

Lesson Study: Beyond Coaching

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In 2000, several of us involved in the Silicon Valley Mathematics Initiatives began exploring how lesson study—a collaborative, teacher-led approach to learning from practice—could deepen and expand the work we were doing together. Since that time, our lesson study work has evolved from a tentative experiment by a few educators in the initiative to an integral part of its ongoing work.

In the basic lesson study cycle, a small team of teachers studies the content of the curriculum and plans a research lesson. One team member teaches the lesson while the others carefully observe students and collect data on their responses to the lesson.

The team then discusses the collected data to explore how the lesson can be improved, to identify the broader implications for teaching and learning, and to develop new questions that they will carry into the next cycle. The Silicon Valley Mathematics Initiative (www.svmimac.org) includes several interwoven strands: a coaching network, an assessment collaborative, and an effort to build professional learning communities in 13 middle schools. Lesson study is woven throughout these strands, and we have found that it deepens and sustains the initiative's work while effectively addressing a number of conundrums of coaching. We address two of those conundrums here.

Coaching Conundrum 1: How can we sustain and broaden educators' learning?

Although one-on-one work between a coach and a teacher often improves the teacher's practice, it does not necessarily lead to sustained, broad growth by the larger community of

teachers. Lesson study can expand and extend the effect coaching in several ways.

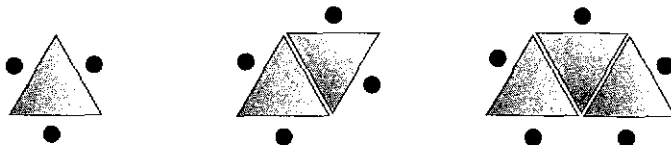
In the Silicon Valley Mathematics Initiative, a coach and several teachers work together as a group, studying a problem of practice together. Because each member of a lesson study group brings his or her own pressing questions to the work, lesson study groups can accommodate differences in understanding of mathematics content without fixing any group member in the roll of “expert” or “novice.” This structure flexibly accommodates differences in the experience and knowledge without sacrificing ideas about relative expertise that may later be difficult to change. Educators may outgrow coaching, but do not outgrow lesson study rather, it grows with them.

Lesson study can embrace both novice and veteran teachers. Barbara Scott, coach of novice teachers in San Mateo City School District, invited novice teachers to join a lesson study group that included experienced teachers. This not only helped the new teachers build relationships with several inexperienced teachers, but also helped learn about protocols for engaging accountable, efficient collegial group work (For example, Silicon Mathematics Initiative lesson study groups use a protocol in which they rotate roles each meeting so that each team member has the chance to practice leadership.)



FIGURE 1. "Seats" Problem

We have a long skinny room and triangle tables that we need to arrange in a row with their edges touching, as shown. Each side can hold one "seat," shown with a circle. Can patterns help us find an easy way to answer the question, How many seats fit around a row of triangle tables?



When they become part of a lesson study group, new teachers don't just develop a relationship with one coach—they begin to build a network of collegial relationships and gain the tools for participation in the larger teacher community. These novice teachers can continue seamlessly in lesson study beyond the induction period.

In addition to working with novice teachers, our coaches often work with experienced teachers who are interested in finding out about recent advances in mathematics teaching and learning or deepening their own understanding of mathematics. For example, during the first week of a summer workshop, coaches and teachers engaged in a lesson study cycle focused on the question, What can elementary teachers do to build a foundation for students' later success in middle school algebra?

The group was considering how they would teach a mathematics problem that asked students to figure out the number of seats that would fit around a row of triangular tables (see fig. 1). The task gives students an opportunity to notice and mathematically represent patterns in the problem—both the *recursive* pattern (that each added table adds one more seat) and the *functional* pattern (that there are two more seats than tables). The ability to notice and mathematically represent functional and recursive patterns is central to success in algebra.

A routine part of planning a research lesson

(Step 2 in the cycle) is to solve the tasks that will be given to students so that the lesson study group can understand student thinking and anticipate the kinds of mistakes students will make.

In this problem, they imagined that students might mistakenly ar-

range the triangles in a form other than a row. The teachers wondered whether the same pattern (in which there are always two more seats than there are triangles) would still hold:

LINDA: What happens if they do this? (She puts a fourth triangle on top of one of the triangles instead of next to the triangle in a row) They still get the same answer.

JACKIE: I love it when stuff like that happens. I think that's so interesting, and kids think it's interesting, too.

DANETTE: Is that always going to be true?
LINDA: Let's discover for ourselves first, so we'll know whether it matters.

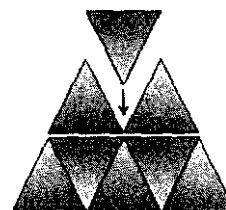
(Teachers work on problem, arranging triangles and counting the number of sides, but each time they add a triangle eliminates just one side of an existing triangle.)

LINDA: So it doesn't matter.

DANETTE: Yeah, with 5 tables I have 7 sides, with 7 tables I have 9 sides.

CAROLYN: You're just matching up one side to a triangle, that's why.

JACKIE: But is it possible to add a triangle and take away 2 sides? Thus far, this would follow the pattern, but now when 1 add



this triangle, I'm taking away two sides.

I'm only going to have one side that's not connected, so that would change the pattern. I have 8 triangles and 8 seats, so it's not plus 2 anymore.

LINDA: Oh, that's cool That is great.

HEATHER: So it does matter where you place the triangles.

Jackie's question, "Is it possible to add a triangle and take away 2 sides?" keeps the team from drawing the premature (and incorrect) conclusion that different arrangements would not affect the functional pattern. Because the teachers had explored the problem in depth, they were well prepared to recognize and handle students' potential misunderstandings.

In this conversation, all members of the team took a learning stance, using the materials to pose and answer questions. When teachers in the group later reflected on the lesson study cycle, they mentioned how satisfying it was to answer through their own experimentation the question of whether the arrangement of the triangles affects the pattern. Participants did not experience this key "coaching moment" in the lesson study as coaching or being coached but as shared inquiry among teammates the par-

ticipatory, egalitarian nature of lesson study makes it easy for information to flow across boundaries of *coach* and *coachee*.

All participants, whatever their level of expertise, join in the shared effort to design an effective lesson and to collect and analyze data on students' learning during the lesson.

Coaching Conundrum 2: How can coaches continue to grow as learners?

A university professor who used to teach high school mused that his high school teaching expertise should perhaps, like canned goods, show an expiration date. He points out a puzzle that faces many coaches—how to keep one's teaching skills and advice current, even as curriculum, standards, instructional methods, and students change.

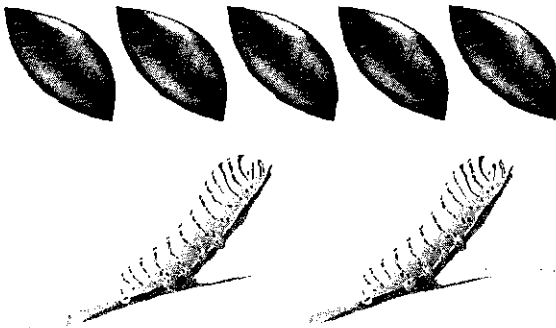
In lesson study, team members with and without daily responsibility for classroom instruction work together to design a lesson, using today's curriculum and standards, and then carefully examine the student thinking that emerges. Lesson study provides a natural context for all team members to update their knowledge as they try out a newly adopted curriculum or as they read and put ideas from a new book or article into action.

FIGURE 2. The Caterpillar Problem

A 4th grade class needs 5 leaves each day to feed its 2 caterpillars. How many leaves would they need each day for 12 caterpillars?

Answer: _____

Use drawings, words, or numbers to show how you got your answer.



Source: Adapted from a National Assessment of Educational Progress test item.

Lesson study groups made up entirely of coaches offer a different kind of opportunity for coaches to continue to grow as learners. Coaches in the Silicon Valley Mathematics Initiative came up with the idea of coaches' lesson study groups to pursue mathematics more deeply than might occur in a less expert group. (Such

content-specific lesson study groups are found in Japan as well, typically at the school district level.)

In one such group, Linda and several coaches in the network studied proportional reasoning, a topic that is "the capstone of elementary school arithmetic and the gateway to higher mathematics" and one in which U.S. 7th and 8th graders have not performed well. Although this topic is typically taught in middle school mathematics, the foundation for proportional reasoning is built in elementary school as students study multiplication and division. The coaches on the lesson study team consulted outside mathematics specialists and studied a wide range of resources on proportional reasoning, including research articles and curriculum resources from the United States, Japan, and Singapore.

The coaches' research illuminated different ways that students might understand and solve a proportional reasoning problem. For example, consider the problem shown in Figure 2, in which students must determine how many leaves would be needed to feed 12 caterpillars if 5 leaves are needed to feed 2 caterpillars. Students could solve this problem by creating a unit rate (2.5 leaves per caterpillar) or a composite rate (5 leaves for every 2 caterpillars); by creating a two-column chart that shows how many leaves for 2 caterpillars, for 4, for 6 and so on; by creating equivalent fractions; or by noticing that the original number of caterpillars (2) is one-sixth the final number of caterpillars (12), so the leaves needed for 2 caterpillars must also be one-sixth of the final number of leaves.

The coaches became interested in how they could help students develop an understanding of proportional reasoning beyond simply setting up a proportion and cross-multiplying. As they planned, taught, revised, and retaught research lessons centered on the problem in Figure 2, the coaches anticipated the methods students might use and planned how best to orchestrate the discussion of the different methods and to connect them to the concept of proportional reasoning.

The coaches' lesson study group offered an opportunity for coaches to build knowledge beyond that routinely expected for all elementary teachers. As this group discussed an article on proportional reasoning, Jackie, a half-time grade 3 teacher and half-time coach, commented,

The article said that the concept of ratio and proportion is among the most important topics in school mathematics. And I thought, How much do I think about ratio and proportion in my everyday world of teaching 3rd grade? I don't feel like it's a big part of my thinking about mathematics. Why is this such a central idea to mathematics? Can you help me think about that?

In the ensuing conversation, team members talked about how multiplication problems can lay the foundation for proportional reasoning by helping students think not just about groups of individual objects, but also about groups as units (for example, units of five leaves for every two caterpillars). At the end of the conversation, Jackie commented that she would thereafter think "differently about the multiplication problems she chose for her 3rd graders." As she later wrote, "Now I think about the importance of really emphasizing groups in measurement and in learning multiplication because it is the base of understanding proportions in later grades."

Another coach on the team reported that the lesson study cycle led her to think differently about the value of *eliciting* and using student solutions:

The idea of having models come from kids seemed big. I still think there is a place where you want students to go in terms of a model or an algorithm that they need to use and understand eventually, but the route to getting there can be more student-centered.

For Linda, as the coaching network's assessment director, the new learning from this lesson study cycle helped her immediately recognize

various student solution methods in the rapid flow of classroom events, so that she could easily orchestrate student presentation and discussion of these methods:

Our playing around and struggling with the mathematics eventually led to us having a really clear idea. So when you look at student work, you just know. You don't have to be thinking on your feet.

These three different types of learning by two coaches and an assessment director highlight the egalitarian nature of lesson study and the differentiated learning that can occur in a lesson study cycle.

Breaking Down Barriers

Veteran coaches, as well as novice teachers, benefit from careful examination of their own practice and reflection on it. Observations of student learning by both novices and veterans help us, collectively, to build a picture of the strengths and weaknesses of instruction. Lesson study has the power to move the education profession beyond traditional hierarchical ideas of coaching and leadership toward a model that both expects and supports lifelong learning by all participants, from novice teachers to experienced leaders of professional learning.

For a graphic illustration of the cycle and more information about lesson study, see Lewis, C., & Hurd, J. (2011). *Lesson study step by step: How teacher learning communities help improve instruction*. Portsmouth, NH: Heinemann.

Additional resources to explore lesson study are available at www.lessonresearch.net National Research Council. (2001). *Adding it up: Helping children learn mathematics*. Washington, DC: National Academies Press, p. 242.

Educational Leadership, October, 2011.

