Lesson study: Nice-to-have or must-have?

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Level 3 mathematics teaching

Japanese mathematics educators and teachers identify three levels of expertise of mathematics teaching (Sugiyama, 2008):

Level 1: The teacher can tell students the important basic ideas of mathematics such as facts, concepts, and procedures.

Level 2: The teacher can explain the meanings and reasons of the important basic ideas of mathematics in order for students to understand them.

Level 3: The teacher can provide students with opportunities to understand these basic ideas, and support their learning so that the students become independent learners.

(Trans. A. Takahashi, 2011a)

Level 1 teaching does not require any special knowledge. In fact, having received decent grades in mathematics in grade school may be all that is necessary. But for Level 2 and Level 3 teaching, special knowledge and expertise are required.

To teach at Level 2, one must possess knowledge of mathematics beyond what is needed in everyday life or what is required to solve problems in school textbooks. For example, knowing the "invert and multiply" rule for division of fractions is enough to be at Level 1 teaching, but for Level 2 a teacher must be able to explain how multiplying by the reciprocal of a fraction produces the quotient. This type of knowledge is important for helping students understand mathematics (e.g., Ball, Thames, & Phelps, 2008). But while Level 2 is considered professional teaching, Japanese mathematics educators believe that all mathematics teaching should be at Level 3, because they have seen that Level 2 teaching does not enable students to develop mathematical proficiency with understanding.

A majority of current government-authorized mathematics textbooks in Japan are designed to support Level 3 teaching. These textbooks are designed for teachers to present students with a problem that the students have not yet learned how to solve. The texts provide structure and allow the teachers to guide the conversation in such a way that students can arrive at a new understanding as a result of their own efforts in solving the new problem. The philosophy behind Level 3 teaching is that students should be given a reasonable amount of independent work, such as problem solving, in order to develop the knowledge, the understanding, and the skills of mathematics (National Research Council, 1989; Polya, 1945).

Japanese mathematics educators can safely assume that most university students have knowledge of mathematics for Level 1 teaching. Their concern, therefore, is to move those students toward Level 2. But there is not enough time in the preservice program to equip the future teachers with Level 2 knowledge of all the contents they might be required to teach. Hence, Japanese universities focus on training students to acquire Level 2 knowledge through a careful study of teaching materials (Sugiyama 2008). They offer courses for elementary mathematics teacher preparation that focus mainly on examining the contents of mathematics for elementary grades and developing a deeper understanding of these contents. This process is called *kyozai kenkyu*—in other

words, "studying teaching materials for establishing deeper understanding for better teaching" (Watanabe, Takahashi, & Yoshida, 2008).

Preparing student teachers for Level 3 teaching is even further beyond the scope of what can be accomplished during the teacher preparation programs at the university. Japanese educators believe that teachers cannot master Level 3 teaching simply by listening to lectures, reading textbooks, and watching videos. Learning to teach at Level 3 is demanding, time-consuming, and is a career-long process. But the universities do help prospective teachers understand what Level 3 teaching is and teaches them the pathway to it.

Helping practicing teachers increase their knowledge and expertise

When designing professional development programs for practicing teachers, it is useful to recognize that professional development falls into two categories: phase 1 and phase 2. Phase 1 professional development (phase 1 PD) focuses on increasing a teacher's knowledge for teaching mathematics, while phase 2 professional development (phase 2 PD) focuses on developing expertise for teaching mathematics—that is, the ability to use new knowledge in the classroom (A. Takahashi, 2011a).

Moving from Level 1 to Level 2 can be achieved through phase 1 PD, and most university courses in teacher preparation programs, which may include reading books, listening to lectures, and observing well-designed mathematics classes, fall into the category of phase 1. Practicing teachers may need phase 1 PD from time to time to update their knowledge for teaching. On the other hand, Level 3 teaching requires very different classroom practices and skills than Level 2 teaching, and learning these practices and skills requires phase 2 PD. To develop this expertise requires considerable teaching experience with a reflection component. Japanese teachers and researchers devised Lesson Study to develop the deeper knowledge and the expertise necessary to make Level 3 teaching available for their students.

Lesson Study as a fundamental driver for mathematics teacher development

Lesson Study has been the primary mechanism of professional development for both prospective teachers and practicing teachers since the Japanese public education system started (C. Lewis, 2000; C. C. Lewis & I. Tsuchida, 1998; Makinae, 2010; Murata & Takahashi, 2002; A. Takahashi, 2000; Akihiko Takahashi & Yoshida, 2004; Yoshida, 1999a). In Lesson Study, teachers conduct intensive *kyozai kenkyu*—study the standards, read relevant research articles, examine available curricula and other materials—and work together to design a lesson focused on a problematic topic while also addressing a broader research theme related to teaching and learning. The lesson they design, known as a "research lesson" (*kenkyu jugyou*), is taught by one teacher from the planning team while the other team members observe. The planning team and observers then conduct a post-lesson discussion focusing on how students responded to the lesson in order to gain insights into the teaching-learning process.

An example of school-wide Lesson Study to support teachers becoming life-long learners

During Lesson Study, teachers have the opportunity to look closely at teaching practices and to judge, based on student learning, whether the lesson properly supports the students in learning mathematics. Researchers credit Japanese Lesson Study with

enabling the implementation of new teaching approaches (C. Lewis, 2002; C. Lewis & I. Tsuchida, 1998; Stigler & Hiebert, 1999; Yoshida, 1999b).

Although Lesson Study is commonly used by teachers and schools to improve teaching and learning in general, Lesson Study is also used to seek practical ideas for the effective implementation of the Course of Study (COS) or the national curriculum (Murata & Takahashi, 2002). This is a very common focus of school Lesson Study work during the transition period from one COS to a new COS

During this transition stage, Japanese schools, especially public schools, typically conduct school-wide Lesson Study events for all the teachers at the school to work collaboratively to address the new curriculum implementation. The following case study shows how this process worked at one public elementary school (Takahashi, 2014).

The school research organization and the research steering committee

The school the author examined in this section (2014b) is a public elementary school in Tokyo. Immediately after the Japanese Ministry of Education released a revision of COS, the teachers at the school decided to focus their Lesson Study work over the next two years on developing students' ability to express their ideas and learn from each other, which was a new point of emphasis in the revised COS.

During the two years of the school-wide Lesson Study, all full-time teachers at the school worked within a structure based on existing grade-level groups. Grade-level groups typically exist in Japanese elementary schools to facilitate the sharing of responsibilities for running school events and for academic activities. Most public schools have time for grade-level meetings in their weekly schedule, typically about one hour. Teachers have desks in a common work area so that they can collaborate on a regular basis. In order to conduct the school-wide lesson effectively, each grade level group was made responsible for crafting a plan for a research lesson, conducting their research lesson in front of the rest of the faculty, serving as panelists during the post-lesson discussion, and supporting the other teams' research lessons. The school also had grade-band teams, which consisted of all the teachers from adjacent grades, such as grade 1 and grade 2. Although the responsibility for lesson planning belonged to each grade group, most of the lesson planning was done in grade band meetings in order to maintain consistencies across the grades and to help the teachers develop a shared view of the scope and sequence of the curriculum in adjacent grades. Finally, the grade band meetings provided more opportunities for each teacher to participate in research lesson planning, a valuable experience especially for novice teachers not only to learn how to design lessons but also to deepen their understanding of the topics they teach.

Following common practice, the school organized a research steering committee, which consisted of representatives of each grade level and the lead teacher for mathematics[1], who was appointed chairperson of the committee by the principal on the basis of his leadership ability and knowledge of mathematics teaching and learning. The committee led the school's efforts and maintained the cohesiveness of ideas across the grades. Among other things, the research steering committee was responsible for the following:

[1] The lead teacher has his or her own self-contained class but also has responsibility for providing support for the upper grade teachers and for preparing curriculum materials for the school.

- Develop a master plan for the school research;
- Schedule and lead monthly meetings to find strategies to address the school's research theme based on the ideas of the teachers;
- Publish a monthly internal newsletter to record the findings from each research lesson;
- Plan, edit, and publish the school research reports, including those for the research open house, and;
- Arrange for knowledgeable others to present lectures, teach demonstration lessons, and give final comments at research lessons.

The first task of the research steering committee was to propose a focus for the school's research. The same proposal was discussed by the entire faculty at the first faculty meeting of the school year. The following was the approved research theme and focus of study:

Research theme: The development of individual thinking and the expression of these thoughts

Focus of study: Seeking effective ways to support students' individual problem solving skills and better facilitation of whole-class discussion in teaching through problem solving

The research theme articulated a goal for students while the focus of study expressed the faculty's idea about a path towards accomplishing the goal.

Each grade level team developed a lesson plan for a research lesson and conducted the research lesson and post-lesson discussion to address the theme. Most of the research lessons were scheduled on one of the half-day professional development days in order for all full-time teachers to be able to observe the lessons and participate in the discussions. As a result, each full-time teacher had the opportunity to be a part of eight research lessons during one school year.

Throughout the two years of the project, the research steering committee met between research lessons to summarize the ideas that had been proposed by each lesson planning team and addressed during the post-lesson discussion. They published their summaries as a school research newsletter each month. These newsletters documented the process of this long-term collaborative effort, and, more important, they allowed the teachers to share what was discussed and helped other teams build on the results of previous research lessons.

Lesson plans and their development

In each stage of lesson plan development, members of the research steering committee reviewed the lesson plan and provided feedback to the team. Through this process, they tried to ensure that all the lesson plans that developed by the school were of sufficient quality to contribute to the school's effective implementation of the new COS. In order to do so the committee distributed to each teacher the following list of questions to guide them toward higher quality lesson plans:

- Does the lesson plan provide sufficient information for the teacher to understand the task and the flow of the lesson?
- Does the lesson plan provide sufficient information about how the planning team decided to teach the lesson as described by the plan?
- Do the objectives of the lesson plan clearly address the Course of Study?
- Are the tasks appropriate for the students given the date of the lesson?
- Are the key questions clear? Will they encourage students to think mathematically and help them complete the task independently?
- Does the lesson plan include reasonable anticipated student responses and indicate how the teacher will help students overcome any misunderstandings?
- Does the lesson plan include a plan for formative assessment and a plan to accommodate individual student differences during the lesson?

Disseminating the results of the school research

Toward the end of Year 2, the school faculty and staff hosted a half-day public open house to share their findings. All content specialists of the district and principals of other area schools were invited to the open house, and many other schools sent their teachers.

The public open house consisted of three major parts: public research lessons, research presentations by the school's research steering committee, and a panel discussion by experts in the field of mathematics education who had been involved with the school's research project. The participants were able to witness strategies for the effective implementation of the COS in live lessons and were able to bring these ideas back to their own school as a set of lesson plans.

Two sets of research reports were also made available for teachers and administrators of other schools as summaries of the school research effort of Year 1 and of Year 2. Since the school used a district grant to produce them, all the research reports were made available for free. In the second year, the school compiled a report covering the entire two-year study. The report was produced as four booklets: three of them were distributed at the public open house and the last was sent to all the schools in the district at the end of the school year. An English translation of one of these booklets is available at http://www.impuls-tgu.org/en/resource/readings/page-26.html.

The results from the school-wide Lesson Study

The Japanese national standards released in 2008 contained a new emphasis on having students learn to express their ideas and learn from each other, as a way to help students develop their own thinking. The teachers at this school chose to spend two years working through Lesson Study to research changes in practice that would address this new emphasis. Some of what they learned—and what they put into practice—is evident in the booklet they published for the open house. Here are a few points from the booklet:

- Students were able to express their ideas by using not only words but also mathematical expressions and diagrams. Because of the cohesive use of diagrams, such as tape diagrams, area diagrams, number line diagrams, and of

expressions and equations throughout the grades, whole class discussions became deeper and productive. Moreover, students were able to express their ideas in similar ways regardless of who was teaching the lessons.

- By crystallizing what was expected of students in each stage of problem solving (e.g. understanding the problem, solving the problem, reflecting upon the solution) and at the major points of teacher instruction, students were able to learn independently.
- By preparing effective key questions for each stage of problem solving, students were able to express their ideas in various ways and to talk to each other clearly by focusing on what should be discussed.
- By planning blackboard writing, the flow of the lessons became more coherent. Students became able to look back at what they learned by looking at the board. Then they could use it to put the various ideas together in integrated and expanded ways, and to evaluate their learning during the lessons by themselves.

Each teacher was deeply involved in planning only one research lesson per year, which may not seem like enough to support such profound growth. But the school's work over the two years was carefully organized to support teacher learning in various ways. Each teacher at the school had at least two opportunities to critique lesson plans from another team during the planning process through the grade-band meetings. Teachers observed and discussed the lessons of all the other grades at the school. And the newsletters published by the research steering committee helped each successive team build on what was learned before.

Supporting the school-wide Lesson Study

When implementing new ideas of teaching and learning, teachers must figure out what the necessary changes will look like in their own classrooms and with their own students. Hence, teachers need to conduct their own research, and Lesson Study provides an organized way to do so. Since Lesson Study is tied directly to teachers' practice, teachers can minimize the gap between research and practice. Outside of Japan, many Lesson Study projects have been conducted by a few volunteers within a school or across school districts. Individual teachers can certainly improve their own teaching by participating in such volunteer groups. But in Japan, as this case study illustrates, improving teaching is a responsibility of all teachers at a school, to be worked on together.

Although teachers work hard to improve teaching and learning by collaborating with their colleagues through Lesson Study, they can be limited by what they don't know. In order to maximize the effect of the collaboration, Japanese school administrators usually provide additional supports for expanding teachers' knowledge. These include a structure to support collaboration (grade level teams and grade-band teams) and distributing leadership in the form of a research steering committee that comprises teachers from multiple grades, and access to new knowledge and expertise via an outside expert.

Researchers have noted the importance of outside expertise provided by the so-called "knowledgeable other" in making Lesson Study effective (C. Lewis & I. Tsuchida, 1998; Catherine Lewis, Perry, Hurd, & O'Connell, 2006; Akihiko Takahashi

& Yoshida, 2004; Yoshida, 1999b). The following section describes the roles of the knowledgeable other in school-wide Lesson Study.

The Role of the Knowledgeable Other

It is common practice among Japanese schools to bring in an outside expert who is knowledgeable about the school research theme. This person is referred to as a "knowledgeable other." Based on a study conducted by the author (2014a), the knowledgeable other is responsible for:

(1) Bringing new knowledge from research and the standards;
(2) Showing the connection between the theory and the practice, and;
(3) Helping others learn how to reflect on teaching and learning.

Recommendations

Stigler and Hiebert (1999) argue that Japanese mathematics lessons better exemplify recent reform ideas than do U.S. lessons. One of the reasons Japanese teachers are able to use reform ideas effectively in their classroom is their participation in Lesson Study. Lesson Study provides the opportunity for classroom teachers to work collaboratively to seek effective implementation of new ideas, rather than struggle in isolation to understand how the ideas look in his/her own classroom. Moreover, Lesson Study provides access to outside experts, the knowledgeable others, so that each teacher can understand new ideas for improving teaching and learning with concrete examples. Thus, having Lesson Study as a fundamental driver for professional development permits teachers to learn not only new ideas for improving teaching and learning but also helps them to develop expertise in Level 3 teaching.

Note

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