

Chapter 2

Mathematics Education Lesson Study in Japan from Historical, Community, Institutional and Development Assistance Perspectives



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Abstract Japanese mathematics education is characterized by structured problem solving (Stigler and Hiebert in *The teaching gap*. Free Press, New York, 1999). Lesson study, where a group of teachers develops a lesson together, refines it furthermore. This learning opportunity has spread to various levels of the educational system during the last one hundred years, forming the lesson study practice and of today and becoming a part of our educational culture. This chapter addresses the culture, which Japanese mathematics education has nurtured from three perspectives such as history, community, and institution. These perspectives are discussed with a basis on Bishop in *Mathematical enculturation: A cultural perspective on mathematics education*. Kluwer, Dordrecht (1989). Besides these, a fourth perspective, developmental assistance, is also employed to compare the perspectives of Japan with those of developing countries.

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2.1 Introduction

The Japanese mathematics lesson is characterized as structured problem solving (Stigler & Hiebert, 1999), and lesson study, where a group of teachers develops a lesson together, is to refine it further. Here, structured problem-solving means a lesson where a teacher provides the students with a procedurally and conceptually demanding problem and allows students to invent their own procedures through a structurally designed problem-solving process (Stigler & Hiebert, 1999, p. 27). The teacher collaboration in lesson study develops the eyes of appreciating lessons—connoisseurship (Eisner, 1991)—through a discussion of possible alternatives, and illuminates the aspects which individual teachers often fail to recognize. Such an endeavor does not stop at school-based lesson study¹ (Stigler & Hiebert, 1999) but also extends to the in-service training at the municipal and prefectural levels and the exemplary lesson demonstration at the national level (Hashimoto, Tsubota, & Ikeda, 2003). These are interrelated and form the lesson study practice of Japan as a whole. In the long run, they have become part of the Japanese educational culture. In other words, the existence of lesson structure and the consistency of lesson study imply the existence of culture² at the background. On the other hand, it is not easy to see the culture by simply looking at a few lessons and/or the result of international comparative surveys such as TIMSS and PISA.

Hofstede (1997) categorized cultural components into two separate ones. One component lies at the core and is an invisible value, which characterizes culture. The other component is at more of a surface level and looks relatively visible, taking some forms such as lesson patterns. And the former value maintains such patterns. We must therefore pay close attention to the cultural values that we take as the convictions that an individual has internalized as being the things of importance and worth. What an individual values defines for her/him is the window through which s/he views the world around her/him. Valuing provides the individual with the will and determination to maintain any course of action chosen in the learning and teaching of mathematics. They regulate the ways in which a learner or teacher's cognitive skills and emotional dispositions are aligned to learning/teaching in any given educational context (Seah & Anderson, 2015, p. 169).

¹School-based lesson study is commonly called *kounai-kenshu*, which literally means a training within school. This is one of the common lesson study practices in Japan.

²Cultural identity refers to the self-awareness of cultural ascription by means of life patterns, customs and languages, which characterize the culture that each member belongs to.

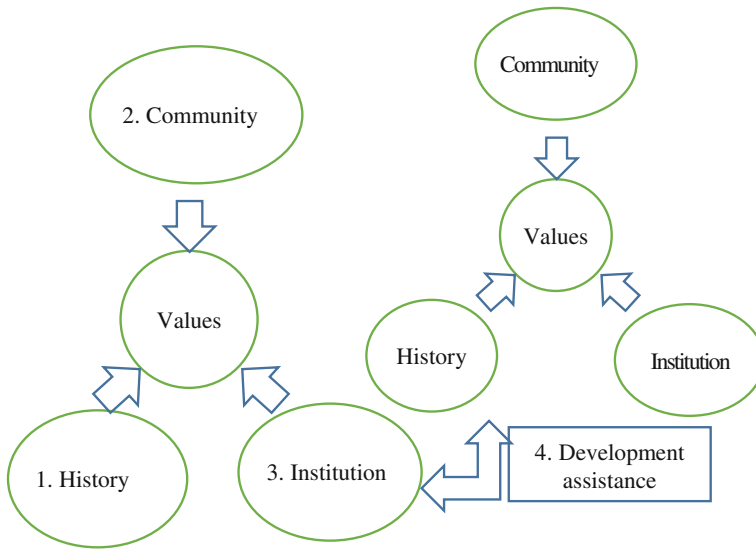


Fig. 2.1 Four perspectives to analyze values of Japanese mathematics education

Such values³ are therefore related to actions and ideas of present day teachers and also those of the previous generations. They are regarded as providing consistency to the actions beyond time and space, as well as lesson study functions to transmit values through generations and preserve them. The patterns of the structured problem-solving lesson are polished and maintained through lesson study (Ueda, Baba, & Matuura, 2015).

The objective of this paper is to clarify the values that Japanese mathematics education has formed over a long period. As discussed later, lesson study is closely related to the historical development of Japanese mathematics education, and is also deeply connected to the values which the community as well as individual teachers have developed and internalized. To attain this objective, this chapter has chosen four perspectives, namely history, community, institution, and development assistance to developing countries (Fig. 2.1). The first three are based on Bishop’s (1989) framework of culture. The last one is used to compare those three perspectives in different cultures.

Firstly, the historical perspective provides a description of how Japanese mathematics education has formed a central idea regarding “children’s subjective

³Bishop (1989) categorized values into three types: general educational values, mathematical values, and mathematical educational values.

and extensive creation of mathematical ideas”. Structured problem-solving for the treatment of mathematical ideas in present-day classrooms lies at the root of mathematics education in Japan. There must have been many practices and discussions in many classrooms before they were organized and crystallized into a complete idea and developed into a new educational philosophy and/or a new pedagogy. All of these efforts are engraved in the history.

Secondly, the community perspective is closely related to the historical perspective. Retracing the formation process of educational philosophy and pedagogical method provides us with the fact that there were many people involved in the process. The community perspective can be considered at various levels such as school, municipal, prefectural and national levels. All these different levels of communities are connected and form the whole community in Japan. The researches on teachers’ community of practice (Wenger, 1999) focus more on the community of today. The above community in Japan is also connected to the one of previous times. For example, newly-recruited teachers participate in such communities peripherally in the form of school-based lesson study and lesson studies organized by prefectural organizations and voluntary study groups. They gradually acquire and reinterpret the values of senior members on how to develop lessons, views on mathematics education, and how to look at the teaching profession.

Thirdly, the institutional perspective provides an insight into how today’s community functions. Here the institution is a rule which is established to control mathematics lessons and teacher education, and provides a regulation which manages each member at different levels. For example, it describes what to learn in the training, when to participate in the training, and how to learn. In this sense, the institutions reflect somehow the values that the community has formed, and may promote or control the community’s activities. The institutional perspective is quite focused on current practice, compared to the history and community perspectives. However, when the reason for such practices is considered, they are connected back to those other perspectives. Thus, both community and institution influence each other through the sharing of values.

Lastly, the perspective of development assistance provides another important aspect. Here development assistance is the collaboration between Japan and developing countries with different cultural backgrounds. What is valued in Japan in terms of history, community and institution is made explicit through comparisons with other countries. What is natural in Japan such as community formation may not be constituted so easily in the developing countries, due to lack of historical conditions and institutions. The intended aim of development assistance may not be achieved by simply introducing the institutions. Here the above three perspectives such as history, community and institution are used to categorize and analyze previous studies.

2.2 Historical Perspective

2.2.1 *Background and Objective*

Historically speaking, mathematical ideas⁴ as a philosophical stance in the national textbook *Jinjo-shogaku-sanjutsu* were used since 1935, preceding the notion of mathematical thinking, which would be developed later on Ueda (2006). This shows that there was a continuing aspiration of the Japanese mathematics education community, despite the temporal mutation during the Second World War, represented by a move towards mathematical thinking. It is possible to identify the roots of what can be observed today through this historical analysis. The objective of this section is to identify the historical development of mathematical thinking as a main focus of mathematics education. Since the period of consideration covers more than a life span, document analysis is employed with special focus on “mathematical thinking”.

2.2.2 *Emergence of Mathematical Thinking in the Course of Study*

Just before the emergence of mathematical thinking, there was a former idea called the ‘central concepts’. This term first appeared in the course of study for senior high schools in 1956. The characteristics of this course of study were the integration of Analysis I, Analysis II and Geometry into Mathematics I, Mathematics II and Mathematics III as mathematical subjects. The central concepts exemplified mathematical thinking to bridge all mathematical subjects with algebraic and geometrical contents. For example, the central ideas in Mathematics I were described as follows:

- a. Expressing the concepts in symbols;
- b. Extending concepts and laws;
- c. Systematizing knowledge by deductive reasoning;
- d. Grasping relations of correspondence and dependence;
- e. Finding out invariance of equations and geometrical figures;
- f. (Identifying) Relations between analytical and geometrical methods.

⁴Mathematical ideas are philosophical attitudes to love and enjoy mathematical philosophy in the pursuit and acquisition of mathematical truth, and to find and consider mathematical relations in daily events and to take actions based on them (Shiono, 1970).

Later, the notion of “mathematical thinking” first appeared in the objectives of the 1958 course of study. It is also called “mathematical thinking and mathematical treatment”. Here mathematical treatment means to symbolize the patterns after finding out some patterns among the objects and simplify them. The objectives at the time were as follows:

- (1) To enable students to understand basic concepts and principles about numbers, quantities and geometrical figures, and to let them develop more advanced mathematical thinking and understand how to treat the objects;
- (2) To enable students to acquire basic knowledge and fundamental skills about numbers, quantities and geometrical figures, and to let them use those effectively and efficiently according to the purpose;
- (3) To enable students to understand the significance of using mathematical terms and symbols, and to let them use expressions and think simply and clearly in situations involving quantitative events and relations using the terms and symbols;
- (4) To enable students to extend the ability to set up an appropriate plan and think logically regarding quantitative events and relations, and to let them treat things more self-dependently and rationally;
- (5) To enable students to develop attitudes favorable towards proactive mathematical thinking and understand how to treat the objects in daily life.
(Underlined by the authors.)

Here, mathematical thinking was expected to develop from acquiring fundamental concepts and basic skills to the more advanced level of knowledge and thinking, and to develop the attitudes to apply them extensively to daily-life situations.

The major concern of mathematics education research and practice at that time was the clarification of the definition and concretization through examples of mathematical thinking. Two researches are representative of many efforts by researchers and teachers. Katagiri, Sakurai, Takahashi, and Oshima (1971) published *Mathematical thinking and its instruction* and categorized characteristics of mathematical thinking into three groups: background to produce mathematical thinking, process orientation to form a flow of mathematical thinking, and content aspect of mathematical thinking. They also listed up some concrete examples of each category (addressing extension). Nakajima (1981) published *Mathematics education and mathematical thinking*. He interpreted mathematical thinking as abilities and attitudes of voluntary and creative activity, and sought to clarify its definition (addressing intention) by paying attention to the process of voluntary and creative activity. Katagiri (1988) reorganized the former categorization into mathematical methods, mathematical contents and mathematical attitudes. Later, Katagiri, Nakajima and many other researchers discussed over definition and examples of mathematical thinking and made this concept much richer.

2.2.3 Open Approach: From Evaluation Method to Nurturing Method

While these analytical researches were being developed to provide meaning to the notion of mathematical thinking, research on evaluation of mathematical thinking was developed almost simultaneously. This became “Developmental Research on Evaluation Method of Higher-Order Thinking Skills”, which later led to “Proposal of Lesson Improvement by Open-ended Approach” (Becker & Shimada, 1997; Shimada, 1977). This research was funded by the JSPS (Japan Society of Promotion of Science) for six years from 1971. Researchers from NIER⁵ (National Institute of Education Research), university researchers, primary, junior and senior secondary schools teachers formed a team to develop evaluation methods of higher-order thinking skills in mathematics education which were interpreted as mathematical thinking.

The team considered that one of the methods could be to give an incomplete problem to students. Here an incomplete problem means the type of problem which allows various answers and/or solutions. They set up a hypothesis that it would be possible to evaluate attainment of higher-order thinking skills from the analysis of the level of solutions and their expressions. The team conducted the research, based on this hypothesis. This developmental study was aimed not only at the development of an evaluation method but also at the development of effective instructional methods to nurture such higher-order thinking skills.

It is significant that the students’ multiple solutions were raised and deliberation on them spontaneously occurred in the lesson. This is because it is not enough to have many ideas. It was recognized as necessary to systematize various students’ solutions as mathematical activity and theorize them. In other words, the mathematization of the phenomenon was a part of mathematical thinking and it was assumed that the mathematization should not be just one way but allow for many possible ways. And it became necessary to revisit the significance of the diversity of students’ solutions. The team understood this as an important research agenda and developed this study as a case of interaction between theory and practice. Gradually, the treatment of multiple solutions has been systematized and theorized.

2.2.4 Treatment and Summarization of Multiple Solutions

The teaching-learning method “open-ended approach” was proposed in 1977. The method, which deals with multiple solutions, has made an impact on textbook

⁵This is the national institute which has been in charge of national curriculum development and education research at the national level. It has been renamed into National Institute of Education Policy and Research but the English abbreviation remain the same as NIER. It is also now in charge of national assessment.

construction. This can be identified in the textbooks, published in 1980 and 1985, containing children's multiple solutions (Ueda et al., 2015). This format continues today.

Multiple solutions in the textbooks promoted research on how to deal with and summarize such various solutions and ideas during the lesson (Koto, 1990, 1998). Koto considered that multiple solutions would lead to the development of mathematical thinking and categorized those solutions into four types: independent, orderable, integrable, and structurable multiple solutions, according to the lesson objective and the relation among these solutions. Koto and others have influenced lesson patterns and made tremendous impact on the structured problem-solving lesson in Japan. These researches are regarded as a culmination of all efforts through lesson study focusing on higher-order thinking, open-ended approach and structured problem-solving.

2.2.5 Summary of the Historical Perspective

This section considered the development of mathematical thinking as an objective in the 1956 course of study through document analysis. It identified the following points:

- Analytical research on the extension and intention of mathematical thinking, development of evaluation methods of higher-order thinking skills and open-ended approach, change in textbooks, and change in teaching approach especially dealing with multiple solutions, are all intertwined in the development of mathematics education. In this development, mathematical thinking plays a central role.
- In the process, many lesson studies have been conducted. In fact, Shimada (1977) contained not only a theoretical framework but also many examples by teachers across the country. All of these are interrelated and have made a tremendous impact on mathematics teachers' shared values in Japan. In this sense, it also indicated how lesson study should be conducted.
- The teachers always consider how to utilize students' various mathematical ideas and solutions and how to let them develop mathematics subjectively and extensively, whether they use the open-ended approach consciously or unconsciously. This attitude has been developed through lesson study and the above historical development.
- This analysis proves that the historical perspective can provide a significant and potential research approach on values, which have been nurtured through the years and have been embedded in lesson study and mathematics lessons.

2.3 Community Perspective

2.3.1 *Background and Objective*

The historical perspective in the previous section focused on the national curriculum and the national level project, which is named as “Open-Ended Approach”. This historical development was substantiated by many teachers and communities at the prefectural and municipal levels. It would not have made any impact on mathematics lessons through the country if it had remained only at the national level. There was no systematic research on the activities of teachers’ community, but it is still possible to directly interview the community leaders of the critical period and to identify what happened from their perspective. So the objective of this section is to identify how the community of mathematics teachers at the local level perceived the national level movement. As for methodology, we take an interview approach to ask those leaders to reflect on how they thought and what action they had.

Here the Saitama prefecture⁶ was chosen as a case because of two reasons. The first is that the community of mathematics teachers has been active for many years to the present time and the community leaders at that time could be approached. The second reason is the representativeness as Saitama is close to Tokyo but relatively quiet. This is regarded as a standard case.

Two types of the teachers’ community here are considered, formal and informal. The formal community is organized within a school or between schools and supported by the Ministry, prefectural and/or municipal board of education. There is also an informal and voluntary community of teachers. In describing the case, the focus was on what measures the prefectural board of education took and how a formal and an informal community of teachers were formed in correspondence with the movement at the national level.

The target period is between the late 1960s and early 1970s, during which the modernization curriculum was introduced. It was the critical period to understand the characteristics of mathematics education in Japan. As mentioned in the previous section, this was the time when the higher-order thinking skills and the open-ended approaches were being developed. In this sense, the today’s mathematics lesson has started around this time.

⁶Prefecture is an administrative unit in Japan. The whole country is divided into 47 prefectures. Saitama prefecture is adjacent to Tokyo. During the above period it was not yet urbanized so much.

2.3.2 *Long-Term Training System*⁷

After the Sputnik shock in 1957, it became a matter of concern to introduce new mathematical contents such as set theory and functions. In Saitama at that time, there was an urgency to develop an in-service training program on such newly introduced contents. In 1964, the Saitama Prefectural Board of Education started a new in-service teacher training system, in which the trainees were to learn these new contents. Ogawa Tadashi was the first long-term trainee, who was sent for one year to Prof. Wada at Tokyo University of Education. His research theme was “Teaching approach for introducing the idea of set”. By that time, Ogawa had never taught sets. The interview in this section is directed at the seven leading teachers, including Ogawa.

Since then, the Saitama Board of Education selected a teacher for long-term training. The selection was done strategically from each area in turn so that he/she was expected to lead an in-service training course in the respective area. In this way, the modernization curriculum necessitated the system of long-term training courses and the formation of core members in the teachers’ community.

2.3.3 *Short-Term Training Course and Edition of Lesson Study Textbook*

The course of study on modern mathematics was released in 1968 (primary), 1969 (junior secondary) and 1970 (senior secondary). Each prefecture started systematic teacher training courses. In Saitama, the training course started with the idea that “lessons matter most” and took the form of developing a lesson. The participants of the long-term training courses led these courses. This emphasis on lessons integrated developing good lessons and growing teachers’ competence through the lesson study in-service training.

The lesson study was often conducted on Saturdays. Back then schools used to be open half-day on Saturdays. So the research lesson, which was conducted in the morning, was organized by the formal community. The participants of the long-term training as well as university professors participated as advisors in some cases. This lesson study was authorized by the prefectural and municipal board of education and thus was called a formal lesson study. In the afternoon of the same day, the research lesson conducted in cooperation with schools, parents and students, was organized by an informal community and was called informal lesson study. For example, Prof. Wada organized an informal study group of mathematics

⁷“Long-term training” means one year training. Many in-service training courses last only a few days or a week. So a one year training is called long term.

teachers and later Prof. Kikuchi in Saitama University developed it to an informal community at the prefectural level. The teachers who were indifferent at the beginning could have had a chance of participating in a research lesson and later become interested in the long-term training. All of this helped community formation.

Another measure which played an important role in modernizing the curriculum, was the development of training materials since 1970. The materials have been mainly edited by the long-term training participants and are being published even now. They were used to convey new mathematical contents to teachers across the Saitama prefecture so that they would learn how to teach the new contents effectively. The materials are called the “references for a post-lesson conference of mathematics lessons”.

After publication, this lesson-based training course became popular. Teachers in each area gradually understood how the contents were introduced in the lesson. For example, in Higashi-Matsuyama City, Mr. Ogawa in Minami Junior High School and Mr. Ono in Matsuyama Junior High School collaborated to develop research lessons on new contents, with slogan of “lesson matters most”. Teachers in the school as well as teachers in nearby schools participated the school-based lesson study. The Board of Education supported participation by the teachers in the nearby schools if it was part of a formal in-service training. They started to participate in formal lesson study and later also in informal lesson study.

2.3.4 Formation of Prefectural Level and Municipal Level Community

The Saitama Board of Education strategically sent teachers to the training course, as mentioned previously, and this made an impact throughout the prefecture. Later, all of the participants formed a community at prefectural level and simultaneously started a community at each area. The prefectural level community led mathematics education across the prefecture and developed an association of the long-term training course participants. The association holds an annual meeting and edits training materials. Its secretariat invites some promising teachers across the prefecture as the associate editors.

Both the teachers who participated the long-term training and those who worked as the associate editors, voluntarily led the formation of a teachers’ community at the respective area. On one hand, these municipal level communities played a role in initiating an in-service training at each area, and, on the other hand, the members of these communities became members of the prefectural level community and supported the in-service training at the prefectural level. In this way, the communities at the prefectural and municipal levels promoted the whole training system.

2.3.5 *Summary of Community Perspective: Values of Teachers' Community*

Through the interviews, the following points are identified for the case of the mathematics teacher's communities at the Saitama prefecture which are in correspondence with the national level movement:

- The slogan “lesson matters most”, which is set by the communities, represents the situation where lesson study has become integrated into daily teaching. Formal and informal communities were created through lesson study and, inversely, these communities developed lesson study.
- One of the notable characteristics at the Saitama prefecture is the blurred distinction between formal and informal communities. For example, the research lesson in the morning session was a formal one and that in the afternoon session was an informal one. Most teachers participated in both sessions. Such blurredness is related to the fact that the members of each community overlapped considerably and spent much time on *kyozai-kenkyu*⁸ even if they were not officially requested. The efforts were supported and appreciated within an informal community. This made an impact on the values of the mathematics teachers who conducted the mathematics lesson study.
- It is notable that the in-service training, which started at the time of modernization curriculum, made an impact on mathematics education later on. During the period, the research lesson focus shifted from “contents” to “methods”. Mathematical thinking was placed in the core of the course of study. Structured problem-solving and an open approach can be a necessary part of the lesson by these communities. Besides, the product of in-service training courses during the modernization period was shared and utilized in growing the next generation of teachers. This way, the values were handed down to the next generation within the community.

2.4 Institutional Perspective

2.4.1 *Background and Objective*

In Japan, many institutions were historically developed to make the whole mathematics education function smoothly. Some examples are curriculum, teacher education, in-service training, and staff management systems. As shown in the previous sections, the development of mathematical thinking and of mathematical

⁸The literal translation is “study on teaching-learning materials”. However, it encompasses all educational aspects of the materials such as objective, questioning, possible learning paths, possible misconceptions, facilitation and so on.

teachers' community, as well as scrutiny of the mathematics curriculum and lessons reveal efforts by many people in the past. As a result, the institution reflects some shared values of the teachers and communities. The institutional perspective can be regarded as providing a cross-sectional view of the historical development in the preceding section.

The institution forms the foundation of lesson study in Japan. In the lesson study, the teachers become reflective through the comments from their colleagues. These colleagues are not only those within the school but also those who work in other schools in the municipalities and/or the prefectures. The collegiality and community become possible due to the transferring system of teachers, which reassigns teachers to different schools regularly. The lesson study is configured on the basis of all these institutions.

Thus, the objective of this section is to clarify the institutional characteristics and the shared values or views through a questionnaire given to teachers. It is possible to describe the institution based on the documents but it is not easy to reveal the impact of the institution on mathematics education. The survey method was adopted to clarify the characteristics of shared views on professional growth and roles of different institutions among Japanese practicing teachers by comparing their responses with those of other groups of teachers.

2.4.2 Views on Mathematics Teachers' Growth

In Japan, teachers are required by law to conduct research and self-improvement efforts and are ensured of having an opportunity of in-service training. There are in-service training programs at national, prefectural and municipal levels. The training by the Board of Education at prefectural and municipal levels is classified as based on length of teaching service or for developing particular knowledge and skills of mathematics teaching (MEXT, 2016). The teachers acquire and maintain skills as well as knowledge and values through these in-service training and everyday practices. Besides, the regular change of the grades and the regular transfer of teachers among schools have an impact on how the teachers see children. Knowing the children in different grades and different school environments enable the teachers to grasp the education more holistically and thus widens their views on professional growth. In this section, teachers' views on professional growth refer to those on the growth of competence to teach mathematics.

Goldsmith, Doerr, and Lewis (2014) summarized six learning categories based on the models of teacher's growth by Clarke and Hollingsworth (2002). The "learning include changes in knowledge, changes in practice (it includes both classroom practice and out of school practice), and changes in disposition or belief which can influence knowledge and practice" (pp. 6–7). The categories are: teachers' identity, beliefs and disposition, teachers' instructional practice, teachers' collaboration/community, attention to student thinking, mathematics content knowledge, and curriculum and instructional tasks.

These values and views on professional growth are held by individual teachers and may vary from teacher to teacher. In this section, teachers' views on professional growth are identified by using the categories of Goldsmith et al. (2014). Ten items (A–J) were created by adding another item “J. Others”. The respondents were expected to answer each item by self-evaluation according to the degree of importance. The answer is responded in the four levels of a Likert scale.

- A. Views on mathematics
- B. Views on mathematics instruction
- C. Views on students' ideas
- D. Mathematics lesson and instruction
- E. Teachers' collaboration/community
- F. Mathematics content knowledge
- G. Curriculum and instructional tasks
- H. Knowledge on teaching-learning materials
- I. Research mind and inquiry attitudes

2.4.3 Improvement of Professional Competence

In this sub-section, results of a questionnaire on the above items are presented. In order to identify the teachers' views, two groups of Japanese teachers and a group of American practicing teachers were given a questionnaire. The first group, which was the Japanese practicing teachers, consisted of seven students in a professional development school, four long-term trainees, one teacher who completed a graduate school, and one teacher from a university affiliated school. The second Japanese group consisted of 19 Year-4 students: five who wished to be prospective primary school teachers, five for junior high school, four for senior high school, and five students who wished to be public servants (and who would not be teachers). The third group, the American practicing teachers, who had participated on lesson study, answered the questionnaire through the internet.⁹ They consisted of 11 primary teachers, five middle school teachers, two junior high teachers, and one senior high school teacher.

The sum of the scores was calculated for each item and the percentage was then calculated by dividing it by the maximum score (i.e., (the number of respondents in the group) \times 4). Among the ten items, “C. Views on students' ideas” got the highest value among the three groups of teachers. This meant that all groups commonly chose this item as the highest importance. The Japanese practicing teachers valued “B. Views on mathematics instruction”, “D. Mathematics lesson and instruction”, “F. Mathematics content knowledge” and “H. Knowledge on teaching learning materials” as the second importance. The “I. Research mind and

⁹The questionnaire was administered with help of Prof. Tad Watanabe.

Table 2.1 Top three important items in mathematics instruction

Item	Japanese practicing teachers	Japanese prospective teachers	USA practicing teachers
A. Views on mathematics	5	16	5
B. Views on mathematics instruction	57	22	0
C. Views on students' ideas	32	66	35
D. Mathematics lesson and instruction	28	39	31
E. Collaboration with colleagues	0	0	23
F. Mathematics content knowledge	8	15	17
G. Curriculum knowledge	0	3	12
H. Knowledge on teaching-learning materials	11	11	22
I. Research mind and inquiry attitudes	12	8	17
J. Others	0	0	18

Note Regarding the American teachers, the data is available only for 13 respondents, due to possible misinterpretation

inquiry attitudes” had some difference between Japan and USA, with higher value for the Japanese teachers.

In addition, the respondents were asked to choose the top three priority items. For each item, the sum of the scores was calculated by converting the “top priority” to 5 points, “second priority” to 3 points, and “third priority” to 1 point. The percentage was then calculated by dividing it by the maximum score (i.e., (the number of respondents in the group) \times 5). Table 2.1 shows that the Japanese practicing teachers regarded “B. Views on mathematics instruction” as the highest priority, and “C. Views on students’ ideas” as second. Both the Japanese prospective teachers and the American practicing teachers regarded “C. Views on students’ ideas” as the highest and “D. Mathematics lesson and instruction” as the second. In comparison with the Japanese practicing teachers, the American teachers valued “B. Views on mathematics instruction” as low priority. The item “E. Collaboration with colleagues” was not recognized by the Japanese practicing teachers but was highly recognized by the American teachers.

2.4.4 Interpretation of the Above Results

The Japanese practicing teachers and Japanese prospective teachers regarded “C. Views on students’ ideas” and “B. Views on mathematics instruction” as the most

important items. This suggests that they hold similar values, however there are some differences. The practicing teachers regarded more items as important than the prospective teachers did. This result showed that practicing teachers tend to acquire wider views through teaching experience and in-service training. Another difference is that “B. Views on mathematics instruction” was not very high at the preparatory stage of teacher training but became very high at the later stage. This is a unique characteristic of Japanese teachers’ views on professional growth.

From the results of the prospective teachers, the values embedded in Japanese lesson study seem to start growing even during the preparatory stage. They regarded “C. Views on students’ ideas” as the most important. It can be interpreted that they received lessons and practices which emphasize this point. For them, “D. Mathematics lesson and instruction” were also important. The prospective teachers wrote that they wanted to observe other teachers’ lessons and implement the lesson effectively.

In summary, the Japanese practicing teachers hold wider views on instruction and teaching learning materials than the prospective teachers who tend to pay more attention to the practical part of the lesson. These results imply that the values that Japanese practicing teachers attach to the in-service training go beyond practical advancement of know-how and enhance views on instruction which support their practice.

2.4.5 Summary of Institutional Perspective

Through the questionnaires on the views of professional growth (above) and roles of different institutions, the following points are identified for institutional perspectives:

- In-service training opportunities influence the formation of values and views on teachers’ professional development. A questionnaire confirmed that there are various types of training and the roles of the board of education and the educational center are crucial. Almost all Japanese practicing teachers mentioned the importance of conducting/observing lessons and this was consistent throughout. The American practicing teachers mentioned not only working around lessons but also different opportunities, such as learning new trends of curriculum or collaboration with outside teachers.
- The Japanese respondents tended to answer that they participated in in-service training only when they were in charge of lesson study in their schools. They voiced that it is not easy to participate in training unless they have more free time. Currently they are expected to play many roles in their schools and their learning opportunities are incorporated into such roles.
- The above point is regarded as a “systemic change”, which is an Eastern perspective in the discussion on cultural differences in teachers’ professionalism. Kaiser and Li (2011) state that “While in Eastern conception a change on a

systemic level is desirable, the Western conception refers to changes on the local level” (p. 349). While Western views of professionalism are limited to the interaction with students in the classroom, Eastern views grasp teachers’ professionalism holistically by including role of the teacher as a researcher and a curriculum developer. The views imply that one of the Japanese teachers’ tasks is to look for training opportunities to meet their individual needs and interests rather than to solely follow their duty and responsibility.

2.5 Development Assistance Perspective

2.5.1 *Background and Objective*

In the previous sections, mathematics education in Japan has been analyzed from the perspectives of history, community and institution. It is not easy to describe in a complete way the mathematics education in a country. So the fourth perspective is to provide a reflective description of such characteristics, through analyzing previous studies and comparing different education systems.

Isoda, Stephens, Ohara, and Miyakawa (2007) stated that there is a peculiar situation in Japan which supports the implementation of lesson study, and this situation has been historically formed. The Japanese government assists developing countries in Asia and Africa economically and technologically, and Japanese scholars and teachers (hereafter scholars) are involved in such an endeavor. Since the developmental assistance is a joint endeavor between the donor and recipient countries, the scholars who are involved in such an endeavor encounter different cultures and societies. Through realizing those differences, they also “encounter” their own society and culture as well.

In order to identify those differences in terms of three perspectives and the values embedded in them, the research method is the secondary analysis of research articles, which were written by different scholars involved in the developmental assistance. The assumption is that these scholars have internalized the values of mathematics education in Japan and those values become explicit when they encounter different cultures and values.

2.5.2 *Analysis of Previous Studies*

The previous studies were collected by the keywords “mathematics education” and “international (cooperation)”¹⁰ on the site (CiNii), and 77 articles were identified. Five more articles were added onto the list later on. All of these were categorized

¹⁰Development assistance is commonly called an international cooperation in the Japanese context.

into the international cooperation (38 articles), the international comparative studies (16 articles), overseas field survey (20 articles), and others (8 articles). The target of analysis is only the category of international cooperation. These articles were obtained electrically except five articles which were unavailable.

Analysis from three perspectives

① History

Regarding history, we discuss two cases from Africa, Kenya and Ghana. Since they were both UK colonies, some similarities are expected such as the introduction of modernization curriculum and use of English as a medium of instruction.

Baba (2002) stated that Kenya used to have four different syllabuses according to different African, Arabic, Asian and European races. After independence, they unified those into one syllabus based on the African one. Later, it was revised into Kenya Primary Mathematics at the primary level and emphasized sets and topology under the influence of the modernization curriculum. In this sense, the government tried to balance local and international contexts. On the other hand, the medium of instruction has continued to be English, even after political independence. This is because there are many local languages and it was not easy to choose one language among them. Yoshida (2000) presented the case of Ghana. A prominent feature is that the textbooks there also contained a reminiscence of modernization in the 1970s containing sets and mappings.

In these papers (Baba, 2002; Yoshida, 2000), the Japanese case was also mentioned in comparison. Yoshida (1998, 2000) pointed out the importance of reinterpreting the modernization process of education and the adaptation of Western mathematics from the Meiji restoration in Japan in relation with the developing countries. As for the language when adapting Western mathematics, it is translated into Japanese language. Referring to Ghanaian case, Yoshida stated that our education largely owes to the efforts of great ancestors. Baba (2004) pointed out that there are two types of outputs from the endeavor of developmental assistance. One type is explicit and the other is implicit. He suggested that the latter is more important and is related to the values of the culture, which underlie the explicit outputs.

② Community

The notion of “community of practice” is being appreciated and experimented in some countries. In many cases, however, sustainability is an issue. On the other hand, the communities of this kind are prevalent all over Japan. As discussed previously, the teachers’ community in Japan does not only refer to colleagues within a particular school but also to teachers in nearby schools, teachers within the prefecture and across Japan, and furthermore teachers of the previous generation. This was manifested in the Saitama case. Thus, the notion of community in Japan has characteristics of time-wise and place-wise connectivity. Through this connectivity, the values have been shared by the members and the community has become more solid. In this sense, sustainability does not matter in Japan. One of the

important shared values can be expressed by the word “観” (kan, the literal translation meaning “views”), representing a particular way of looking at the lesson.

In Japan, the attitudes and the way of looking at the teaching materials and lessons have been nurtured and shared within the group. The word “kan”, used as lesson “kan” and teaching material “kan”, indicates a way of looking at lessons and teaching materials. This is namely a cultural way of interpretation below the surface (Baba, 2014).

When Japanese scholars are engaged with development assistance, they focus on how the lack of such community causes difficulty in organizing any activity. So as a first step, it was regarded as important to form such a community in those countries.

Nagao (2003) mentioned patterns of mathematics lessons in Ghana: basic calculation exercises, explanation of key terms and definitions, demonstration of solution of today’s problem, demonstration of solutions of similar problems, exercises and homework. Such patterns may have been acquired through their own education and teacher education system. If the patterns are to be changed, there must be a provision of opportunity in which the teachers are made to reflect on their practices and patterns. Community can play an important role in providing such an opportunity. Okubo and Tsuji (2005) observed and stated that teachers in Egypt might have a difficulty in introducing new views and methods and developing their capacities. While considering it, they reflect that most Japanese teachers have developed the capacity to overcome shortcomings of views and methods through participating in lesson study.

These reflections are made by Japanese scholars who were involved in the international cooperation endeavor. On the other hand, it is difficult for the scholars in those countries to become conscious about non-existence of such communities. It may be similar to the concept of “0”. While Isoda (2010) discussed the issues of development assistance, one critical point is the difficulty of being properly able to appreciate the quality of lesson study and the scarcity of experts who can explain such quality.

Baba (2014) pointed out that in the developing countries the fragility of the professional foundation is related to the non-existence of academic associations, open research lessons, and so on. While these difficulties exist, school based in-service training and lesson study can serve as a first step to providing an opportunity of reflection over lessons. If these opportunities would function well, the participants should have common ways of looking at lessons and shared values for quality of lessons.

③ Institution

Many articles (Baba, 2002; Einaga, 2000; Nisikata & Nakajo, 2014; Watanabe, 2000) have stated that developing countries have a priority in industry development and thus have strong interests in mathematics and science education. For this purpose, it is necessary to improve an intended curriculum, the teacher education system (both pre-service and in-service) as well as the examination system.

As for the curriculum improvement, some countries still have an influence of modernization curriculum. At the same time, they have started discussing more advanced competences such as 21st century skills. While it still has a traditional teaching style, which has an examination orientation, an important task for those countries is to overcome the traditional teaching style and realize a new style of lessons to promote these advanced competences.

As for the teacher education, many scholars pointed out the weak capacity of teachers in the developing countries. Teachers in Laos are not conscious about the above trend of new abilities such as logical thinking and application to daily life (Akita & Saito, 2008). Ghanaian teachers attribute problems to the lack of teaching materials, but in reality they do not have enough capacity to utilize the teaching materials even if they are available (Nagao, 2003). This lack of capacity is caused by teacher education, which does not pay attention to such utilization. The teacher education system and environment in Japan are well developed to support lesson study practice and teachers' professional growth. For example, Japanese teachers conduct lesson study and open lesson within their working hours. They base their research lesson on the national curriculum and views on mathematics education and students (Isoda, 2010).

As for the examination and assessment system, in Ghana there is a national assessment system but the results are not utilized fully for the improvement of curriculum and lessons (Yoshida, 2000). The introduction of a new approach for new competences may be hindered or promoted by the examinations.

2.5.3 Summary of Developmental Assistance Perspective

Through the secondary analysis of academic papers, the following points are identified regarding developmental assistance perspectives:

- The three perspectives of Japan and of developing countries were discussed in the context of developmental assistance. The perspectives become explicit through interacting with the countries of different cultures and histories. They have been implicit in Japan and this may be one of the reasons why few articles on lesson study are found in this country. This fact itself may be indirect proof of how much we have internalized these in ourselves.
- Baba (2001) pointed out that reviewing the history of Japan and what to do in developmental assistance prompts us to think about the position of mathematics education in Japan in terms of the world trends. Yoshida (2000) also held the same view that revisiting the experiences in the process of modernizing education and thinking about what is useful for developing countries may provide universalization of Japanese peculiarity within the worldwide framework.
- The Japanese government values the principle of “self-help” in development assistance. It regards that the self-help is a crystallization of the modernization efforts from Meiji till today, and thus is a catalysis for developing countries to

engage in such modernization efforts. The above three perspectives are closely connected to self-help within the mathematics education development.

- Developing countries borrowed models from the colonial governments even after independence. Though Japan has not been colonized, it adapted the Western mathematics and education system into a traditional education practice. Of course they cannot be made exactly the same way (Baba, 2002). Model borrowing shows the externality of professionalism and gives rationales to the need for the formation of professional knowledge and a professional group for curriculum development (Baba, 2014). While in this situation, lesson study holds such characteristics as closeness to practice (Ruthven & Goodchild, 2008) and it can provide an alternative model to self-help.

2.6 Summary

Cultural characteristics of lesson study in mathematics may remain implicit as long as one stays inside the culture. Thus a comparative approach was employed to reveal these implicit characteristics. Three perspectives such as history, community and institution were used to shed light on cultural characteristics of mathematics education and lesson study in Japan.

First, as for comparative perspective in the development assistance, several developing countries were chosen as an object of comparison. Because they do not have some aspects, which are very obvious for us in Japan, we become conscious of the comparison of those implicitly “existing” aspects. On the other hand, if the developed countries are chosen as an object of comparison, then the comparison makes us find some aspects “not existing” in Japan. So we can learn from them. As for the historical perspective, we need to return to the root of those practices, when they were newly created, with a combination of development assistance and historical approach. Here explicit and implicit problems can be traced back to historical development. The third is to pay attention to the reason why those implicit features are being valued. This is related to the second issue. Tracing back to the origin gives us the reason behind the creation of such practices. This makes us conscious about the reason of creation and provides us with an opportunity to revisit whether it is still relevant to the present day or to other contexts.

In the above discussion, lesson study by the community with acquisition of voluntary and professional learning is an important and ultimate goal. Can such an ultimate goal be achieved simply through the introduction of a particular institution? Once an institution is established, its reason does not have to be questioned. Lesson study may sometimes look very superficial even in Japan if we only pay attention to the institutional aspect. Thus, institution is a necessary but not sufficient condition for the implementation of lesson study. If it is not accompanied by voluntary learning, it may remain an empty promise.

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