Improving Teaching through Lesson Study

The lesson study model of professional development that originated in Japan is becoming increasingly popular in the United States (Lesson Study Research Group 2009; Stigler and Hiebert 1999). At its core, lesson study is a means of bringing teachers together to carry out the process of planning a lesson, implementing and observing it, and then examining it during a debriefing session (Yoshida 2008). The debriefing component is one of the most distinctive characteristics of this type of professional development. It provides a means—discussion—for reflecting on the strengths and weaknesses of the collaboratively planned lesson. As such, the debriefing component merits special attention from those currently engaged in lesson study as well as those considering using it.

GETTING STARTED

This article describes debriefing session conversations that occurred during a lesson study project that established four lesson study groups (A, B, C, and D) in three high schools. The project brought university mathematics and mathematics education faculty together with high school teachers to collaborate on two lesson study cycles for each group. **Figure 1** (see p. 448) summarizes the components of a lesson study cycle for the project.

The first step in the cycle was for teachers to write a four-column lesson plan collaboratively (Curcio 2002) to address a common goal for student learning (see **fig. 2,** p. 449). Each group set different overarching goals for its work. Group A concentrated on teaching factoring by using Algebra Tiles™. Group B worked on lessons about systems of equations.

Careful reflection during the most important phase of lesson study merits special attention.

Debriefing

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Group C wanted to become familiar with using the Calculator Based Ranger (CBR) to teach algebra. Group D focused on the geometry topics of volume and the Pythagorean theorem.

After writing the initial lesson, the teachers sent it to the university faculty for review. Reviewers provided feedback on the proposed teaching strategies and the lesson's mathematical content. Project leaders asked the teachers to take the feedback into account and refine the written lesson before implementing it, although each group had the autonomy to accept or reject any proposed changes.

After the groups made final refinements to the written lessons, one teacher from each group taught the lesson and had it videotaped. Although having all members of the lesson study group present when the lesson is implemented is ideal, scheduling constraints often prevent full attendance. Videotaping does not allow as much flexibility for observing all the dynamics of a classroom because the window into teaching recorded at any given time is narrow. Nonetheless, videotaping does allow teachers not able to be present during the lesson to see many of its key aspects. It also allows the group to pause at crucial decision points to discuss alternative instructional paths that may be fruitful to pursue. (Freezing the action in this way is not possible in a live classroom setting, of course.)

During the debriefing sessions, each teacher was asked to identify at least one strong point of the lesson being discussed as well as one aspect that could be improved. In accord with a protocol described by Lewis (2002), the teacher who taught the lesson offered his or her thoughts first, and

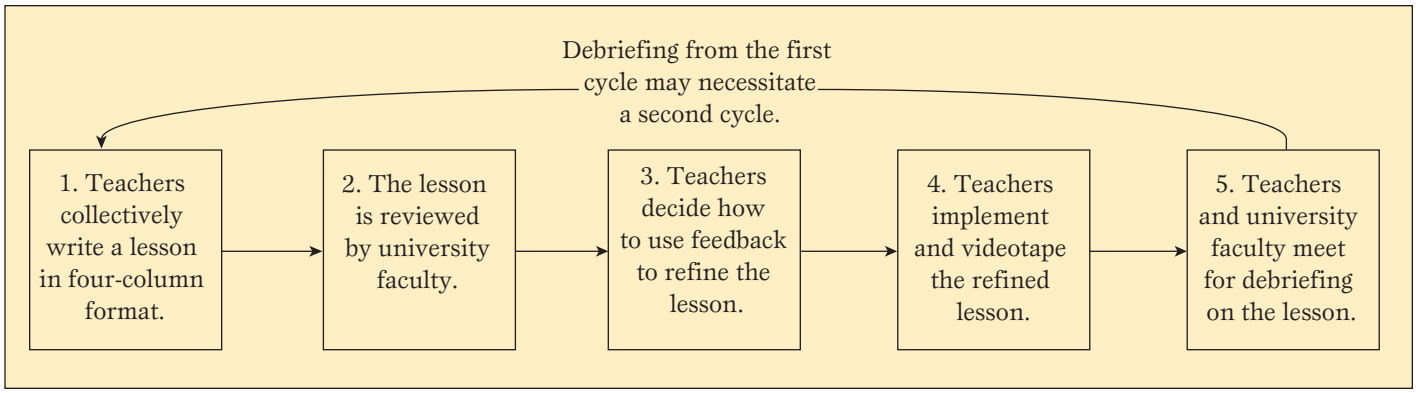

Fig. 1 A lesson study cycle consists of five steps.

then other members of the group contributed to the discussion. University faculty members also participated in the debriefing sessions; previous research has indicated that the perspectives of outside consultants can prompt teachers in a lesson study group to consider ideas they may not conceive on their own (Fernandez 2005). Afterward, a less-structured conversation allowed a freer exchange of ideas.

As the debriefing conversations flowed, teachers were encouraged to attribute strengths and weaknesses of the lesson to the entire group rather than solely to the teacher implementing it. Attributions can often be quite subtle. Take, for example, the following three comments (italics added):

- "A strength is that *you* did a really great job with explaining things."
- "*Your* class participation was great."
- "I think if *you* become more confident with the technology, then all the other pieces of *your* lesson will go so much more smoothly."

The first two comments focus on aspects of the lesson that the group should be accountable for planning together—explaining to and engaging students—rather than just the individual implementing the lesson. The third comment does not mention the group's responsibility for helping each member understand how to use the teaching tools needed for the lesson.

Contrast the three statements above with the following one from one group's debriefing session (italics added):

- There were so many things *we* could do to save some time because it took so long for the kids to get started. *We* could have had the markers already set up outside in the hallway … and things like that, that could have just expedited things a little bit, so that *we* could have saved some time in the beginning so *we* could get to the meat of the lesson.

This comment acknowledged that more than one individual is responsible for the lesson's success or failure, thus highlighting the need for further collaboration.

TOPICS DISCUSSED DURING DEBRIEFING SESSIONS

Several topics of conversation emerged during project debriefing sessions as lessons were discussed. Underlying theories of instruction were often made explicit. Student thinking in response to the lessons was explored. Mechanisms in place for evaluating student thinking were examined and refined. Mathematical coherence of lessons was scrutinized. Different strategies for operating and using everyday teaching tools were shared. Discussions about these topics often naturally led to conversations about how to optimize the next lesson study cycle that the group would undertake.

Topic 1: Theories of Instruction

As teachers discuss the strengths and weaknesses of lessons with one another, personal theories about effective instruction can begin to emerge. During group A's debriefing sessions, for example, two conflicting theories about the optimal use of Algebra Tiles came to light. Before the lesson study project, the teachers in group A operated under the assumption that the primary use of Algebra Tiles was to illustrate previously learned procedures. During lessons on factoring, teachers introduced the tiles as a means of visualizing polynomial factorization and encouraged students to check the correctness of their tile representations by redoing each problem with procedures they had learned in the past.

University faculty members voiced a different view on the instructional use of the tiles. They suggested making connections between the area of a rectangle with constant dimensions and the area of a rectangle with variable dimensions. The former type of rectangle was one that students had worked with a great deal during past instruction, and the latter was implicit in the Algebra Tiles representation for factoring any given polynomial. By seeing connec-

Steps	Main Learning Activities	Anticipated Student Responses	Remarks on Teaching

Explanations and Definitions for Column Headings

Steps: Give short, general descriptors for each segment of the lesson (e.g., "group work," "whole-class discussion," etc.).

Main Learning Activities: Describe each segment in more detail, including the problems students will be asked to solve as well as the activities students are to do during each segment.

Anticipated Student Responses: Describe how you expect students to react to each of the main learning activities. What will they find easy? What will they find difficult?

Remarks on Teaching: Provide notes about teacher actions that must be carried out in order to help students succeed with each segment of the lesson. Include such actions as special instructions given to students, questions you plan to ask, or aspects of the lesson on which you especially wish to focus students' attention.

Fig. 2 The format of a four-column lesson plan is well suited for lesson study.

tions between the two, faculty members hypothesized that students would be able to understand polynomial factorization in terms of area.

In their second lesson, teachers began to acknowledge the importance of area as a conceptual foundation for work with Algebra Tiles. Although they did not abandon all elements of their previous instructional theory about use of the tiles, the conversations during debriefing sessions prompted them to consider the merits and viability of a competing theory. The willingness of teachers and university faculty members to voice different, competing ideas about Algebra Tiles was fundamental to eliciting the important characteristics of the tool.

Voicing personal theories of instruction is important for teachers, even when doing so means disagreeing, to ensure that conversations go beyond the superficial. Lesson study groups should seek to form a common understanding that disagreement is a healthy aspect of debriefing session conversation rather than something to be avoided at all costs.

Topic 2: Student Thinking

An important indicator of the success of any lesson is the type of student thinking it fosters. Neatly structured lessons are of little use if they do not build mathematical understanding. Aspects of group A's debriefing sessions exemplified a focus on student thinking.

In one group's first debriefing session, a question arose about whether students should be encouraged to use grid paper to draw diagrams of Algebra Tiles. The group observed that some students interpreted tile diagrams on grid paper as indicating that the variable lengths in the model were actually known, fixed lengths. The teacher implementing the lesson remarked that she was able to remedy this misconception through conversations with students during the lesson: "When I was walking around, that's one thing that I noticed … They were just concerned—"How am I going to fit all of these [tiles] on this paper?' [I told them,] 'I didn't expect that you would keep the x^2 the exact same size—you can shrink it down, as long as it's a square.' … And so, that helped."

The issue was discussed again during the second teaching of the lesson because students seemed to continue to exhibit the same sort of misunderstanding. The grid paper was initially introduced as a way to help students produce neat diagrams, but its use came into question as the group examined the type of student thinking it sparked.

In debriefing sessions in which discussions of student thinking do not occur as readily as they did within group A, lesson study group members can be encouraged to refine their written four-column lesson plan (see **fig. 2**). The third column asks for conjectures about how students will respond to the main learning activities. Facilitators can ask teachers to compare their initial conjectures against what they observe during the lesson. Discrepancies between conjectured and observed patterns of student thinking can lead to proposals for modifying the lesson.

Topic 3: Mechanisms for Assessing Student Thinking

For a lesson to be judged on the basis of the student thinking it sparks, assessment mechanisms must be in place to elicit student thinking. Hence, another valuable type of conversation during debriefing sessions is one that evaluates these assessment mechanisms.

Group D, for example, attended to the teacher's location in the classroom while students worked as

well as to the types of questions the teacher asked. During the first debriefing session, one teacher in the group remarked that moving about the room could have helped the teacher implementing the lesson gain a better understanding of the types of strategies students were using to solve problems. During the second debriefing session, the teachers made observations about the types of student response required by the teacher's questions. The teacher who implemented the lesson remarked, "One thing I noticed is I need to have the students expand on their answers. Instead of giving me one word or one sentence, they need to give a little more explanation with it … Maybe that would come from more in-depth questions instead of just 'What's this?' and 'What's that?' fill-in-the-blank kind of thing."

Disagreement is a healthy aspect of debriefing session conversation rather than something to be avoided.

Questioning the effectiveness of assessment mechanisms already in place sets the stage for refining them. In turn, lessons improve as they become more responsive to student thinking.

Topic 4: Mathematical Coherence

Debriefing sessions can also help improve the quality of lessons when mathematical coherence is scrutinized. A content-oriented discussion came up during the debriefing session for group C's first lesson. In this lesson, students were to gather data on an individual's distance vs. time when walking toward and away from a CBR unit and then to graph the data by transferring them from the CBR to a calculator. The lesson's objective was to have students investigate linear relationships within this context.

One of the university faculty members, however, noticed that the need for constant walking velocity to produce a linear relationship was not discussed during the lesson. When the group members were asked whether this issue had been brought up with students, they acknowledged that it had not. This question led to discussion about how the effect of variable velocity could be incorporated in future lessons. Teachers suggested using a "match the graph" activity that would require students to walk at rates that produce both linear and nonlinear graphs. By confronting an aspect of the lesson that needed greater mathematical coherence, the group was able to strengthen the mathematical content of future lessons.

Because content knowledge is a sensitive issue, conversations about a lesson's mathematical coherence can be among the most difficult to foster. University mathematics faculty members were helpful in getting such conversations started for the four groups in the project. The low-stakes, nonconfrontational nature of the evaluations they provided on the initial written lessons and during debriefing sessions helped identify areas in which the mathematics of the lesson could be improved.

Lesson study groups that do not have university faculty members to play this role should ask other trusted, mathematically knowledgeable individuals from outside the school to scrutinize lesson content. Online lesson study databases (e.g., http://www.tc.edu/lessonstudy/lsgroups.html) can help lesson study groups connect with one another, opening up the possibility of having outside observers contribute their perspectives during debriefing sessions.

Topic 5: Everyday Teaching Tools

In addition to helping teachers create more mathematically coherent lessons, lesson study debriefing sessions can help them become more familiar with everyday teaching tools. At some point during the debriefing sessions, each of the four groups discussed the mechanics of using such tools. Group A discussed what the various colors on their set of Algebra Tiles were meant to represent and how students interpreted the colors. Group B considered how to operate efficiently the computer projection devices used during their lessons. Group C discussed the logistics of connecting the CBR to the calculator to enable transfer of data, and Group D examined effective use of the chalkboard to display problems. Chalkboard use has also been a topic of interest in other instances of lesson study because of its potential to help organize student thinking (Stigler and Hiebert 1999).

Although conversations about everyday tools may seem mundane in comparison with the other topics discussed thus far, they serve an important function. Other teachers are not likely to adopt lessons if the tools used to carry them out seem unfamiliar or intimidating. By discussing the mechanics of a tool's optimal use, teachers become more comfortable with the idea of making the lesson their own. Hence, it is important for debriefing session facilitators to treat such conversations as integral parts of the lesson study process rather than off-topic distractions. In addition to discussing the strengths and weaknesses of a given lesson, teachers can be encouraged to raise questions about the mechanics of using the tools needed for the lesson.

Topic 6: The Next Lesson Study Cycle

Thorough discussion during a debriefing session often leads naturally to discussion of how the

group will revise the lesson. Group A, for example, decided to concentrate on improving its approach to teaching factoring with Algebra Tiles during the second lesson. The discourse from the first debriefing session directly influenced this decision. During the debriefing session, teachers became interested in how students might interpret the tile model if teachers discussed it explicitly in terms of what students already knew about area. This idea was then built into the beginning of the revised lesson, and the group continued to refine its approach to connecting factoring and area during the second debriefing session.

The teacher who implemented the revised lesson previously had no experience with the Algebra Tiles model. The debriefing session discourse, especially the portions that focused on the intended meanings of the colors in the tile representation, helped her become comfortable enough with the model to volunteer to implement the group's second lesson. Also, she was enthusiastic about trying the Algebra Tiles model in her own classroom because she saw students who were previously unsuccessful with algebraic concepts begin to solve problems successfully during the first lesson.

A single lesson may serve as the focus for several successive cycles, and thus lesson study requires patience. Lesson study differs significantly from forms of professional development that emphasize creating several lessons and units. Lesson study places a premium on the quality of instructional strategies rather than the quantity of materials produced. In group A's case, passing the lesson from the first cycle along to a new teacher helped the group persist in refining the same lesson for the next cycle; the group wanted to ensure that the new teacher would have a successful experience with the lesson.

The same strategy can be tried by other lesson study groups. It works particularly well for semester-long courses that are offered twice a year, because the second cycle can be completed during the spring (or winter) semester. If such courses are not available, groups might consider completing one cycle per year for a given lesson.

CONCLUSION

The debriefing session of the lesson study cycle serves two vital roles. First, it helps the lesson study group reflect on instructional theories and on how well the lesson it planned met students' learning needs. The group can then make adjustments to the lesson on the basis of students' observed responses to it and its mathematical coherence. Developing the ability and disposition to adjust lessons in this manner helps improve instruction well beyond the bounds of just the lesson under consideration by the group.

Second, the debriefing session can help lay the foundation for the next lesson study cycle. Debriefing sessions serve as a link between past and future cycles of lesson study and so are a vital part of the model's infrastructure. Lesson study groups can evaluate and refine—or set up—their own operational infrastructure by looking for opportunities to raise these six discussion topics in their own debriefing session conversations.

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Editor's note: For more on four-column lesson planning, see Michael E. Matthews, Christopher S. Hlas, and Teresa M. Finken, "Using Lesson Study and Four-Column Lesson Planning with Preservice Teachers," *Mathematics Teacher* 102, no. 7 (March 2009): 504–8.

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