Learning from the Key Tasks of Lesson Study

Catherine Lewis, Shelley Friedkin, Elizabeth Baker and Rebecca Perry

Introduction

Lesson study is a professional learning approach that originated in Japan and has recently spread among both prospective and practicing teachers in North America. In lesson study, teachers engage in cycles of inquiry in which they collaboratively plan, observe, and discuss classroom "research lessons" in order to improve their shared understanding of teaching, learning, students, and subject matter. These "research lessons" are ordinary lessons in the sense that they are real classroom lessons with students, with the unpredictability and on-the-spot decision-making that all teaching entails. Research lessons are often unusual, however, in that a group of teachers has carefully studied the subject matter and collaboratively considered the lesson design most appropriate to the students, and these teachers (as well as invited colleagues) observe, collect data, and formally discuss how the lesson actually unfolds with students. When practised over time, lesson study is designed to build the skills, habits of mind, tools, and culture for teachers to learn daily from colleagues, students, and curriculum materials. Japanese teachers typically teach one research lesson in their own classroom each year and observe and discuss research lessons in about 10 other classrooms (Fernandez and Yoshida 2004).

This chapter breaks out the five core tasks of the lesson study cycle shown in the left column of Table 1. Typically, lesson study begins with teachers formulating a shared "research theme" that captures their long-term goals for student learning and development. Often this is done by a whole school faculty. Next, teachers break into grade-level or subject matter groups to study the topic they want to teach (often

This material is based upon research supported by the National Science Foundation and the U.S. Department of Education Institute for Education Sciences, award #REC-0633945 and #R308A960003, respectively. Any opinions, findings, and conclusions or recommendations are those of the authors and do not necessarily reflect the views of the grantors. We wish to thank the teachers of "Alma" Middle School.

C. Lewis (✉)
Mills College Lesson Study Group, Oakland, USA
e-mail: clewis@mills.edu

O. Zaslavsky, P. Sullivan (eds.), *Constructing Knowledge for Teaching Secondary Mathematics,* Mathematics Teacher Education 6,
DOI 10.1007/978-0-387-09812-8_10,

Table 1 Five key tasks of lesson study and their impact on teachers

Task	Impact on individual teachers	Impact on teacher community
Task 1: Develop research theme	Consider long-term goals for students Connect daily instruction to long-term goals such as student motivation to learn	Teacher community develops shared long-term vision
Task 2: Solve and discuss mathematics task, anticipate student thinking	Develop own mathematics knowledge Develop knowledge of student thinking	See colleagues as useful resource for understanding mathematics and student thinking
Task 3: Develop shared teaching-learning plan	Refine and build own ideas about mathematics and its teaching- learning by negotiating a shared lesson plan Develop a habit of anticipating student thinking and connecting daily lessons to long-term goals	Negotiation of lesson plan builds shared ideas, reveals differences Written teaching-learning plan enables teachers to see how anticipated and actual student thinking compare Written plan allows teachers to capture their learning and revisit and spread their ideas
Task 4: Collect data during the research lesson	Develop knowledge of student thinking, focus on student thinking, and skill capturing it	Teachers focus on different students, enabling teacher community to construct picture of learning across the class Data on student thinking enables re-design and improvement of teaching-learning plan
Task 5: Conduct a post-lesson discussion	Refine ideas about mathematics teaching and learning by hearing colleagues' perspectives on instruction seen by all Develop habits of lesson analysis and refinement	Develop shared vocabulary for analysis of teaching-learning that is linked to actual instruction Develop sense of shared responsibility for all students' learning

looking at innovative curricula and research related to that topic) and they collaboratively choose or develop a "research lesson" designed to bring to life their long-term goals for student development as well as their goals for student learning about the topic. One team teaches the research lesson in a classroom, with other team members gathering data on student thinking and responses as the lesson unfolds. In the post-lesson discussion, teachers share and discuss the data they collected during the lesson, using these data to consider how the lesson might be improved and more generally to build their knowledge of teaching, learning, students and subject matter (Lewis 2002a; Lewis et al. 2009).

Lesson study originated in Japan but has spread to many other countries in recent years, and is used by both preservice and practicing teachers (Akita 2004, 2007; Cossey and Tucher 2005; Isoda et al. 2007; Lewis et al. 2006; Matoba et al. 2006; Wang-Iverson and Yoshida 2005)

This chapter will explore five tasks that together constitute the major elements of the lesson study cycle. Each task is described briefly, followed by examples from

Alma Middle School (pseudonym), a public lower secondary school serving a racially and socioeconomically diverse student body (ages 11–14). The final section of the chapter makes theoretical conjectures about the contribution of the tasks to teachers' development.

Task 1: Development of a Research Theme

The first task of lesson study is to develop a "research theme" to guide the lesson study work. The research theme allows teachers to voice their long-term aspirations for students and come to a shared set of goals. Figure 1 provides a step-by-step guide to developing a research theme. Each part of the task should be presented separately, before seeing the next part. Typically, the research theme is developed by all the teachers at a school or all the members of a class for prospective teachers, based on careful observation of the strengths and challenges of students they teach. The purpose of development of the research theme is to focus teachers on their long-term goals for student development, and to identify gaps between these goals and students' current characteristics.

While at first blush, the process of developing a research theme may not seem "mathematical," it lays the groundwork for teachers' mathematical lesson study

Part 1:
Think about the students you serve. What qualities would you like these students to have 5-10 years from now? Jot down a list of the qualities you would like your students to have if you were to meet them 5–10 years from now.
Present this prompt separately, verbally or visually, before looking at the prompts below. Have participants discuss their lists.

Part 2:
Once again, call to mind the students you serve. List their *current* qualities. Think about their strengths as well as any qualities you may find worrisome. Make a second list, of your students' current qualities.
Present this prompt separately, verbally or visually, before looking at the prompts below. Have participants discuss their lists.

Part 3:
Compare the ideal and the actual qualities you listed. Identify a gap between the ideal and the actual that you really feel merits your attention as an educator.
Have participants briefly work individually, and then share their ideas with the group.

Part 4:
Collaboratively develop a research theme—that is, a long-term goal—for your lesson study work, by *stating positively* the ideal student qualities you wish to build. For example, teachers at a school serving low-achieving students whose families had suffered discrimination chose the following goal:
"For students to develop fundamental academic skills that will ensure their progress and a rich sense of human rights."

Teachers (for example, a school faculty or a class of prospective teachers) work together develop a shared research theme.

Fig. 1 Development of a research theme work in three important ways. First, teachers focus on qualities crucial to students' *long-term* development as mathematics learners that may be neglected in daily planning, such as curiosity, persistence, or the habit of relating mathematics to daily life. Second, teachers carefully consider their students: Who are they, and what are their strengths and challenges? As they share out ideas, teachers can compare their own views of students with those held by colleagues. For example, science teachers at a California high school were shocked to realize that the teachers of the ninth graders saw incoming students as very curious about the subject matter and eager to learn, but that by twelfth grade students were seen as disaffected. Third, development of the research theme can provide motivational fuel, by connecting teachers' most central goals as teachers—such as building motivation to learn—to the particular topic under study. The long-term focus of the research theme provides a welcome counterbalance to the short-term focus of much educational evaluation, reminding us that it is important not simply whether students have learned to perform a particular procedure, but whether they have learned to do it in a way that fosters mathematical habits of mind more broadly. For prospective teachers, the research theme also provides a way of seeing what they share with colleagues, and a chance to practice negotiating some of their differences of educational goals before entering the challenging realm of planning the research lesson.

As one prospective teacher commented,

> A lot of [American] schools develop mission statements, but we don't do anything with them. The mission statements get put in a drawer and then teachers become cynical because the mission statements don't go anywhere. Lesson study gives guts to a mission statement, makes it real, and brings it to life.[1]

Development of the Research Theme

Mathematics teachers at Alma Middle School have practised lesson study since 2002, and they typically revisit their research theme each year, adjusting it as necessary to fit their current concerns. Of persistent interest to these teachers has been the very large achievement gap among students. Mathematics classes are not tracked, and they include a very wide range of student achievement levels. Hoping to build students' persistence and self-image as mathematics learners, the teachers developed in 2003 the research theme of "helping students learn to have mathematical conversations and reason mathematically." During subsequent years, as teachers noticed continuing achievement gaps among students, they expanded their research theme to include a focus on improved achievement on the state test, and they also focused on ways to increase the "status" of students who might be ignored in classroom conversations because they were not considered mathematically able by their peers. The research theme informed teachers' development of the teaching-learning plan (see Sect. Task 3: Development of a shared teaching-learning plan).

[1] I am indebted to a prospective teacher at Mills College for this remark, January 12, 2001.

For example, in order to build mathematical conversations, the teachers included in one research lesson a large visual representation that would enable students to easily share their thinking with the class. When focused on raising the "status" of low-achieving students, the teachers had students learn certain "expert skills" at the beginning of class that they could share with classmates during the lesson. The research theme helped teachers begin their work from long-term goals, such as having students show persistence and success as mathematics learners, and to consider the intermediate steps, such opportunities to engage in mathematical reasoning and mathematical conversations, that might be designed into research lessons to promote these goals.

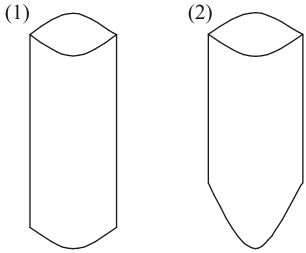
Task 2: Solve the Mathematical Task in Order to Anticipate Student Thinking

A second task of lesson study is for teachers to solve and share their thinking about the task to be given to students during the research lesson, in order to help anticipate a range of student responses. As teachers discuss their approaches, they make their mathematical thinking visible to colleagues, and teachers may expand their knowledge of solution methods in this way. These conversations may also surface difficulties or misunderstandings related to the subject matter, making problematic ideas available for discussion and revision. By solving tasks, sharing solutions, and anticipating student solution methods, teachers may build their own understanding of both mathematics and student thinking.

The following conversation occurred during an hour-long lesson study meeting at a Alma Middle School. These practicing mathematics teachers had just solved a problem from a Japanese textbook (see description of problem in Fig. 2); the problem was provided along with a range of other US and foreign resources in a toolkit designed to support teachers' lesson study on proportional reasoning. Comparing how different curricula (such as those from US and Japan) present a topic can expand teachers' thinking about what is important. When the teachers shared their solutions and anticipated how students might think about the problem, one teacher commented that some students might not distinguish between proportional and non-proportional increases. His comment sparked a conversation about whether students in their school have had an opportunity to learn to make this distinction (Video-recorded teacher meeting on 1.21.08, video timecode: 24:00–35:48):

Teacher 3: So … my belief is that some students when they attempt to answer the question will think, "More water, more depth" for the first, "More water, more depth" for the second, so they'll say both are proportional. More water, more depth: as one goes up, the other goes up, so it's kind of like correlation.

Teacher 5: And the table carries that through …



If water is poured into these test tubes, looking at these containers do you think the depth of water will be proportional to the amount of water?

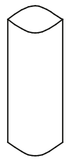
For container (1) __________________

For container (2) __________________

What do you notice about the numbers in the tables below?

(1)

Amount of Water *(dl)*	1	2	3	4	5	6
Depth of Water *(cm)*	4	8	12	16	20	24



(2)

Amount of Water *(dl)*	1	2	3	4	5	6
Depth of Water *(cm)*	4	7	10	13	16	19

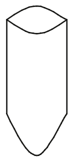


Fig. 2 How things change (Problem reproduced from Book 6A Tokyo Shoseki's Mathematics for Elementary School (p. 72). Copyright 2004 Global Education Resources (myoshida@globaledresources.com). Do not copy, reproduce or distribute without written permission)

Teacher 3: So the constant rate, that's not mentioned anywhere. *You* see the constant but they don't see the constant. Constant in the first one but not in the second one.

Teacher 4: I would really like to be able to have my students in the 7th grade be able to look at the tables and realize that the top one is dealing with equivalent fractions and the bottom one isn't. To know that aspect of proportionality, through ratio tables or, yeah

Teacher 5: Either ways, equivalent fraction or common multiplier … that they should be flexible enough to do that, and know that it doesn't apply to the second table.

Teacher 4 Um hmm. [As if he is a student solving it:] 2 times 3 is 6, 8 times 3 is 24.

Teacher 5: So do you think if you gave this to your seventh graders now, they would have an understanding of it, since you guys have finished your ratio and proportion unit? I don't think my 7th grade intervention class would do very well with this …

Teacher 3: What if it was stripped of the problem context … would they be able to look at the two tables and say which one is proportional?

Teacher 5: That's a good question. I don't know, but I like that thinking. What do you think, Teacher 2?

Teacher 2: I *don't* [think so]. Because I think that's the piece we haven't done. We've done work with ratio tables but we've kind of stated "This is a rate problem, this is a problem where you use proportional reasoning." They haven't done much to determine *when* a situation is proportional or not … when the data follows that. So I think that's sort of where we're heading with the multiple representations: being able to distinguish cases in which it should be proportional and in which it shouldn't.

The preceding conversation illustrates what teachers may learn from solving and discussing a student task and anticipating student responses to the task. Teachers identified a potential difficulty for students (distinguishing between proportional and non-proportional increase) and discussed the implications for their own teaching. Through such discussions, teachers can share and build their knowledge of student thinking. Although the teachers in this lesson study group all seemed to be clear about the difference between proportional and non-proportional increase, in other lesson study groups this task surfaced teachers' own misunderstandings of proportional increase, and enabled discussion of them.

Research suggests that these teachers are quite right in observing that students may have difficulty distinguishing proportional from non-proportional situations (Van de Walle 2007). More generally, research suggests that teachers who ground their instructional decisions in careful analysis of students' current mathematical knowledge may be better able to promote student learning (Peterson et al. 1989) and that orientation to student thinking supports continuing learning by teachers (Franke et al. 2001). The activity of solving and discussing a task in order to anticipate student solutions thus builds a core aspect of teachers' instructional skill.

Task 3: Development of a Shared Teaching-Learning Plan

Development of the Shared Teaching-Learning Plan brings together the research theme (Task 1) and the mathematical topic teachers want to focus on during the lesson (explored in Task 2), as teachers ask, "How can we help students learn about

Teaching-Learning Plan

Date:
Grade:
Subject:
School:
Instructor:
Planning Group:

1. Unit Name

2. Unit Objectives

3. Research Theme (or "Main Aim") of Lesson Study

4. Current Characteristics of Students

5. Learning Plan for Unit:
- Unit Goals or Outcomes (Connections to Standards and Prior and Subsequent Learning, if appropriate)
- Sequence of Lessons in the Unit

Number of Lessons	Content	Points to Notice and Evaluate	Materials, Strategies

- Explanation of Unit "Flow" that will Enable Students to Move From Current Understanding, Motivation, and Skills to Desired Outcomes

Fig. 3 Template for teaching-learning plan

6. Plan for the Research Lesson			
Teacher Activity	**Anticipated Student Thinking and Activities**	**Points to Notice and Evaluate**	**Materials, Strategies**
a. Aims of the Lesson			
b. Learning Process for the Lesson (What "drama" of activities and experiences will help students move from their initial understanding to the desired aims?) (*This chart may continue for several pages.*)			
c. Evaluation of This Lesson (Major Points to Be Evaluated)			
d. Copies of Lesson Materials (e.g. Blackboard Plan, Student Handouts, Visual Aids)			
7. Background Information and Data Collection Forms for Observers (e.g. Seating Chart, Prior Student Work, Note-taking Forms, Information on Particular Students to be Observed)			

Fig. 3 (continued)

this topic in a way that supports our research theme?" Figure 3 provides a template for the Teaching-Learning Plan that is developed collaboratively during lesson study. Even when the group starts, as it should, with the best available lesson plan on a topic, it may take two or more meetings to flesh out the Teaching-Learning Plan, which includes elements often omitted from standard US lesson plans—such as anticipated student thinking and data to be collected during the research lesson. Development of a shared teaching-learning plan surfaces teachers' ideas about the important content within a topic *and* about how students best learn mathematics. As teachers' thinking becomes visible, so may differences of opinion among them. The instructional plan represents the thinking of the whole lesson study group about three concentric layers of practice: the lesson itself, the larger unit and academic subject area of which it is part, and the even larger domain of students' long-term development. As a lesson study team moves on to conduct the research lesson, the instructional plan will:

- Support the research lesson teacher, by providing a detailed outline of the lesson and its logistical details (such as time allocation, needed materials and wording of key problems);
- Guide observers' data collection by specifying the "points to notice" and data to be collected;
- Help observers understand the rationale for the research lesson, including the lesson's connection to goals for subject matter and students and the reasons for particular pedagogical choices;
- Record the lesson study group's thinking and planning, so that team members can revisit it after the research lesson and notice where their thinking may have changed.

Because the instructional plan plays several important roles and because it may be quite different from the lesson plans familiar to American teachers (which tend to focus on *teacher* actions), it is useful to examine in some detail instructional plans developed by experienced Japanese or US lesson study practitioners (Global Education Resources 2006; Lesson Study Communities Project in Secondary Mathematics n.d.; Lewis 2002b; Mills College Lesson Study Group n.d., 2005; Teachers' College Lesson Study Research Group n.d.). Team members "become aware of how you think about lessons and about mathematics."[2] as each element of the plan is considered, including anticipated student thinking, the learning flow of the entire unit, how the topic connects to prior and subsequent learning and to long-term goals for students, and the data that will be collected during the lesson.

For example, one teaching-learning plan developed by teachers from Alma Middle School integrated twin goals of providing challenging mathematics tasks and implementing research-based strategies to raise the status of low-achieving students (Cohen 1994). The teachers noted in their pre-lesson brief for observers that the research lesson is designed to "allow more students to contribute *mathematically* … not just I'll be the colourer." One team member commented:

> Some of us have experimented with group roles, and that promotes experimentation, but sometimes the engagement was not at a very high mathematical level; it was "I'll be the record-keeper, and you tell me what to write." There's not much cognitive demand there. So here, it's hopefully are they engaged at a mathematically high level.

[2] Nakamura, T. p. 18, in Zadankai: Shougakkou ni okeru juugyou kenkyuu no arikata wo kangaeru. (Panel Discussion: Considering the nature of lesson study in elementary schools) in Ishikawa et al. 2001.

The team members asked observing teachers to collect data on individual students over the course of the lesson, in order to see whether low-achieving students showed increased mathematical participation after an intervention that taught them a particular "expert skill" (how to represent data in a table).

Development of the teaching-learning plan helps teachers refine their knowledge of mathematics and its teaching and learning by making their own knowledge visible and negotiating with other team members about what constitutes good instruction and important mathematical content. Researchers have documented the cacophony of competing demands on teachers and the very limited opportunity for teachers to integrate and make sense of these demands in the context of actual classroom practice (Elmore 1996). In their lesson study cycles, the Alma teachers have persistently experimented, over multiple lesson study cycles and several years, with strategies to increase the participation of low-achieving students and to build mathematical problem-solving.

Task 4: Enactment of the Research Lesson with Data Collection

As noted earlier, research suggests that teachers who ground their instructional decisions in careful analysis of students' current mathematical knowledge may be better able to promote student learning (Peterson et al. 1989; Franke et al. 2001). The fourth lesson study task, collection and discussion of student data during the research lesson, develops teachers' knowledge of student thinking. Although 4–6 is an optimal number of teachers for lesson planning, additional teachers may be invited to observe and collect data during the research lesson. For example, teachers of algebra may work as a lesson study group to plan a research lesson, and invite teachers of other mathematics classes to observe and discuss the lesson. During the research lesson, team members and invited observers carefully observe selected students throughout the lesson, collecting detailed data on their activities, speech, writing, and use of materials. These data allow the team to construct a detailed record of how the lesson "played" from the point of view of the observed students. How did they initially think about the problem? How did their thinking change or develop over time? What supported or obstructed their progress? What role did the problem design and wording, visual aids, the teacher's interventions, or comments by peers play in the development of their thinking?

Because the data to be collected vary with the specific mathematical topic, there is no single blueprint for data collection, making it one of the most challenging aspects of lesson study. However, some rules usually apply. The thinking and actions of several target students should be documented in as much detail as possible from the beginning to the end of the lesson. The target students should be selected to represent different issues the team wants to understand: for example, how does the lesson look from the point of view of high-, middle-, and low-achieving students, second-language learners, students who show little curiosity about mathematics, or other subgroups of interest. The observers should not teach or help the students or otherwise interfere with the natural flow of the lesson. (It should be explained to students that the teachers are there to investigate the *lesson*—not to evaluate students or to provide help.)

A second general principle is that the lesson should be designed to reveal as much student thinking as possible (Lesh et al. 2000). Gathering students' written work supplements the in-depth observation of selected students and provides a broader picture of learning within the class. For example, the lesson by Alma Middle School teachers, described in the previous section, was designed to help lower-achieving students take a more active role in heterogeneous small groups, by teaching these students certain mathematical "expert skills." Each observer followed a selected student to see whether and how they brought skills from their "expert" groups back to the heterogeneous groups, and how their written work on a proportional reasoning task changed after learning the "expert skill" of making a table to record data. Written work and observational data suggested that the expert skills enabled some students, but not others, to increase their mathematical participation in the heterogeneous groups. The contrast among the students was striking, with some students moving from virtually no written work prior to the "expert skills" experience to extensive written work afterwards, and other students making little apparent advance in their mathematical participation. The contrasts offered a useful reminder of the diverse experiences within a class and the power of data collection.

Task 5: Discussion of the Research Lesson

The fifth task is discussion of the research lesson. The purpose of this task is for teachers to draw conclusions about the strengths and weaknesses of their lesson design, and more generally to refine their ideas about mathematics teaching and learning based on an actual concrete sample of instruction that all members have all just seen. Figure 4 provides a protocol designed to support thoughtful, data-focused discussion of the research lesson. The protocol allows the teacher who taught the lesson to speak first, followed by the team members, who focus on presenting the data they collected on student thinking, rather than on evaluation of the teaching.

The discussion following a research lesson by Alma Middle School teachers illustrates the potential for learning about lesson design and about instruction and student learning more broadly. This proportional reasoning lesson focused on the relationship between the height of a ball's bounce and the height from which it is dropped. Students found it hard to focus on the proportional relationship because they struggled with variations in measurement of the bounce height. The observers of the lesson also noticed that although students efficiently calculated the mean of three bounces, they were not clear about the purpose of calculating the mean as a way to mitigate error. A team of elementary teachers, whose students feed into Alma Middle School, observed the research lesson. Part of the discussion follows.

1. The Instructor's Reflections
The instructor describes the hopes for the lesson, comments on anything that was surprising, and reflects on what was learned in planning and conducting today's lesson.

2. Background Information from the Lesson Study Group Members
Using the instructional plan, the lesson study team members explain their long- and short-term goals, and why they designed the lesson as they did. They may also describe how the lesson changed over time.

3. Presentation of Data from the Research Lesson
Lesson study team members present data on student thinking and behavior from the research lesson (and sometimes the larger unit of which it is part). The data may include observational notes, student work, discussion record, record of the blackboard, etc., that have been agreed upon in advance.

4. Discussion
A brief free discussion period, facilitated by a moderator, may be provided, during which additional participants add their observations. The focus is on student learning and development. Comments of a sensitive nature may be conveyed privately at a later time.

5. Outside Commentator (optional)
An invited outside commentator may discuss the lesson.

6. Thank
If the gathering is large, it is common for an administrator to thank the instructor, planners, and attendees.

Note: The items in bold are the actual agenda items from a faculty discussion following a research lesson. The regular typeface is our commentary. It is common for each speaker to preface his or her comments with an expression of thanks to the teachers who taught, planned, and supported the lesson.

Fig. 4 Agenda for discussion of a research lesson

Alma Teacher 2: Well, I think that's really interesting [that they didn't grasp the purpose of calculating the mean] because, I think a ton of time at the beginning of the year in seventh grade is spent calculating means, so …

Alma Teacher 5: And sixth grade.

Elementary Teacher: And fifth grade and fourth grade.

Alma Teacher 2: So we didn't say this is why we calculate mean, but the fact that it's not entirely clear to them says that the way we've been teaching it is … you know, I don't. No student said, "How do you calculate mean?" Like they all knew how to do it.

Elementary Teacher: But … the purpose of doing it was not clear, which is really, sort of diagnostic, you know, do kids make sense of the power of mean not just how to do it.

Discussion of the lesson yielded ideas about how to improve lesson design; in a later version of the lesson, students received data, and were able to focus more clearly on the proportional relationship. In addition, the discussion led both elementary and secondary teachers to consider what kind of instruction would facilitate better understanding of the purpose of calculating means. As this lesson study example illustrates, using data from the lesson may yield implications for the lesson design, and also for the understanding of student learning and instruction more broadly—for example, the idea that students may efficiently calculate means without a good understanding of the purposes for doing so.

How Do the Tasks of Lesson Study Support Teachers' Learning?

Figure 5 reproduces a widely-used framework for understanding mathematics teachers' learning from and in practice (National Research Council 2001). It represents as three points of a triangle the three major types of learning *within practice*—learning from colleagues, learning from students, and learning from mathematics (from curriculum, mathematical tasks, etc.). Lesson study supports learning from each element of practice represented in the triangle. Teachers learn from each other as they consider long-term goals for students, solve and discuss mathematical tasks, collaboratively develop the teaching-learning plan, and share and discuss observations from the research lesson. They learn from students as they observe and collect data during the research lesson, and from mathematics as they study curriculum and solve and discuss the mathematical tasks. Lesson study often brings the points of the triangle into closer relationship so that teachers can draw on colleagues' ideas to help them unpack student thinking and to make sense of the mathematics in the curriculum. For example, one teacher wrote at the end of a lesson study in which she solved several mathematical tasks and then discussed

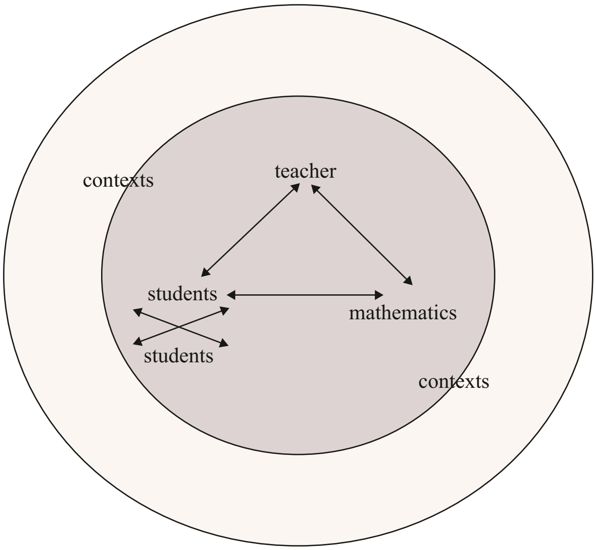


Fig. 5 How teachers learn from and in practice (National Research Council 2001, p. 9.)

them with colleagues, "The discussion with colleagues along with the review of student work opened my eyes to the many possible ways to solve the problem. Many people will have different ways to do things than me and I need to understand that to be a better teacher."[3]

Lesson study makes elements of teachers' thinking visible that might otherwise remain invisible and unexamined. For example, the lesson study cycle "How Many Seats?" (Lewis et al. 2009; Mills College Lesson Study Group 2005) surfaced a disagreement among teachers about whether it was desirable to have students struggle to organize data themselves (rather than be given an empty function table that "spoonfed" them the pattern). Teachers often expand or refine their own thinking as they encounter colleagues' ideas. For example, teachers in the "How Many Seats?" lesson study cycle adopted the idea of examining students' counting methods after watching a colleague use this strategy productively to gain insight into student thinking during a research lesson (Lewis et al. 2009). As noted above, after watching students struggle to describe the relationship between ball bounce and dropped height, the Alma teachers developed a shared realization that students could calculate a mean but did not understand the purpose of doing so.

The five tasks of lesson study described in this chapter are not "one-shot" tasks, but core elements of lesson study cycles that recur throughout one's lesson study work as a prospective and practicing teacher. Table 1 summarizes influences of these tasks on individual teachers and on the teacher community. Over time, these tasks build teachers' knowledge of mathematics, pedagogy, and student thinking, as well as habits of mind that are central to teaching, such as careful observation of students and an inquiry stance toward teaching. Beyond impact on individual teachers, lesson study also impacts the teacher community, as teachers come to share goals for students, ideas about what is good instruction, and a common language for talking about features of teaching and learning.

References

Akita, K. (2004). *The Japanese model of cooperative learning: Teachers professional development*. Paper presented at the International Association for the Study of Cooperative Education, Singapore.

Akita, K. (2007, March). *Japanese teachers' learning systems in school: Collaborative knowledge building through lesson study*. Paper presented at the International Conference of Competency-Based Educational Reform, Seoul National University.

Cohen, E. (1994). *Designing groupwork: Strategies for the heterogeneous classroom* (2nd ed.). New York: Teachers College Press.

Cossey, R., & Tucher, P. (2005). Teaching to collaborate, collaborating to teach. In L. R. Kroll, R. Cossey, D. M. Donahue, T. Galguera, V. K. LaBoskey, A. E. Richert, & P. Tucher (Eds.), *Teaching as principled practice: Managing complexity for social justice* (pp. 105–120). Thousand Oaks: Sage.

[3] Teacher reflection comments collected on 1.18.08, from teacher ID 323.

Elmore, R. F. (1996). Getting to scale with good educational practice. *Harvard Educational Review, 66*(1), 1–26.
Fernandez, C., & Yoshida, M. (2004). *Lesson study: A case of a Japanese approach to improving instruction through school-based teacher development*. Mahwah: Lawrence Erlbaum.
Franke, M. L., Carpenter, T. P., Levi, L., & Fennema, E. (2001). Capturing teachers' generative change: A follow-up study of professional development in mathematics. *American Educational Research Journal, 38*(3), 653–689.
Global Education Resources. (2006). The APEC-Tsukuba International Conference on Lesson Study: Lesson plan resources. http://www.globaledresources.com/resources/apec_lesson_plans.html. Accessed 1 May 2008.
Ishikawa, K., Hayakawa, K., Fujinaka, T., Nakamura, T., Moriya, I., & Takii, A. (2001). Nihon Sugaku Kyouiku Gakkai Zasshi. *Journal of Japan Society of Mathematical Education, 84*(4), 14–23.
Isoda, M., Stephens, M., Ohara, Y., & Miyakawa, T. (Eds.). (2007). *Japanese lesson study in mathematics: Its impact, diversity and potential for educational improvement*. Singapore: World Scientific Publishing.
Lesh, R., Hoover, M., Hole, B., Kelly, A., & Post, T. (2000). Principles for developing thought-revealing activities for students and teachers. In A. Kelly & R. Lesh (Eds.), *Handbook of research design in mathematics and science education* (pp. 591–646). Mahwah: Lawrence Erlbaum Associates.
Lesson Study Communities Project in Secondary Mathematics. (n.d.). Sample lessons. http://www2.edc.org/lessonstudy/lessonstudy/. Accessed 1 May 2008.
Lewis, C. (2002a). Does lesson study have a future in the United States? *Nagoya Journal of Education and Human Development, 1*(1), 1–23.
Lewis, C. (2002b). *Lesson study: A handbook of teacher-led instructional change*. Philadelphia: Research for Better Schools.
Lewis, C., Perry, R., Hurd, J., & O'Connell, M. (2006, December). Lesson study comes of age in North America. *Phi Delta Kappan, 88,* 273–281.
Lewis, C., Perry, R., & Hurd, J. (2009). Improving mathematics instruction through lesson study: A theoretical model and North American case. *Journal of Mathematics Teacher Education, 12*(4), 285–304.
Matoba, M., Crawford, K. A., & Sarkar Arani, M. R. (Eds.). (2006). *Lesson study: International perspectives on policy and practice*. Beijing: Educational Science Publishing House.
Mills College Lesson Study Group. (n.d.). Lesson plan. http://www.lessonresearch.net/res.html. Accessed 1 May 2008.
Mills College Lesson Study Group (2005). How many seats? Excerpts of a lesson study cycle [DVD]. Oakland: Mills College Lesson Study Group.
National Research Council (2001). *Adding it up: Helping children learn mathematics*. In J. Kilpatrick, J. Swafford, & B. Findell (Eds.), Mathematics learning study committee, center for education, division of behavioral and social sciences and education. Washington: National Academy Press.
Peterson, P., Fennema, E., Carpenter, T., & Loef, M. (1989). Teachers' pedagogical content beliefs in mathematics. *Cognition and Instruction, 6*(1), 1–40.
Teachers' College Lesson Study Research Group. (n.d). Example descriptions for lesson study plans. http://www.tc.edu/lessonstudy/worksamples.html. Accessed 1 May 2008.
Van de Walle, J. A. (2007). *Elementary and middle school mathematical: Teaching developmentally* (6th ed.). Boston: Pearson Education.
Wang-Iverson, P., & Yoshida, M. (2005). *Building of understanding of lesson study*. Philadelphia: Research for Better Schools.