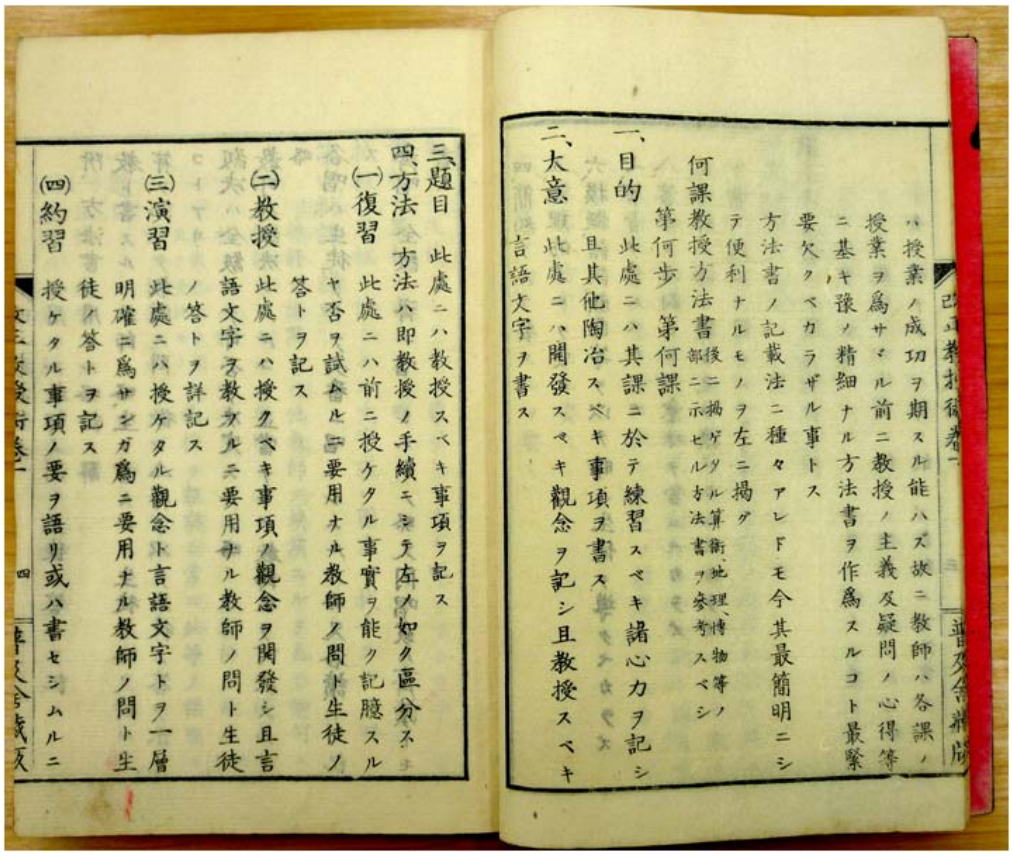


Figure 2. ‘Reform the Methods of Teaching’ (1883)

In early 20th century, the bottom up way of innovative teaching approach movements appeared and influenced by movements of educational reforms in Germany and the U.S. Jingo Shimizu wrote a book ‘Teaching Elementary School Mathematics through Problem Posing by Children’ (1924) which explained the innovative teaching approach including a fact that an activity of learning mathematics begins from children’s problem posing. In this era, *Japanese Teaching Principle*, *‘Learning by/for Themselves’* had been described by teachers and educators who wrote the teachers guidebook for teaching.

Since the end of World War II, developing thinking ability by themselves and learning by/for themselves have been major issues of the national curriculum standards. Problem Solving Approaches became a major method of teaching approaches (Isoda et al 2007). The origin of it was before WWII, but it has spread in 1980s and became standards approach in 1990s.

Figure 3. Problem Posing Approach by Jingo Shimizu (1924)

Problem Solving Approach for Leaning by/for themselves: Japanese Problem Solving Approach, known as the process through 'posing a problem', 'independent solving', 'comparison and discussion', and 'summary and application', was known in the US through the comparative study on problem solving in the 80s by Tatsuro Miwa and Jerry Becker. It influenced the world through the TIMSS video study in 90s (Stigler and Hiebert 1999). Problem Solving Approaches are one of the shared approaches in Japan and developing such a sharable approach itself is one of the long-term results of lesson study. Lesson study spread into the world with Problem Solving Approach. It may not have been spread if it were only explained by the lesson study cycle. The problem solving approaches combined with lesson study has spread to the world from Japan through the comparative studies and teacher training programs for developing countries from 1980s, the Japan International Cooperation Agency's projects from 1993 (See, Isoda et al 2007) and APEC projects from 2006.

What are the lesson study strategies for developing children at School level?

Each Japanese elementary school usually sets a theme of lesson study project on school level through a year depending on the demands of national reform movements, teachers and school district. Major themes of lesson study projects at elementary schools are Japanese, Mathematics or general topics. General topics are usually related with crossing curriculum topic such as Physical and Mental health. More than 50 years, improvement of mathematics teaching for better achievement of curriculum has been a major theme of lesson study (Isoda

et al 2007). In these days, the achievement of Japanese, Mathematics and Science on PISA has been lower due to the 20 % reduced curriculum in 1999, Mathematics and Japanese are two major subjects in Elementary School lesson study project

On this context, more than 50 teaching guidebooks for elementary school mathematics are published, every year. Here, for explaining about lesson designing strategy and showing how meaningful it is for improvement of children' performance, the teachers' guidebook titled 'Designing Problem Solving Class with the Basic Standards for Teaching Given by Check Sheets' by Isoda (2009), is introduced because it is currently known as one of the best-sellers in this area: the 1st printing was sold out within two months and now the 2nd printing is selling and also some of the same checking sheets are already published in Spanish (Isoda and Olfos 2009).

A characteristic feature of this book is that it is written as the result of school level lesson study project and descried for novice teachers who do not know well how to teach mathematics even if they might have several years of experiences.

In Japan, problem solving approaches are shared to develop children's ability to think and learn by themselves. For knowing their achievement, there are two sets of assessment tests problems in the national assessment. First type focuses on understanding and skills and second type focuses on mathematical thinking including mathematical argumentation. Both tests problems are developed on the national curriculum standards and the problems of the second type are deeply related with problems solving approach itself.

The Checklists as for Strategy in school level lesson study: The book by Isoda includes several checklists for teachers to develop teachers' pedagogical content knowledge and for children to develop their knowledge for learning how to learn. The lists are developed by the core teachers group in Ozone Elementary School in Tsukuba City with Isoda to improve teachers' pedagogical content knowledge and children's achievement through lesson study on problem solving approach. The following checking list (figure 4) is an example of teacher's checklists for lesson planning which are used by self-evaluation before every lesson observation and used after the every observation for knowing the reflection points:

Problem Posing	**Self-Evaluation**
1. The lesson sets tasks that can be solved in a variety of different ways by applying previously learned knowledge, and presents the content to be learned.	4 3 2 1
2. The lesson planned with tasks (problem given by teacher) and problems (problematic from students), and promotes problem (problematic) awareness.	4 3 2 1
3. The teacher expected methods and solutions before.	4 3 2 1
Independent Solving	
1. The children can recall and apply what they have already learned.	4 3 2 1
2. The children's ideas are predicted before.	4 3 2 1
3. Inappropriate solutions are predicted, and advice and hints are prepared for them before.	4 3 2 1
4. The teacher, walking around, observes and helps children to	4 3 2 1

insure that children use mathematical representation to solve the problems.				
5. Notebook are written and taken in a manner such that they will be helpful for presentation as well.	4	3	2	1
Comparison and Discussion				
1. Steps (Validity, Compare, Similarity and Generalization or Selection) are planned for comparative discussion.	4	3	2	1
2. The ideas to be taken up are presented in an order that is planned before.	4	3	2	1
3. The method for writing presentation sheets is planned in advance and directions are provided.	4	3	2	1
4. In addition to develop the ability to explain, children are also fostered with the ability to listen and the ability to question.	4	3	2	1
5. When ideas are brought together (generalized), it is important to experience them by themselves.	4	3	2	1
6. The reorganization or integration of ideas proceeds smoothly from the presentation and communication of children.	4	3	2	1
Summary				
1. Activities are incorporated that let children experience for themselves the merits of the ideas and procedures that are generalized.	4	3	2	1
2. The summary matches the aims and problems (problematic) of this lesson.	4	3	2	1
3. It is recognized that both correct and incorrect answers (to the task) have something good in the foundation of their ideas.	4	3	2	1
4. Children are made to experience the joy and wonder of learning.	4	3	2	1

Figure 4. Lesson Planning Checklist: Self-Evaluation [4: Achieved; 1: Not Achieved]

Isoda (2009), Isoda & Olfos (2009)

On this lists, the deference of problem (task) and problematic (problem) is a key because problematic is necessary for children leaning by/for themselves. On the other hands when the school began to use the checking lists on their project, most teachers did not understand the meaning of each checking list. Because in the case of this school most of teachers do not know how to teach mathematics well even if they have a chance to see other teacher's problem solving approach. After conducting school-level lesson study project for a year and half, through having lesson study once a month in each grade, the teachers well understood the meaning of check lists and developed high achievement.

The Achievement of the School Level Lesson Study: After the one and half year mathematics lesson study project in Ozone Elementary School through using checking lists for mathematics, children's achievement improved as follows.

In figure 5, Children's mathematical thinking ability which is a key for leaning by/for themselves is improved. It shows that achievement of children in the 5^{th} grade improved by 15 points in mathematical thinking test compared with the average of the whole prefecture. Figure 6 implies that the achievement of school-level mathematics lesson study during one and half year is not only limited to the improvement of children's mathematics achievement but also influenced positively other subjects such as Japanese, Science and Social Studies. It means that the lesson study efforts on the teaching approach in mathematics through using checking lists may influence other subject of teaching. Indeed, in Ozone Elementary School, a teacher teaches almost all subjects. Children's awareness of empowerment in mathematics

led to improvement of their interests of learning and developed their wish to study.

Figure 5. Ozone Elementary School's Academic Abilities Compared to the Regional Average

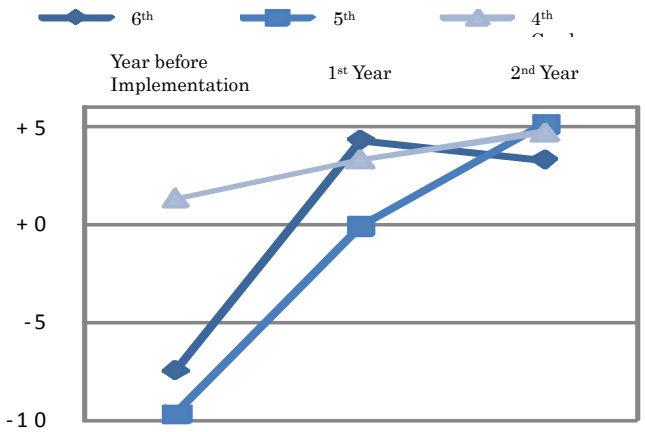
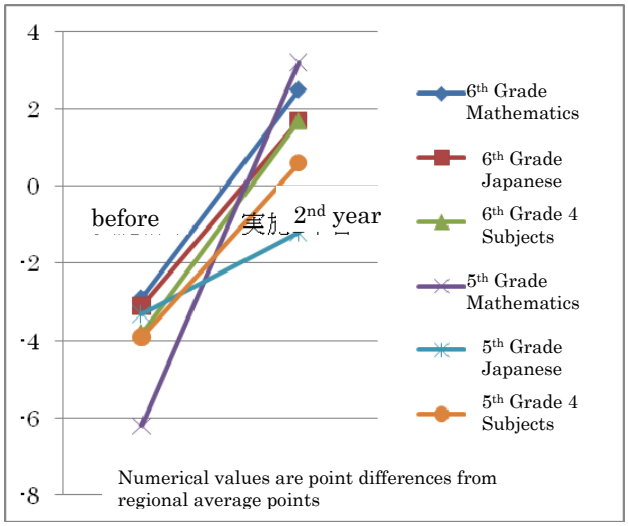


Figure 6. Ozone Elementary School's Academic Abilities Compared to the Regional Average



The achievement is the result of lesson study through using the check lists in the school. For improvement of classroom teaching, it is important that teachers and children share objectives. Ozone Elementary School developed Lesson Planning Checklist, Children Leaning How to Learn Checklist, and Lesson Plan Checklist, and also more checklists such as the way or blackboard planning were added in the book by Isoda (2009) and improved on Isoda and Olfos (2009) for Latin America. They provide opportunities for children to check by themselves for reflecting on what should be improved.

Following figure 7 is the result of the self-evaluations by teachers on the lesson planning checklist in order to verify their instruction method and the problem solving approach have been appropriate or not. Figure 7 compares the achievement at start time with that of 1.5 years later.

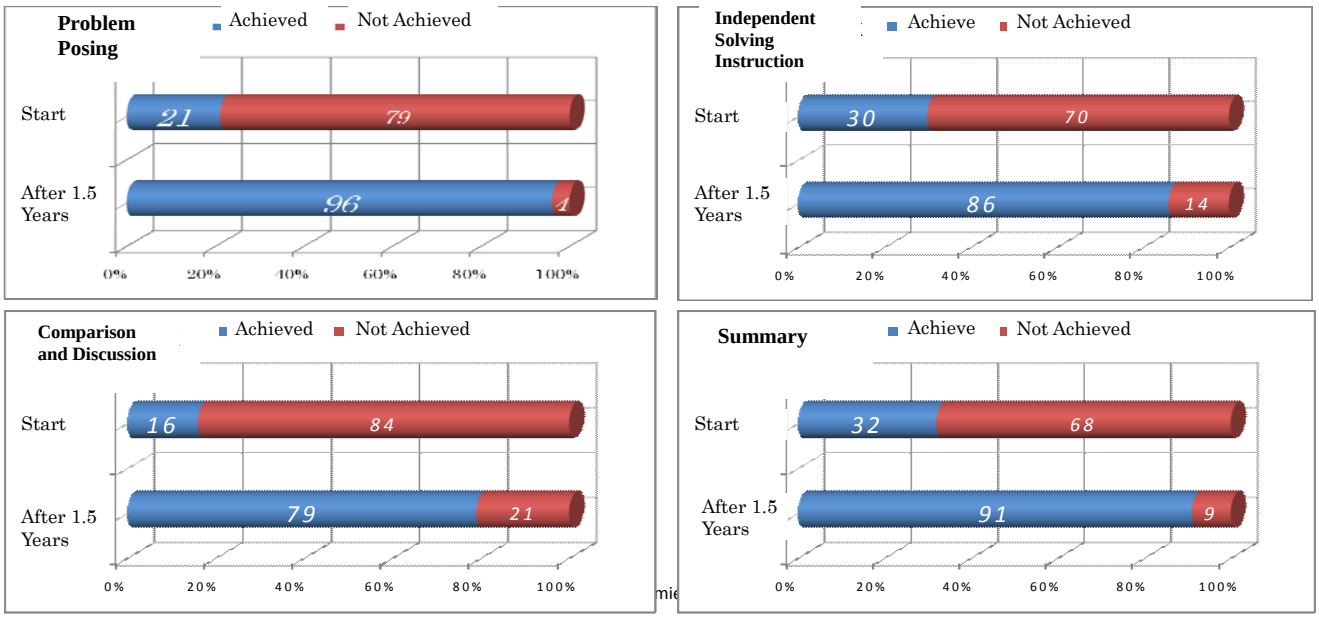


Figure 7. Improvements in Teacher Instruction as Measured with the Lesson Planning Checklist

At the beginning of this research (1.5 years before the lesson study open school), teachers were not sure of the meanings of the words listed on the lesson planning checklist. By taking on the challenge of this project throughout the entire school for one and a half years, the teachers gained confidence in their instruction method. Through the improvement of teachers' teaching practices through the school lesson study project in only one and half years, teachers teaching methods are improved and then, children's achievement are improved beyond mathematics. It was the result of collaborative lesson studies by Ozone Elementary School teachers.

How can a school level lesson study be implemented?

Necessary Conditions for Success: In the case of Japan, Japanese teachers have obligation of self-study and training by themselves (Isoda et al. 2007). Japanese schools have several departments run by teachers and each school has a study department which plans the lesson study topic for whole school level and a training program, and manages lesson study project through the year. A head teacher of the study department and the principal usually collaborate and encourage teachers' lesson study throughout the year. For implementing the lesson study project in mathematics, the head teacher must know mathematics teaching, problem solving approach, and lesson study. At the same time, he/she has to plan the step-by-step progress of teachers teaching abilities: Lesson Planning Checklist is a tool for fostering teachers. In the case of Ozone Elementary School, the head teacher shows their model practice and explains the meaning of the list. In the process of lesson study, the head teacher and the principal participate in the editing process of lesson plan and provide a lot of ideas for teaching. Before actually conducting a lesson, a teacher tries to simulate his/her plan on the blackboard to confirm. In the lesson observation, other teachers observe the class with the same checking lists and at the reflection time after the lesson, they confirm if the lesson was conducted in accordance with the list or not and discuss the necessary preparations for achievement. Through these activities, teachers can share the aims of checklists and be able to give better lessons than in the past, gaining more self-confidence.

For Adaptation into APEC economies: The Problem Solving Approach distinguishes a problem (or a task given by teacher) and a problematic (or a problem posed by children). To differentiate this, it is necessary for comparison and discussion because the Problem Solving Approach is not aimed to solve a problem (or a task) but teaching an objective of lesson through solving a problematic (or a problem). This approach is not easy for a novice teacher because he/she usually tries to teach how to solve a given problem, faces various unexpected

answers including misunderstanding and focuses on teaching objective in the process of discussion.

On the other hand, the open-ended approach which is using open-ended problem is easier approach because it aims to solve problems. There are no inappropriate solutions because conditions of a problem are not enough to get necessary solutions. Thus, every child enjoys other's presentation because they just enjoy difference of reasoning and not necessary to learn new content. The open-ended approach is easier for letting teachers know new ways of teaching approach such as problem-solving, posing problem, independent solving, comparison and discussion, and summary and application. This is because if a teacher gives a well-known open-ended problem, most children may produce expected answers and the teacher can ask them to present their answers more easily. With this approach, every child is able to present his/her way of thinking. So if there is no model teacher for the Problem Solving Approach, the open-ended approach is preferable approach to introduce.

In the case of Japan, the open-ended approach has been practiced since even before World War II but it was in 1970s that was recognized on it name. In the case of APEC lesson study projects, for instance, Thailand has introduced the open-ended approach instead of the Problem Solving Approach because it was done through practicum by pre-serves teachers and the open-ended approach is a very good approach to change traditional teachers' teaching belief and children's mind setting (Inprasitha 2006).

For sharing the methodology: The checklists are already introduced in Chile in Spanish (Isoda and Olfos 2009). In Thailand, the approach was introduced through a week lesson study seminar by Isoda with Inprasitha in 2009. The Thailand version is under the process of publication (Isoda and Inprasitha, under preparation). English translation is available only partially (Isoda, under preparation).

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At the CRME, Khon Kaen University, Thailand:
http://www.crme.kku.ac.th/Home_APEC.htm

JICA Website in relation to Japanese Experience on Education (Multi Language):
http://www.jica.or.id/english/publications/reports/study/topical/educational/index.html