

Building Communities of Inquiry in Mathematics Classrooms: The Key to Facilitating Reasoning, Communication, and Connections in Mathematics



Yoshinori Shimizu
University of Tsukuba
yshimizu@human.tsukuba.ac.jp

Mathematics Teachers Conference 2011, June 2, NIE

Outline




- **The Uniqueness of Japanese Mathematics Lessons**
 - A “structured problem solving” approach
- **Communities of Inquiry** in Mathematics Classrooms
 - **Video Clips:** Reasoning, Communication, and Connections
 - Some pedagogical ideas shared by JTs
- **Kyozai-Kenkyu:** Analyzing the topic to be taught
- **Valuing Students’ Thinking in the Classrooms**
 - *Some practical suggestions*
- **Matome (Main points)**



Some Findings of International Studies of Mathematics Classroom Practices

The Uniqueness of Japanese Lessons



A “structured problem-solving” approach with clear goal(s)

- Teaching as **cultural activity**
- A **story** or a **drama**, which has a climax and concluding, as a metaphor for a good lesson
- Emphasis on the **form**
- Valuing **students’ thinking**

TIMSS Videotape Classroom Study

- 1995 TVS : The first attempt ever made to collect and analyze videotapes from the classrooms of national samples of mathematics teacher at work: Germany (100), Japan (50), United States (81).

(Stiglar et al., 1999)

- 1999 TVS : 638 videotaped lessons from seven countries including Japan. The focus of the study was basically on the actions of teachers.

(Hiebert et al., 2003)

The Learner's Perspective Study

(Clarke, Keitel & Shimizu, 2006)

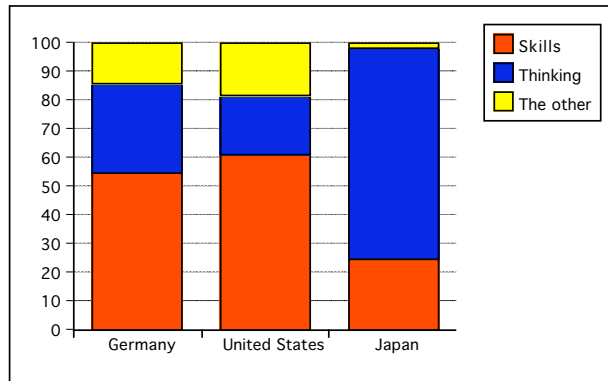
- **Competent teachers** defined by local criteria
- **Lesson sequences** covering one 'topic' for each teacher
- Three video cameras plus on-site mixing to provide interview stimulus
- **Post-lesson video-stimulated interviews** with students and teacher
- Written materials photocopied and scanned in
- Student test(s) and Teacher questionnaires

The Learner's Perspective Study
International Research Collaboration in Mathematics Education

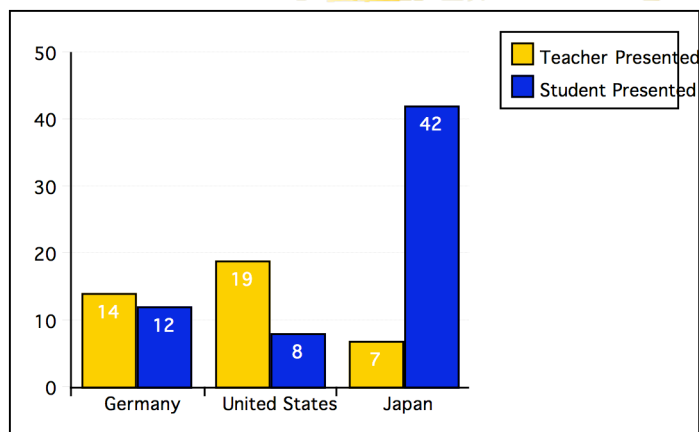


Goal of Lessons (Stiglar et al., 1999, p.46)

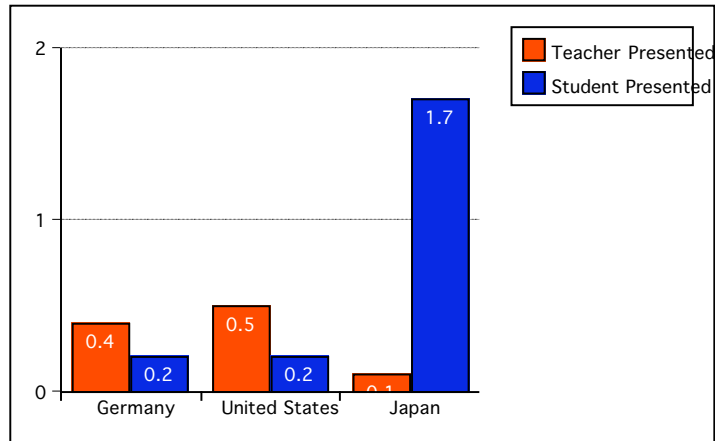
Teachers' Responses on the Questionnaire: the Goal of Lesson (%)



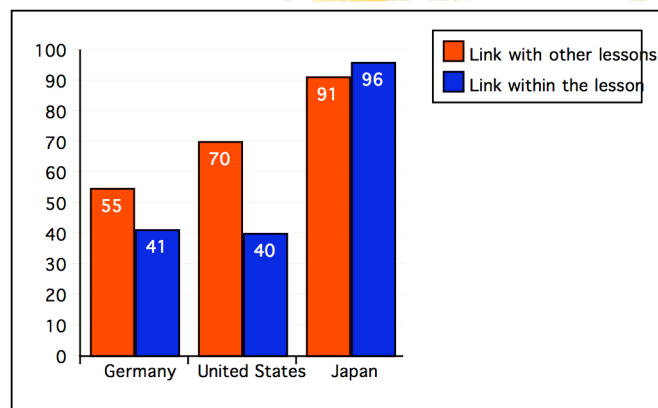
Alternative Solution Methods for a Problem Percentage of Lessons That Included Teacher-presented and Student-presented Alternative Solution Methods (Stiglar et al., 1999)



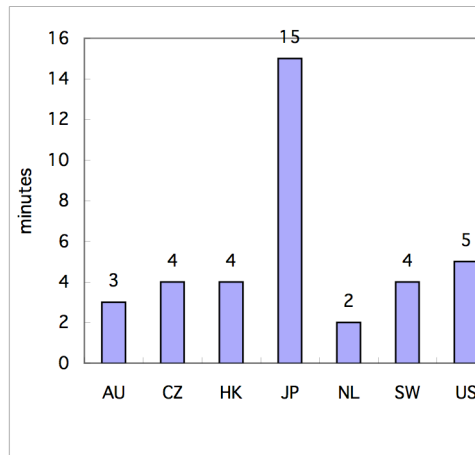
How many alternative solution methods in a single lesson? (Stiglar et al., 1999)



Linking to ideas or events in a different lesson or in a current lesson (%) (Stiglar et al., 1999)

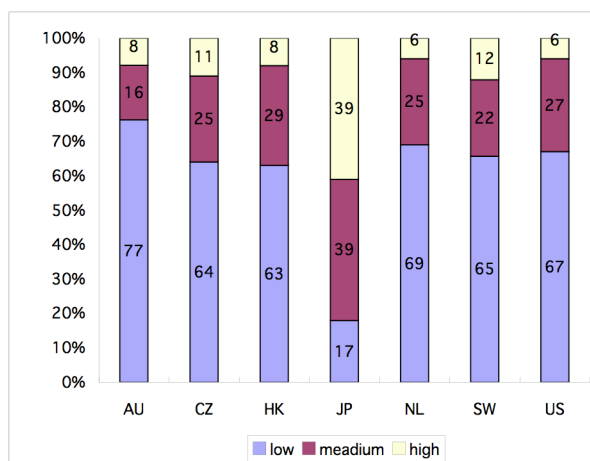


Time spent for one problem



(Hiebert et al., 2003)

Complexity of Tasks Posed in the lesson



(Hiebert et al., 2003)

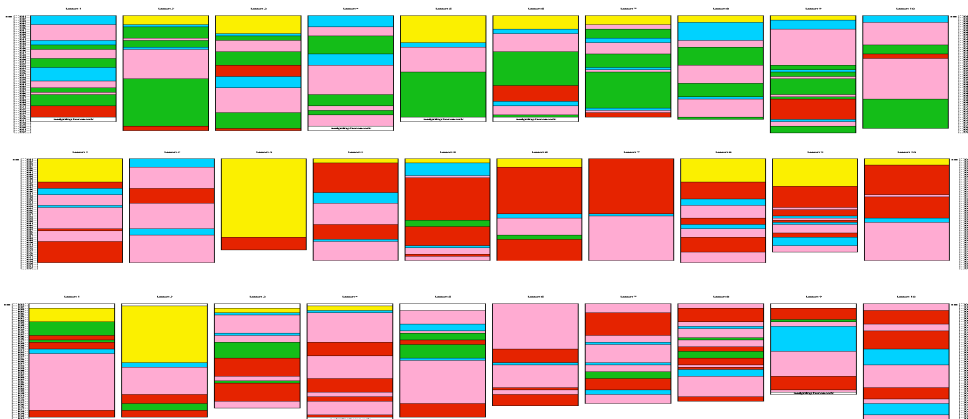
(Stigler, J. W. & Hiebert, J. (1999). *The Teaching Gap*. New York: Free Press.

The Japanese Pattern

Five activities characterize Japanese lessons:

	Reviewing the previous lesson
	Presenting the problem for the day
	Students working individually or in groups
	Discussing solution methods
	Highlighting and summarizing the major points

Lesson pattern in the sequence



(Clarke, Mesiti, Jablonka & Shimizu, 2006)

The Uniqueness of Japanese Lessons

A “structured problem-solving” approach with clear goal(s)

- o Teaching as **cultural activity**
- o A **story** or a **drama**, which has a climax and concluding, as a metaphor for a good lesson
- o Emphasis on the **Form**
- o Valuing **students’ thinking**

Communities of Inquiry in Classrooms

Key features (cf. C.S. Peirce, 1839–1914)

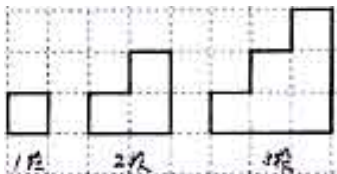
- o The development of skills and dispositions associated with **good thinking, reasoning, and dialogue**
- o The use of subject matter that is conceptually **complex and intriguing, but accessible**
- o Classroom environment characterized by a **shared common purpose, mutual trust, and risk-taking**

The School: LPS J1



- The school is located in the old downtown Tokyo.
- The teacher, Ms. K, has been teaching mathematics for more than twenty five years.
- The videotaped 8th grade class consists of thirty-two students.
- The data covers videotaped lessons from the first through tenth class period in the unit of "linear function"

The Stairs Problem



- Draw the next two figures.
- What changes when the number of steps changes?
- Explore the relationship between the numbers of steps and the **perimeters**.
- Explore the relationship between the numbers of steps and the **numbers of right angles**.

The Origami Problem

Here is a yellow paper with length of 12 cm and width of 15 cm. What happens when we fold the paper like the following? Explore the relationship between changing two values.



The problem in J1-L5

- She then asked the students to think about what changed, or not changed, when she changed the location of the folds.
- The students came up with the following ideas; the color portion, the sides, the shape, the area, the perimeter, and so on.
- Then the class decided to explore the **relationship between the location of the folds and the perimeter**.
- In the lesson J1-5, then, the students were asked to draw the graph of the relationship between the location of the folds and the perimeter.

Ms. K' Classroom

Video Clip 1

Video Clip 2

Video Clip 3

Video Clip 4

Key pedagogical terms shared by Japanese teachers

- **Hatsumon**: Key questioning
- **Kikan-shido**: Instruction between desks
- **Neriage**: "Polishing up"
- **Yamaba**: The highlight or climax of the lesson
- **Matome**: Summing up



The Japanese Lesson Pattern

(Stigler & Hiebert, 1999, pp.79-80)

- Reviewing the previous lesson
- Presenting the problems for the day
Hatsumon (発問)
- Students working individually or in groups
Kikan-Shido (机間指導)
- Discussing solution methods
Neriage Yamaba(山場)
- Highlighting and summarizing the main point
Matome



A Story, or a Drama, as a Metaphor for a Good Lesson

Ki-Sho-Ten-Ketsu, The structure of Chinese Poetry

- *Ki-----Opening*
- *Sho -----Continuing/Developing*
- *Ten -----Switching*
- *Ketsu -----Conclusion*

See The Last Samurai

together with

Yamaba, or Miseba

Yamaba (climax)

- Yamaba is the highlight or climax of a lesson. Japanese teachers talk about Yamaba with shared beliefs that a lesson should have a climax in order to be interesting and exciting to students, just like a drama or a story.

"Matome" (summing up)

Japanese teachers think that this stage is indispensable to any successful lesson. At Matome stage Japanese teachers tend to make a final and careful comment on students' work in terms of mathematical sophistication.

Commonalities in the Form of Matome



- Teacher's Public Talk, mostly in front of the classroom
- Effective Use of the Chalkboard, referring to what they have done
- Reference to the corresponding Textbook pages



- Interactive utterances between the teacher and the students

Kyozai-Kenkyu

教材研究

- Examining Tasks in Their Sequence
- Emphasis on Students' Thinking in the Classroom

The Unit Plan of “Linear Function” and the Corresponding Lessons in the LPS data

Teaching Unit	Sub-Units	Lessons in the sub units and topics to be taught	Data in LPS
“Linear Function” (16 class periods)	1. “Changing variable and linear function—Part One”	Lesson 1-1: Finding variables in the “step problem” Lesson 1-2: Exploring the relationship between the number of steps and length of perimeter	<i>JP1-1</i> <i>JP1-2</i> <i>JP1-3</i>
	2. “Changing variable and linear function—Part Two”	Lesson 2-1: Finding variables in the “paper holding problem” Lesson 2-2: Exploring the relationship between the number of steps and length of perimeter Lesson 2-3: Reflecting on the exploration	<i>JP1-4</i> <i>JP1-5</i> <i>JP1-6</i> <i>JP1-7</i>
	3. “Change of Values of linear function and the Graph”	Lesson 3-1: Drawing the graph of linear functions: slope and y-intercept Lesson 3-2: Drawing the graph of $y=-2x+4$,	<i>JP1-8</i> <i>JP1-9</i> <i>JP1-10</i>

<i>School</i>	<i>J1</i>	<i>J2</i>	<i>J3</i>
Within lessons	10	9	9
Across the lessons	10	10	10



Table 1: Numbers of lessons that included explicit linking within and across lessons

A common framework for lesson plans

	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)			



Lesson Plans

- Step-based descriptions
- Planned teaching-learning process with anticipated students' response to the problem posed
- With or without figures
- Alternative solution methods

Main learning activity. Anticipated students' responses

Introduction

Development

Summing-up

Support for the students

The image shows a handwritten lesson plan in Japanese for the topic of 'Area of a Parallelogram'. The plan is organized into three main sections: Introduction, Development, and Summing-up. Each section contains detailed notes on what to teach and what to expect from students. There are also callouts from a blue speech bubble pointing to specific parts of the plan, such as 'Main learning activity. Anticipated students' responses' pointing to the Introduction section, 'Support for the students' pointing to the Development section, and 'Introduction', 'Development', and 'Summing-up' pointing to their respective sections. The handwriting is in black ink on white paper.

Kyozai-Kenkyu

- **Being explicit with the goal of lesson**
- **Posing a challenging task**
- **Formulating problems with students**
- **Anticipating Students' Alternative Solutions**
- **Looking back and Looking forward**

Valuing Students' Thinking in the Classrooms

- **Suggestion 1: Label students' methods with their names**
- **Suggestion 2: Use the chalkboard effectively**
- **Suggestion 3: Use the whole-class discussion to polish students' ideas**
- **Suggestion 4: Choose the numbers in and the context of the problem carefully**
- **Suggestion 5: Consider how to encourage a variety of solution methods**

Matome (main points)

- | Building a **Community of Inquiry**
- | A “structured problem-solving” approach with clear goal(s)
- | **Kyozai-kenkyu**教材研究
- | Valuing **students’ thinking** the classroom



THANK YOU!

For the contact;

yshimizu@human.tsukuba.ac.jp

