

## Studying Sample Lessons Rather than one Excellent Lesson: A Japanese Perspective on the TIMSS Videotape Classroom Study

Yoshinori Shimizu, Tokyo (Japan)

**Abstract:** The findings of the TIMSS Videotape Classroom Study include aspects of mathematics lessons showing a strong resemblance between Germany and the U.S. in difference to Japan. This paper discusses some of the features that appear to make Japanese lessons different from the other two countries. In particular, the paper examines the goals of lessons described by Japanese teachers, how lessons are structured and implemented, and the emphasis on alternative solutions to a problem in the teaching and learning processes. The characteristics of Japanese lessons identified by the TIMSS Videotape Classroom Study can naturally be interpreted as indications of teachers' efforts to foster students' mathematical thinking in the classroom.

**Kurzreferat:** *Stichprobenhafte Untersuchungen von Unterrichtsstunden sind besser als Untersuchungen einer mustergültigen Stunde: Japanische Aspekte der TIMS-Videostudie.* Die Ergebnisse der TIMS-Videostudie enthalten Aspekte des Mathematikunterrichts, die große Ähnlichkeiten zwischen Deutschland und den USA aufzeigen sowie Unterschiede zu Japan. In diesem Beitrag werden einige Merkmale des japanischen Mathematikunterrichts behandelt, die den Unterschied zu den beiden anderen Ländern ausmachen. Insbesondere geht es um die von japanischen Lehrern genannten Ziele ihres Unterrichts, darum, wie Unterrichtsstunden strukturiert und gehalten werden sowie um die große Rolle, die alternative Lösungen einer Aufgabe im Lehr- und Lernprozess spielen. Die Merkmale japanischen Unterrichts, wie sie durch die TIMS-Videostudie identifiziert werden konnten, können als Indikatoren für das Bemühen der Lehrer, das mathematische Denken der Schüler zu fördern, angesehen werden.

**ZDM-Classification:** D10, D40

### 1. Introduction

The Video component of the Third International Mathematics and Science Study (TIMSS) was the first attempt ever made to collect and analyze videotapes from the classrooms of national probability samples of teacher at work (Stigler & Hiebert, 1997; Stigler et al., 1999). Focusing on the actions of teachers, it has provided a rich source of information regarding what goes on inside eighth-grade mathematics classes in Germany, Japan and the U.S. with certain contrasts among three countries. The findings of the study identified aspects of mathematics lessons showing a strong resemblance between Germany and the U.S. and differences to Japan.

In this paper, based on his experience both as a Japanese teacher educator and a Japanese consultant of the study, the author discusses some particular findings of the TIMSS Video Study. A focus is on features that appear to make Japanese lessons different from the other two countries. In particular, the paper discusses how Japanese teachers promote mathematical thinking in the classroom with respect to the goals of lessons described by Japanese teachers, how lessons are structured and implemented, and

the emphasis on thinking and discussing alternative solutions to a problem.

### 2. Studying sample "average" lessons rather than one excellent lesson

The ultimate goal of any study of classroom process is to improve teaching practice for enhancing students' learning, even if its major focus would be on, for example, constructing a theoretical model of teaching or comparing teaching methods among countries. For this goal, various approaches and methodologies can be adapted.

The TIMSS Video Study was a breakthrough as a scientific exploration into the classroom, showing the feasibility of applying videotape methodology in wide-scale national and international survey of classroom instructional practice. It has provided a rich source of information regarding what goes on inside eighth-grade mathematics classes in the three countries. Also, objective observational measures of classroom instruction were developed to serve as valid quantitative indicators, at a national level, of teaching practices in the three countries.

Another type of approach to improve teaching practice has traditionally been taken by Japanese teachers in a practical way. In Japanese schools, workshops of particular style, "Jugyo Kenkyu-kai" ("lesson study meeting"), are regularly held at each school level or at the other levels. This opportunity has a strong impact on teacher development (Shimizu, 1999). These workshops include an actual lesson (a "research lesson") observed by many teachers as well as an extended discussion after the lesson (Lewis & Tsuchida, 1998). Teachers exchange ideas about the lesson they have just observed focusing on the task on which students worked, the content taught, students' response to the problem, and the teachers' roles. Experienced teachers or mathematics educators are often invited to comment on the development of the lesson observed, interpretations of the topic taught, and how the lesson could be improved. By observing and discussing an actual lesson, aspects of lessons are examined and explored.

Based on their experience, Japanese mathematics teachers and educators would believe that studying one excellent lesson intensively is likely to be more beneficial than studying many "average" lessons. They are interested not in how eighth grade mathematics is taught in Japan but how an excellent teacher, in any one of three countries, teaches mathematics in her classroom.

The size of the Japanese sample in the study was reduced from 100, the original plan, to 50 primarily because the Japanese collaborators "determined that 100 classrooms would create too great a burden for their country" (Stigler et al., 1999, p.9). This reduction was further justified by the fact that certain characteristics of Japanese education (e.g., lack of tracking within or across schools, adherence to a national curriculum, and culturally more homogeneous population) led the research team to expect lower variability between classrooms in Japan. Japanese teachers and educators would think that fifty lessons would be more than enough as a sample from Japanese mathematics classrooms. Moreover, they would think that it would be important for them to examine the

lesson taught by an excellent teacher. From a Japanese perspective, it is interesting to see in what extent the objective observational measures of classroom instruction developed by the TIMSS Video Study would be used to examine the lesson taught by an excellent teacher.

### 3. Emphasis on mathematical thinking in Japanese classrooms

#### 3.1 Goals of lessons: The emphasis of understanding and thinking

In the TIMSS Video Study teachers' responses on the questionnaire to the question were analyzed, "What was the main thing you wanted students to learn from today's lesson?" There was a significant difference between the reported goals of teachers in Japan and teachers in the other two countries. A majority of Japanese teachers reported that fostering mathematical thinking was the main goal for their lessons, while 55 percent of German teachers and 61 percent of U.S. teachers reported that development of skills was the main thing to be learned (Stigler et al., 1999, p. 46). Here teachers' responses were coded as "Mathematical Thinking" when they emphasized students' exploration, development, and comprehension of mathematical concepts, or the discovery of multiple solutions to a problem.

Table 1: Teachers' responses on the questionnaire about the goal of a lesson (%)

	Germany	United States	Japan
Skills	55	61	25
Thinking	31	21	73

The result of the teachers' questionnaire shows that Japanese teachers described their goals of lessons in consistency with the goals of teaching mathematics described in the Course of Study in which fostering students' mathematical thinking is emphasized (Ministry of Education, 1989). Also, similar statements to what teachers described in the questionnaires as goals of their lessons can be found in each chapter of the teacher's editions of textbooks.

One of the Japanese mathematics lessons in the sample coded as "JP-012", for example, was on equal areas of triangles within parallel lines. The problem on which students worked in the lesson was the "land problem", in which the boundary between two lands is to change without changing the area of them. Students were expected to apply what they had learned in the previous lesson; the area of triangles obtained by using the same base but translating the vertex opposite the base along a path parallel to the base, thus keeping the height constant. In the teacher's edition of a eighth grade textbook, three goals for the lesson on this topic are described from the learner's perspective with an emphasis on understanding and thinking (Tokyo Shoseki, 1996, p. 219):

- Students can understand that the distance between two parallel lines is a constant.
- Students can understand the area of two triangles that share the base and have the same height are equal and use this property to solve the problem
- Students can change the shape of a polygon without

changing the area of it.

There is a follow-up problem in the textbook to change a quadrilateral into a triangle without changing the area. The "land problem" is included in the teacher's edition as a "related problem" which is expected to appear at certain points in the sequence of lessons. Also, software for specific purposes is available, to demonstrate the dynamic movement of the vertex of a triangle without changing the base and height, for example, as was used in the lesson. Teachers can easily access to those materials designed as a whole for specific goals of lessons, that is, fostering mathematical thinking through students' exploration, comprehension of mathematical concepts, or the discovery of multiple solutions to a problem. Thus, teachers could naturally respond to the question of the main thing they wanted students to learn from today's lesson by reporting "mathematical thinking" as the main goal of it.

#### 3.2 "Lesson scripts"

In the TIMSS Video Study a concept of "lesson script" was proposed as a commonly accepted and predictable way of structuring a classroom session and sequencing its instructional activities. "The difference in the scripts undoubtedly follow from different instructional goals and are probably based on different assumptions about the nature of mathematics, the ways in which students learn, the appropriate role of the teacher" (Stigler & Hiebert, 1997, p. 18).

U.S. and German lessons tend to have two phases: an initial acquisition phase and a subsequent application phase. In the acquisition phase, the teacher demonstrates and/or explains how to solve an example problem. In the application phase, students practice solving examples on their own while the teacher helps individual students who are experiencing difficulty Japanese lessons appear to follow a different script. The cultural script for Japanese lessons was described in the study as follows. First, the teacher poses a complex, thought-provoking problem. Then, students struggle with the problem. Various students present ideas or solutions to the class. The teacher summarizes the class' conclusions. Students practice similar problems (Stigler et al., 1999, p. 136).

A mathematics lesson in Japan, which lasts fifty minutes in secondary schools, can typically be divided into several segments (Becker et al., 1990; Shimizu, 1999). A common organization of lessons is comprised of the following segments which often serve as the "steps" or "stages" both in teachers' planning and in teaching-learning processes (Shimizu, 1996): Presentation of a problem; problem solving by students; a whole-class discussion about the methods for solving the problem; summing up by the teacher; (exercises/extensions) (see Fig. 1). Simpler organization of lessons may also be used: an introduction, developments, and summary.

While students are working on the problem, the teacher moves about to observe students' work. During this time period, the teacher gives suggestions or helps individually those who are having difficulties. She or he also watches for students who have good ideas, with the intention of calling on those students in a certain order in the subse-

Steps	Main learning activities	Anticipated students' responses	Remarks on teaching
Posing a problem			
Students' problem solving on their own			
Whole-class discussion			
Summing up			
(Exercise/ Extension)			

Fig. 1: A common framework for lesson plans

quent discussion. Then, a whole-class discussion begins. In this discussion, students spend the majority of their time listening to the solutions proposed by their classmates, as well as presenting their own ideas. When discussing solutions to the problem, the teacher asks students to present alternative methods to solve the same problem. Presenting an idea, even a wrong one, is strongly encouraged and praised.

A common framework, that has a similar structure as the typical pattern of organization described above, is usually used by teachers when they are writing lesson plans (see Fig. 1). An underlying assumption of using such a framework is that it enables a teacher to give students opportunities for working on problems by themselves, even individually or in a group, and for communicating ideas with their classmates.

Though they do not write lesson plans for their daily practice, Japanese teachers do have opportunities, at lesson study meetings, for example, for writing and reading lesson plans. Also, they can easily access a sample lesson plan for any particular topic that also includes expected students' responses to the problem to be posed. Actually, both the Ministry of Education and private textbook companies publish support materials for the teacher that include lesson plans. Experienced teachers and mathematics educators are invited to write sample plans for such support materials.

The cultural script for Japanese lessons identified by the TIMSS Video Study seems to fit quite naturally with such a typical framework for writing a lesson plan. It would be safe to say that one of the origins of such a cultural script would be in the tradition of use of such a framework by Japanese teachers in planning and implementing lessons. Again, an underlying assumption of using such a framework is that it enables a teacher to foster mathematical thinking through opportunities for thinking and discussing mathematical ideas with their classmates.

### 3.3 Are Japanese teachers talkative?

In the TIMSS Video Study, "Teacher Talk/Demonstration" was coded when teachers engaged in lecturing in the class. Here teachers would simply talk, with or without objects, presenting lesson-relevant information to students. There was more Teacher Talk/Demonstration in Japan than in the other two countries. The overall percentage of time devoted to this activity was not large, but more Japanese lessons included at least some Teacher Talk/Demonstration than in either Germany or the United States. The percentage of lessons in which such segments occur is reported in Table 2 (Stigler et al., 1999, p. 85).

Table 2: The percentage of lessons in which teacher talk/demonstration segments occurred

	Germany	United States	Japan
Percentage of lessons	17	15	71

How could such a big difference be explained? One possible interpretation may be that Teacher Talk/Demonstration was done mainly at the Matome stage (Shimizu, 1999). "Matome" in Japanese means "summing up". Japanese teachers think that this stage is indispensable to any successful lesson. The Matome stage is identified as a critical difference between the U.S. and Japanese classroom activities (Fujii et al., 1998). According to the U.S.-Japan comparative analysis, at the Matome stage Japanese teachers tend to make a final and careful comment on students' work in terms of mathematical sophistication. In contrast, the U.S. teachers appear to make general comments at the end of a lesson, for example, that everybody has done fine work, or that each student's work is equally worthy. It would be interesting to explore both when in each lesson the Teacher Talk and Demonstration segments had occurred and what the teacher had talked.

### 3.4 Thinking and discussing alternative solution methods for a problem

In the TIMSS Video Study, tasks on which students were working during seat work were coded into three mutually exclusive categories: Practice Routine Procedures, Invent New Solutions/Think, and Apply Concepts in New Situations. As to the average percentage of seat work time spent in three kinds of tasks, Japan differed markedly from the other two countries, spending less time on practice of routine procedures during seat work and more time inventing new solutions or thinking about mathematical problems (Stigler et al., 1999, p. 102).

Invent New Solutions/Think, in particular, was coded to describe tasks in which students had to create or invent solution methods, proofs, or procedures on their own, or in which the main task was to think or to reason. The expectation, in these cases, was that different students would come up with different solution methods.

When we consider the difference of time spent in Invent New Solutions/Think between Japan and the other two countries, it seems to be interesting to explore whether the lesson contains alternative solution methods and who

Table 3: Average percentage of seat working time spent in three kinds of tasks

	Germany	United states	Japan
Practice routine Procedures	89.4	95.8	40.8
Invent New Solutions/Think	4.3	0.7	44.1
Apply Concepts in New Situations	6.3	3.5	15.1

provides the alternatives. In the TIMSS Video Study, whether an alternative solution method was presented by the teacher, or by students, during the course of each lesson was coded. Table 4 (a) shows the percentage of lessons that included alternative solution methods of each type. Table 4 (b) shows the average number of alternative solution methods of each type presented in the lessons of the three countries (Stigler et al., 1999, p. 54).

Table 4 (a): Percentage of lessons that included teacher-presented and student-presented alternative solution methods

	Germany	United states	Japan
teacher-presented	14	19	7
student-presented	12	8	42

Table 4 (b): Average number of teacher- and student-presented alternative solution methods presented per lesson

	Germany	United states	Japan
teacher-presented	0.4	0.5	0.1
student-presented	0.2	0.2	1.7

The U.S. lessons included significantly more teacher-presented alternative solution methods than did Japanese. Japanese lessons included significantly more student-presented alternative solution methods than did either German or U.S. lessons.

One of the striking characteristics of mathematics lessons in Japanese elementary and lower secondary schools relates to the frequent exposure of students to alternative solution methods for a problem. Japanese mathematics teachers, in elementary schools in particular, often plan to organize an entire lesson around the multiple solutions to a single problem in a whole class instruction mode (Nagasaki and Becker, 1993; Shimizu, 1996). Several students out of thirty to forty students in a classroom usually present alternative solution methods for the problem. Discussing multiple solutions to a problem in a whole-class mode is a common style for teaching mathematics in Japanese schools. As shown in Tables 4 (a) and (b), the study identified the characteristics of mathematics lessons in Japan with respect to the presentation of alternative solution methods. A further analysis would be needed for finding how those alternative solution methods were treated in a whole class discussion in order to attain the goals of the lesson.

#### 4. Beyond the scope

##### 4.1 Collecting and analyzing data over a lesson sequence

In the study, using the sub-sample of 90 lessons coded by the Math Content Group, explicit linking of ideas and experiences in lessons was coded that the teacher wants students to understand in relation to each other (Stigler et al., 1999, p.117). Two kinds of linking were coded. Linking across lessons and linking within a single lesson. In the study, linking was defined as an explicit verbal reference by the teacher to ideas or events from another lesson or part of the lesson. The reference had to be concrete (i.e., referring to a particular time, not to some general idea); and the reference had to be related to the current activity. The results of this coding show a resemblance between Germany and the U.S. in difference to Japan. The highest incidence of both kinds of linking, across lessons and within lessons, was found in Japan. Indeed, teachers of Japanese lessons linked across lessons significantly more than did teachers of German lessons, and linked within lessons significantly more than teachers of both German and U.S. lessons.

Table 5 shows percentages of lessons that include explicit linking by the teacher to ideas or events in a different lesson, and to ideas or events in the current lesson (Stigler et al., 1999, p. 118).

Table 5: Linking to ideas or events in a different lesson or in a current lesson (%)

	Germany	United states	Japan
In a different lesson	55	70	91
In a current lesson	41	40	96

Japanese teachers usually plan a lesson as a part of a unit, a sequence of several lessons. This means that each lesson in a unit has a different purpose for attaining the goals of the unit, depending on the phase in the unit. At an introductory phase in a unit, for example, the lesson will be in a concept- oriented mode for introducing a new idea or concept. On the other hand, at the summative phase, the lesson may be more practice or skill oriented. Thus, lesson scripts for lessons at each phase will be slightly different from each other even in the same county. Collecting and analyzing data over a lesson sequence are needed for further study to clarify such issues.

##### 4.2 Learners' perspectives

It should be noted that the focus of the TIMSS Video Study was basically on the actions of teachers. A more complete description of the practice of mathematics classrooms would be obtained, if learners' perspectives were incorporated into the findings of the study. Student interpretations of mathematics classrooms are necessary for a detailed account of classroom practice.

There appear to be some differences among the lessons coded. For example, a Japanese classroom would never have someone come into the lesson while it was under way. It would also be very rare for a lesson to be interrupted by a PA announcement. These events certainly took place

in the lessons coded in the U.S. and to some extent in Germany. As a natural consequence of such events in the classroom, students' views on a lesson should be quite different among three countries.

Another difference among the three countries concerns relationships among teacher, students, and mathematics in each country. When I watch the field tested video from the three countries, lessons from each country seemed to be quite different with respect to the relationships. German teachers, for example, seemed to teach mathematics in a "one-to one" question and answer mode with an authority of mathematics behind them. On the other hand, Japanese teachers seemed to behave keeping their position at somewhere in between mathematics and students without authority of mathematics behind them. A part of my early impressions was confirmed by the objective observational measures of classroom instruction developed by the TIMSS Video. We need to have a framework with which we can integrate the findings of the study as a whole both from the teacher's and students' perspective.

### 5. Final remarks

In this paper, the author discussed some of features that appear to make Japanese lessons different from German and the U.S. In particular, the paper examined the goals of lessons described by Japanese teachers, how lessons are structured and implemented, and the emphasis of alternative solutions to a problem in the teaching and learning processes. The characteristics of Japanese lessons identified by the TIMSS Videotape Classroom Study can naturally be interpreted as indications of teachers' efforts to foster students' mathematical thinking in the classroom.

It is always interesting for us to observe lessons in a foreign country because we can find some aspects of the lessons in our own country that is often invisible. By looking into the results of the TIMSS Video Study, Japanese teachers and educators can reflect on what kind of lesson is the one regarded as an excellent lesson.

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### Author

Shimizu, Yoshinori, Tokyo Gakugei University, Dept. of Mathematics & Informatics, Koganei-Shi, Tokyo 184-8501, Japan. E-mail: shimizu@u-gakugei.ac.jp