A STUDY OF JAPANESE PRIMARY SCHOOL TEACHER PRACTICES DURING NERIAGE

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This research aims at analyzing teacher practices in a Japanese context with a focus on the neriage, a specific phase of structured problem solving lessons. We analyze teacher practices with the specific tools of the double didactical and ergonomical approach, during a neriage that takes place during a sequence of lessons on length in 3rd year of primary school. This research highlights some characteristics of practices during neriage promoted in the problem solving approach.

INTRODUCTION

Mathematics teaching in Japanese primary school has some specificities: the ordinary lessons are often in a structured problem solving lesson format (for example, Stigler & Hiebert, 1999; Takahashi, 2008). Pre-service and in-service often manage in Lesson Study, a format of teachers' professional development based on their collaborative works (for example, Miyakawa & Winsløw, 2009).

The structured problem solving lesson consists of several phases of which one is called *neriage,* a whole-class discussion in which students compare and discuss ideas, solutions or methods for solving the problem. *Neriage* means polishing up and is used by Japanese teachers and researchers in mathematics education (Shimizu, 1999). *Neriage* has a "dynamic and collaborative nature of a whole-class discussion during the lesson" (p. 110). According to Shimizu, the teacher's role is to orchestrate students' strategies and ideas, to highlight important mathematical ideas to reach the goals of the lesson, and to help students polish their solutions in order to learn mathematical content. During this phase, students struggle with the problem and should find their own way to solve it: this experience let them make links between their earlier knowledge and the new content that they are going to learn through *neriage* (Shimizu, 1999). For Japanese teachers, the *neriage* is considered as the heart of teaching mathematics through problem solving (Takahashi, 2008). Furthermore, the *neriage* is "critical for the success or failure of the lesson" (Shimizu, 1999, p. 110).

In a case study of three Swiss primary school teachers, we highlighted the difficulty for teachers to manage whole-class discussions with comparison of students' strategies, hierarchization of strategies, and to emphasize the knowledge or the method at stake in the problem (Batteau, 2018). This difficulty is well known in the French context also (for example, Charles-Pézard, Butlen & Masselot, 2012; Peltier-Barbier et al., 2004). In the Japanese context, this research proposes to focus on the teacher's practices during this specific phase, the *neriage*, because that is part of ordinary practices and considered as the heart of the lesson by Japanese teachers.

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We present some elements of the double didactical and ergonomical approach, the research question and, the methodology. Then, we present the analysis of the teacher practices during a *neriage* that takes place during a sequence of lessons on length in 3rd year of primary school (8-9 years old). The last part is a conclusion of this research.

THEORETICAL FRAMEWORK

Robert and Rogalski (2005) developed a framework based on a double viewpoint, one in the French didactic of mathematics and another in ergonomics with activity theory (Leontiev, 1975; Leplat, 1997). This framework allows to analyze practices in taking into account the complexity of teaching, both as an individual and a professional act. The term practice concerns speech, actions and, thoughts of teachers and also "all work done by that teacher, whether before, during, or after class time" (Robert & Hache, 2013, p. 25). Indeed, this framework aims at analyzing the relation between teachers' and students' activity in class, but also the constraints on teachers in the context of their profession. Thus, two closely linked elements are considered to analyze teachers' practices: students' activities and teachers' management of the class (Robert & Hache, 2013; Robert & Rogalski, 2005). Teacher practices are analyzed with two specific components of practices in the class, the organization of the tasks for the students, the *cognitive* component, and teachers' interactions with students, the *mediative* component (Robert & Hache, 2013; Robert & Rogalski, 2005).

> The cognitive component corresponds to a teacher's choices regarding content and tasks, including their organization, their quantity, their order, their inclusion within a curriculum beyond the class period, and plans for managing the class period. (Robert & Hache, 2013, p. 51)

The *mediative* component corresponds to the teacher's choices that

> may include improvisations, speech, student investment and participation, instructions, assistance to students in completing the tasks, identification of their work and the work of the teacher, validations, explanations of knowledge, etc. (Robert & Hache, 2013, p. 51)

To include the professional dimension in the practices' analysis, Robert and Hache (2013) add three other components of practices: *personal*, *social* and, *institutional*. The *personal* component describes how the teacher invests his/her leeway, what his/her representations (about mathematics, teaching of mathematics, his/her students) and, his/her mathematical knowledge are. The *social* component corresponds to the fact the teacher is not alone in his/her classroom, how he/she is enrolled in his/her school. The *institutional* component corresponds to constraints: schedule, official programs…

This article focuses on some aspects of the *cognitive* component of practices (the progress of the lesson, the choice of tasks) and on some aspects of the *mediative* component of practices: teacher interventions, validations, helps (collective, individual, with or not reduction of mathematical requirements, procedural or constructive) and, explanations of knowledge (contextualized to the task or decontextualized, new and old knowledge).

RESEARCH QUESTION

We analyze the *cognitive* and *mediative* components of practices in order to understand how a teacher manages *neriage*. The question is: what are specific tasks, interventions, validation of solutions, helps and explanation of knowledge managed by the teacher during the *neriage* in order to teach what is aimed in the activity?

Thus, the Lesson Study process is used as a favored access to analyze and to understand the Japanese teacher's practices during *neriage*. "Teaching is not a simple skill but rather a complex cultural activity that is highly determined by beliefs and habits that work partly outside the realm of consciousness" (Stigler & Hiebert, 1999, p. 67). So, we assume that Japanese teachers prepare, anticipate and, implement specific and culturally embedded practices in order to manage the *neriage* phase of structured problem solving lessons.

METHODOLOGY

Within a qualitative methodology we have been collecting data in a 3rd grade class (students of 8-9 years old) in a primary school during a sequence of 15 lessons, between 30 and 150 minutes each, on "feeling the length". The 3rd lesson is the *neriage* of personal strategies for the measure of the length of the corridor. The 8th lesson is a research lesson that takes place during a lesson study process inside the school. That means we collect the lesson plan of this research lesson and the report of the research lesson. The lesson plan includes teacher mathematics analysis about the sequence, not only for the research lesson. The corpus contents videos of 15 lessons and written data: blackboards of each lesson, lesson plan, report of the research lesson, textbook and teacher's guide. We analyze *cognitive* and *mediative* components of teacher practices from written data and from the *neriage* during the 3rd lesson, transcribed and translated.

The primary school is attached to the University of Education of Joetsu. It means that teachers are considered as experts and they do research, one of which lesson study. The teacher, Kazu, has twelve years of teaching experience.

The next part is some results of the analysis of the Kazu's practices in the double didactical and ergonomical approach.

ANALYSIS OF THE TEACHER'S PRACTICES

Cognitive component: Progress of the lessons

During the 1st lesson, Kazu presents the task: measure the length of the corridor in the school, students think about how they can realize this task. Kazu manages a whole-class discussion about their ideas. During the 2nd lesson, students measure the length of the corridor with personal strategies. This is the detailed progress of the 3rd lesson. At the beginning (1:00-6:21), each group of students give their results, the measured length of the corridor in meters and centimeters (in the table, see figure 1).

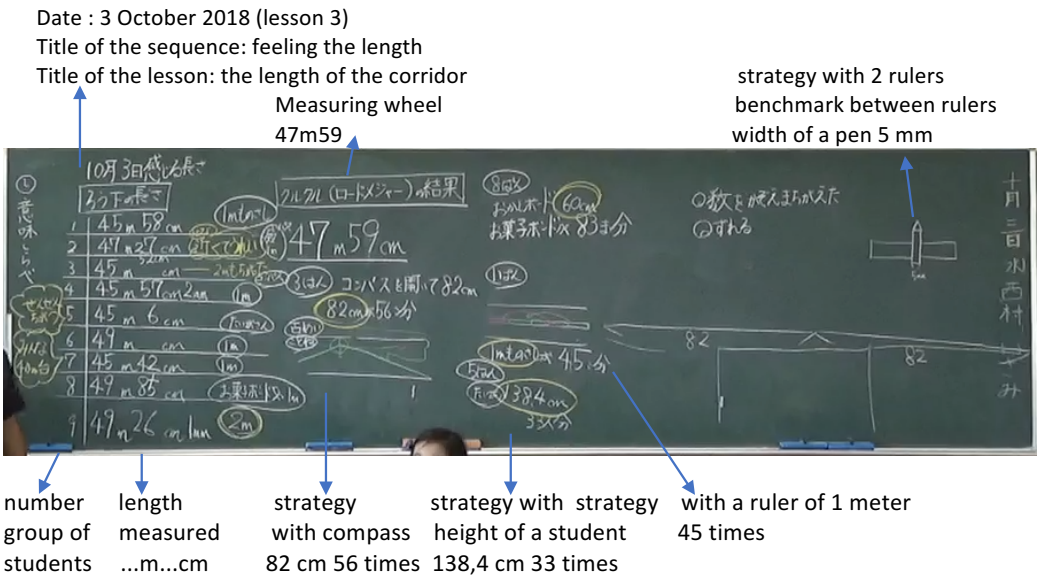

Figure 1: the blackboard at the end of the 3rd lesson

Kazu asks students to compare the different results. Then he presents a measuring wheel and its operation (8:55-11:39). One of the students measures the length of the corridor with the measuring wheel, observed by the others (11:39-19:39). Thus, they obtain the exact result of the length of the corridor, 47 m 59 cm (19:39-23:59). Then, Kazu manages the *neriage* phase (23:59-57:00).

	Kazu interventions during the *neriage*	Mathematical activity proposed by Kazu to students
23:59	What is the closest result to the exact length? How did students of the group n°2 measure the length? How did they feel?	Compare results with the exact result The group of students n°2 explains his strategy and what they feel
26:09	How did the other groups of students measure the length? Validate the students' strategy Justify measuring mistakes: why are the students' results different of the exact length?	Each group of students present and explain their strategy Students explain their measuring mistakes
49:28 - 57:00	What is the artefact used by each group of students to measure the length? What is the length of each chosen unit and the number of chosen units?	Each group gives the chosen artefact, the length of the chosen unit, the number of chosen units

Table 1: Interventions of Kazu and mathematical activity proposed by Kazu to students during the *neriage*

Kazu chooses one task, measuring the length of the corridor, during 5 lessons (almost 5 hours) even if the exact result is given at the beginning of the 3rd lesson.

***Mediative* component: Teacher's interventions**

The Kazu's interventions have the following characteristics: the importance according to various students' strategies and an "affect" dimension. During the *neriage*, students present five different strategies and it does not seem enough for Kazu. He said a lot of groups of students use the ruler of 1 meter to measure the length of the corridor. That is why during the next lesson, he asks again students to measure the same corridor with other personal strategies. At the end of the 4th lesson, students apply more than fifteen different strategies to measure the length of the corridor. This characteristic of his practices also affects the *cognitive* component (choice of tasks). Furthermore, during the *neriage*, Kazu asks several times to students what is their feeling about the task.

Another characteristic of Kazu's interventions is that he asks students to explain their strategy with details and he writes it on the blackboard for each strategy (Figure 1): the different measured lengths, the used artefact (ruler of 1 meter, compass, height of a student…), the length of the chosen unity (1 meter for the ruler, 82 cm for the compass, 138,4 cm for the height…), the number of times the chosen unity is used, some diagrams of strategies (with the compass and with the rulers).

Kazu also asks to compare the different results between us ("Can you say that everyone is on the 40 meters' range?") and with the exact result measure with the measuring wheel ("Which is the closest?" or "Was it accurate as it was?").

From the exact result, Kazu asks students to explain why they did not find the exact result. It means the reasons of their mistakes to justify the difference between their results and the exact result. Thus, he asks students to have a reflexive attitude about their own strategy.

Kazu's interventions also prepare the next phase: the *matome*, the summing up by the teacher, what is aimed in the task. There is not written mathematical expression during this *neriage*, but the written information and Kazu's interventions prepare the mathematical expression of the *matome* that takes place during the next lesson. The *matome* is: "the whole length = the length of the chosen unity × the number of chosen units". For example, the group 3 uses a compass for a blackboard to measure the length of the corridor. One of the students repeats and explains the strategy on the blackboard (Figure 1). The compass spacing is 82 cm.

1	Teacher:	I mean that this is 82 centimeters. So, how about the second time? So?
2	S1:	Again like this, again at 82 centimeters, 82 centimeters plus 82
3		centimeters, what is it? 164. So, again with such feeling, we will
4		measure more and more. […]
5	S2:	What did you calculate?
6	S1:	As Miki, you calculate as a calculator, for example, 82 plus 164, and so
7		on.

8 Teacher: If so, how many 82 centimeters? […]

9 S3: 56 times.

Kazu asks students how many times they used the compass' spacing of 82 cm. He uses the idea of multiplication as an iterative addition from the S1 speech. During the next lesson, he writes on the blackboard: 82 cm 56 times, $82_{cm} \times 56_{times} = 4592_{cm} = 45_{m}92_{cm}$.

***Mediative* component: Validation**

Every result proposed by students (see table of the Figure 1) is different, Kazu asks students, "Is there anything correct in this?" In order to validate the different students' results, he presents a measuring wheel and its operation. Thus, one of the students measures the length of the corridor with the measuring wheel, observed by the others. The validation of the results of the task is done by students themselves, and not by Kazu. There is also a validation of students' strategy by Kazu when students explain that they measure two or three times the length of the corridor, he answers, "It will be a good result if you do it three times, do not you?"

***Mediative* component: Helps**

Kazu does not propose helps to students during the *neriage* because every group of students already finds a result for the length of the corridor. And when a group of students explain that they encountered a difficulty, he asks all students how they can find a solution. For example, the group 3 did zigzag when they measured the corridor, so they have to follow a straight line in the middle of the corridor to measure it.

***Mediative* component: Explanation of knowledge**

The objective of this sequence of fifteen lessons is to feel long lengths, to discover a new unit of length: the kilometer, to manipulate long lengths (addition, comparison). Students already know to convert centimeters in meters and centimeters, to manipulate lengths in meters, centimeters and, millimeters. During this lesson, Kazu converts centimeters in meters and centimeters when he reads the length on the measuring wheel, for example. The explanation of knowledge concerns some conversions already known. During this *neriage*, we do not find new knowledge: it means students using old knowledge to execute the task and to explain it. Kazu writes on the blackboard each separated mathematical elements of the previous mathematical expression: the whole length, the length of the chosen unity and, the number of chosen units. The knowledge during the *neriage* is contextualized to the task. The Kazu's interventions during the *neriage* prepare the new knowledge, summing up in the *matome* that is decontextualized to the task.

CONCLUSION

This analysis of *cognitive* and *mediative* components of practices during a *neriage* highlights some characteristics of practices promoted by Japanese problem solving approach. Kazu uses a same task during five lessons even if students already find the exact result of the length of the corridor. A characteristic of Japanese problem solving approach is that the lessons do not end even if each student find the solution of the

problem and the heart of the lesson begins after students come up with solutions (Takahashi, 2008).

In the *mediative* component of Kazu's practices, the "affect" dimension and the importance of various strategies can be explained by one of the objectives of problem solving teaching: create interest in mathematics and stimulate creative mathematical activity (Takahashi, 2006). During the *neriage*, Kazu compares students' results, asks students to explain their own strategy and, to adopt reflexive attitude about it. The explanation and the comparison of strategies are also characteristics of practices promoted by Japanese problem solving approach. In the written lesson plan, he compares different students' strategies: it is difficult to have a precise measure with a long chosen unity and it is difficult to use a small chosen unity to measure a long length. Kazu analyzed the given task, anticipated the mathematical expression of *matome* and his interventions during the *neriage* necessarily to the mathematical expression. The *neriage* is indeed the critical phase in which students use their own knowledge to explain how they executed the task whereas the teacher aims to teach the new knowledge and methods from students' strategies.

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