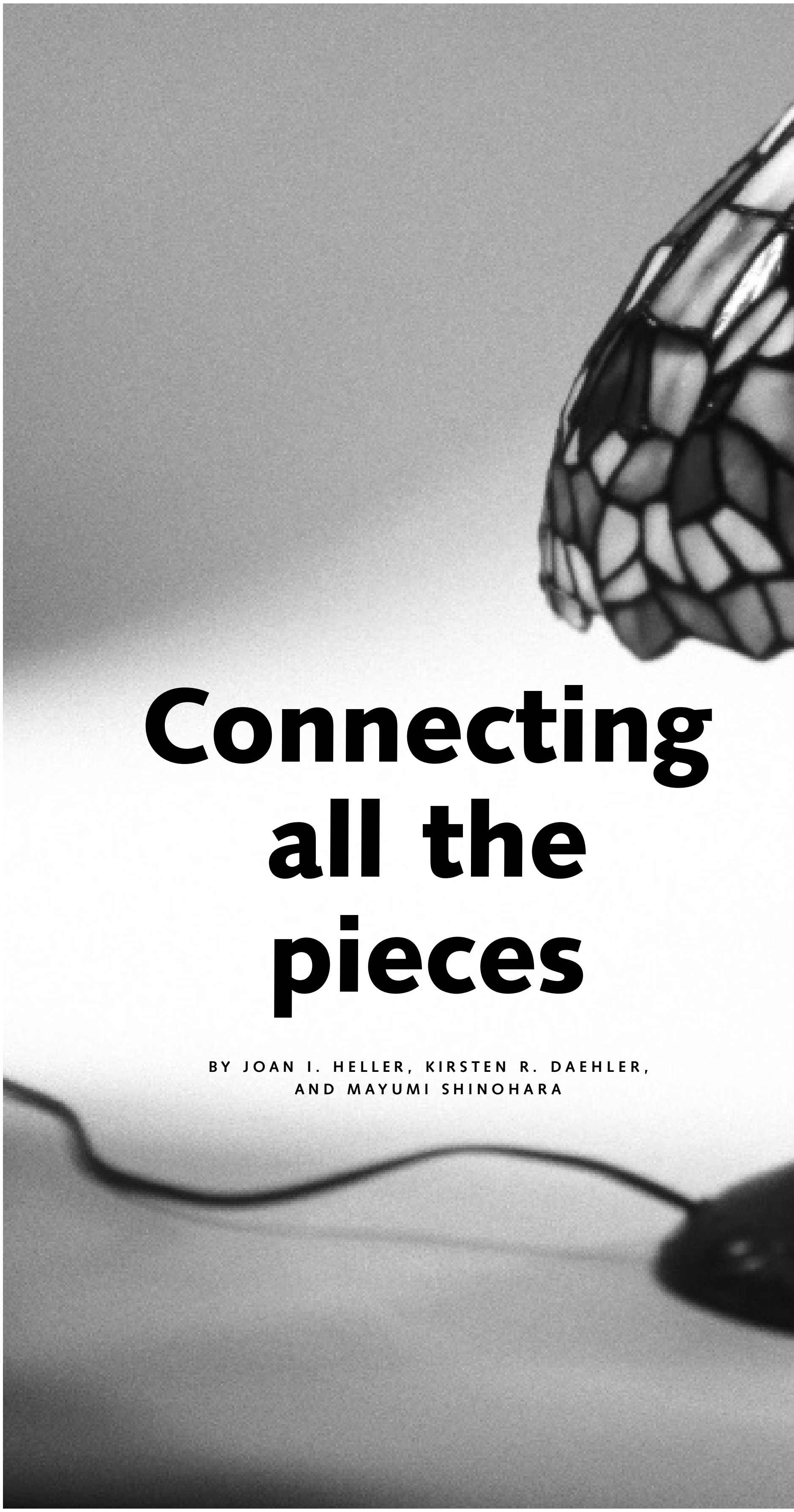

Connecting all the pieces

Mosaic approach to evaluation makes a complete picture

BY JOAN I. HELLER, KIRSTEN R. DAEHLER, AND MAYUMI SHINOHARA

EXAMPLE IN PRACTICE

How can we tell what influence our staff development efforts have on the teachers who participate in them, or on their classrooms or students? Teachers, learning environments, and students continually change for many reasons, and attributing changes in student learning to a particular staff development experience is nearly impossible.

We used an evaluation mosaic (Heller, 1995) to seek evidence of the impact of a professional development project in Science Cases for Teacher Learning. Guided by an evaluation framework, we conducted multiple interrelated studies. Any one of the studies is meaningful in itself, but the sum, like a mosaic, presents a broader picture and more convincing evidence than separate pieces.

When we found converging evidence of impact, we could argue not only that our work resulted in a coherent set of changes, but we also

were able to trace reasons for negative results, helping us fine-tune the staff development program.

CASCADE OF INFLUENCES

An evaluation framework has helped us integrate staff development design with evaluation design in the project. The major outcomes expected from the project were clearly outlined (see chart on page 38).

With outcomes defined, we addressed several questions in our evaluation:

- Do the staff development sessions have the features they were intended to have?
- Do participating teachers demonstrate shifts in thinking, knowledge, beliefs, and teaching practices consistent with the project's philosophy and objectives, and with the process and content of the actual sessions?
- Are such shifts accompanied by corresponding changes in these teachers' classrooms, with new and better opportunities for students to learn?
- Are these classroom changes accompanied by corresponding changes in what students know and can do?

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CASE-BASED MODEL

Evidence from several studies (Weiss, Gellatly, Montgomery, Ridgeway, Templeton, & Whittington, 1999; Cohen & Hill, 1998; Birman, Desimone, Porter, & Garet, 2000; Hawley & Valli, 1999) shows student learning improves when teacher learning experiences:

- Focus on content;
- Are sustained over time; and
- Offer opportunities for professional dialogue and critical reflection.

The aim of the Science Cases for Teacher Learning Project is to develop teachers' pedagogical content knowledge (Shulman, 1986) — their understanding of what makes learning a science topic easy or difficult, and knowing how to present and explain the material to make it easier for learners to understand.

Any one of the studies is meaningful in itself, but the sum, like a mosaic, presents a broader picture and more convincing evidence than separate pieces.

During the 2000-01 school year, we piloted a case-based curriculum for teachers in electricity and magnetism with nearly 50 3rd-, 4th-, and 5th-grade teachers from four San Francisco Bay area districts. Teachers met monthly over the school year in six to eight sessions for a total of 20 to 50 hours. Each three-hour session began with a hands-on science investigation during which teachers actively learned science content using the same curriculum materials they use to teach students.

These investigations were linked to the teaching cases. The teachers then examined and discussed cases drawn from actual lessons with events that perplexed, surprised, or disappointed the teacher in whose class-

Evaluation framework of Science Cases for Teacher Learning Project

CRITICAL FEATURES OF SCIENCE CASE DISCUSSION METHOD	TEACHER OUTCOMES	CLASSROOM OUTCOMES	STUDENT OUTCOMES
Exploration of scientific meanings Teachers discuss, investigate, and think carefully about the meaning of specific science concepts in each case.	• Rich and accurate understanding of the science concepts in the cases. • Confidence and positive attitude toward learning, doing, and teaching science.	• Discussion and activities focus on the meaning of science concepts. • Science content meets grade-level expectations in accuracy and coverage.	• Accurate understanding of science concepts in the cases. • Grade-level appropriate knowledge of science content. • Ability to observe, look for patterns, and draw conclusions.
Focus on student thinking Teachers examine and interpret student work, talk, and behaviors in each case to determine what students understand and are thinking.	• Heightened attention to student thinking. • Understanding of what is important for students to know about the content. • Knowledge about what makes science learning difficult for students.	• Instruction and assessment elicit and build on student thinking and deal directly with what is difficult for students. • Curriculum addresses what is important for students to know about the content.	• Ability to avoid or move beyond misconceptions and errors. • Skill in thinking and communicating scientifically.
Critical analysis of practice Teachers analyze the effectiveness and coherence of instructional practices, activities, materials, and scientific representations in each case.	• Pedagogical reasoning that is analytical, complex, and detailed. • Ongoing reflection about the effectiveness of instructional practices, activities, and materials. • Skill in making science comprehensible to students.	• Instructional practices and materials communicate and develop the meaning of science concepts. • Activities are coherent, structured sequences of inquiry. • Instructional decisions are adjusted as a result of ongoing analysis of student understanding.	• In-depth understanding of science concepts. • Ability to represent scientific meanings in a variety of ways.
Experience in a learning community Teachers participate in a learning community where members engage in a process of collaborative inquiry about scientific ideas and phenomena and reflect on the teaching and learning of science.	• Ability to engage in and support collaborative inquiry. • Deliberately plans instruction that supports collaborative inquiry. • Believes that explanations and discussions are essential parts of learning science.	• Students engage in collaborative inquiry to make sense of scientific ideas. • Students interact with each other to learn science. • Students have opportunities to articulate and justify their scientific ideas and explanations.	• Skill in collaboratively making sense of science. • Ability to articulate and justify scientific ideas and explanations.

room they occurred. Project staff had helped classroom teachers write these narratives, and the lessons included student work, student-teacher dialogue, descriptions of instructional materials and activities, teacher behaviors, and the teacher's thoughts. The cases stimulated in-depth discussions among teachers in groups guided by teacher-facilitators and staff.

In the case "A Complete Circuit is a Complete Circle," for example, a 4th-grade teacher taught a sequence of lessons on complete circuits. Despite careful planning and instruction, she was baffled to find her students still didn't understand how to make a bulb light. Using the case in the professional learning session, the participants were challenged to make a bulb light up using only a battery, a wire, and a small flashlight bulb. Then they compared what worked and what didn't to develop a working definition of a complete circuit.

After the science investigation, teachers worked in small groups to examine student thinking and analyze the instruction presented in the case. This led to a whole-group discussion, where teachers wrestled with the science content and explored alternative perspectives and solutions to the problem at the heart of the case. The facilitator helped focus and deepen the discussion, often asking teachers to draw diagrams and use hands-on materials or other resources to illustrate ideas.

No matter how carefully this professional learning experience was designed, though, we couldn't claim it worked without evidence. We particularly wanted to link teacher, classroom, and student impacts. The evaluation framework and mosaic approach gave us the means to take on the task and provided results from multiple data sources.

EVALUATION FRAMEWORK

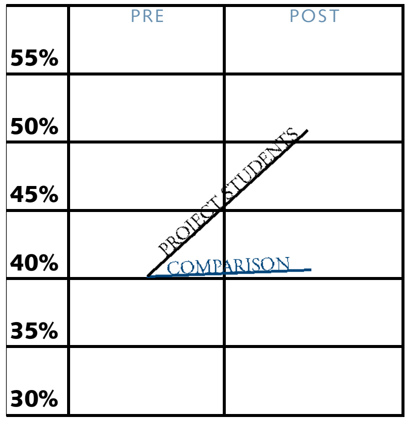
Developing an evaluation framework was an important step. We first made explicit the critical features of our staff development model and then described theoretical connections between those features and target outcomes. We began to create this framework by identifying the major features of the science case discussion experience:

- Exploration of scientific meanings;
- Focus on student thinking;
- Critical analysis of practice; and
- Experience in a learning community.

Each feature also has associated teacher-, classroom-, and student-level outcomes. For example, exploring scientific meanings is intended to strengthen teachers' understanding of those concepts, which would influence student opportunities to learn through the way those concepts are taught, which would affect students' understanding of the concepts.

Putting these concepts in a matrix of columns and rows helped simplify the situation, although these aspects overlap and are interrelated. This framework is not intended to be prescriptive, linear, or hierarchical. It is a tool to help determine whether case

Higher scores were measured for students of teachers who participated in case discussions



Pre-test and post-test percentage correct scores on electricity and magnetism test for Oakland project participants' students (N=166) and Oakland comparison students (N=105).

discussions have an impact and, if so, what and where that impact may be. This evaluation framework evolved as the work proceeded. With each analysis, we gained a clearer understanding of both what might be important to look at and how to assess each aspect.

RESEARCH APPROACH

Building an evaluation mosaic required studying outcomes listed in the framework. We began by looking for evidence of an impact for individual cells under teacher and student outcomes that related to the project's focus on exploring scientific meanings, focus on student thinking, and critical analysis of practice.

We selected target outcomes in the evaluation framework to investigate using a combination of data collection methods, including written surveys, content tests, interviews, and focus group discussions to look at both the process and the project's outcomes. We conducted small-scale but intensive longitudinal studies, relying in part on tests given both before and after the case discussions to different cohort groups of teachers and their students. The studies also included comparisons between project and control groups.

The evaluation revealed that teachers who participated in science case discussions were better able to describe students' conceptual difficulties, give examples of how these difficulties showed up in student work or performance, and more often made explicit links between specific student difficulties and instructional interventions (Daehler & Shinohara, 2001; Heller & Kaskowitz, 2002).

Also, students whose teachers took part in case discussions learned more. For example, a sample of 166 students of participating teachers scored significantly higher on a science content pre- to post-test, but comparable students of nonparticipating teachers showed no pre- to post-test gains (see graph at left). Students of all abilities taught by participating teachers showed significant gains from pre- to post-test. Particularly encouraging was that low-performing students showed the most dramatic increase.

Putting these concepts in a matrix of columns and rows helped simplify the situation, although these aspects overlap and are interrelated.

FINAL COMMENTS

In this evaluation, we found significant gains in relation to each of the target outcomes we investigated from the evaluation framework. Teachers demonstrated better knowledge of science content, a striking increase in their pedagogical content knowledge, especially in their attention to student thinking, and reported changes in their teaching practices. We also found significant improvements in students' scores on a test of related science content. More participating teachers taught grade-level appropriate electricity and magnetism curriculum to their students than they had previously and than their colleagues did in comparable classrooms. Teachers shifted from having students engaged in isolated activities and unstructured hands-on exploration to structured sequences of inquiry activities, and teachers learned to use with their students the kinds of questioning strategies that group facilitators modeled. This pattern of results, taken together as pieces of an emerging mosaic, lend credence to the claim that the Science Cases for Teacher Learning Project had an effect on students' learning.

Quotes from participating teachers

• "So much of the reason why it was more exciting and enjoyable was that it was in dialogue format, and almost none of our professional development is. ... This was based on the idea of drawing from us constantly, almost entirely, instead of telling us what to think about. ... Nobody listens to us, ever, in other professional development."

— Oakland Unified School District (OUSD) focus group comment, April 2001

• "In the examination of the cases, we were able to discuss both the science concepts and the effectiveness of the instructional practices used, and the common misunderstandings of both children and teachers. In most science professional development, it's mostly one or the other."

— OUSD written survey response, April 2001

• "The biggest thing I got from the case studies was just a whole different type of questioning. ... Before this, I was asking dead-end questions that just had an answer, like, 'What do you see?' ... (Here we) had modeled types of ... questions like 'What happens if ...?' 'Can you get it to work a different way?' 'Why do you think so?' 'Tell me more about ...' 'How else could we do it?' Those types of questions brought the science alive."

— OUSD focus group comment, April 2001

The evaluation process helped the professional development staff learn several valuable lessons:

- **Develop an evaluation framework at the beginning.**

We knew the value of planning evaluation from a project's start, but this lesson was driven home when we worked together as a project-evaluator team to write our own evaluation framework. These discussions forced us to articulate, at a conceptual level, what the Science Cases for Teacher Learning Project was really about. It was tempting to decide on evaluation methods and instruments too quickly. Instead, we took the time to clearly describe the core features of our model. This forced the team to develop a common language and shared focus. We completed our first version of the evaluation framework by building a bridge of outcomes to link the staff development we offered with logical, related outcomes for teachers, classrooms, and students. These conversations not only supported our formative evaluation, but they shaped the kind of summative data we would collect over the course of several years.

- **Use an evaluation framework and mosaic approach to spend your evaluation dollars effectively.**

In an era of accountability and limited money to support the evaluation of staff development programs, it was critical to be specific about what we wanted to accomplish with teachers and then measure those outcomes. Our evaluation framework provided a clear target. It also helped us focus on what was most important vs. what was nice to do. For example, when someone had an additional good idea (like videotaping students doing a specific hands-on task) or wanted to look at something new, we could consult the framework and make strategic decisions about each choice in the context of the whole. The mosaic approach also helped us allocate our resources to best document the complexities of our results. Rather than spreading our evaluation pennies sparingly across every cell in the evaluation framework or clustering the resources around only a few outcomes, we prioritized the cells and then chose the instruments and methods.

- **Set yourself up to succeed by promising what's possible.**

Evaluation can collect evidence only of what's actually there. If it will take time for your professional development to have an impact on students, give teachers time before you seek evidence of student outcomes. Or if you think it will take time to refine the professional development model, wait a year or two before collecting evidence of impact. This can be hard advice to follow and may involve drawing some lines with funders and the communities you serve. But it's an important part of openly and accurately communicating reasonable expectations, and it ultimately works to your benefit.

- **Understand that evaluation is a process and not an event.**

We joke that we are now using the umpteenth version of our evaluation framework, and it has both grown and shrunk in terms of length and detail. Yet this review-and-revise process has both shaped and kept pace with our staff development work. By making our evaluation a process, we have been able gradually to collect pieces of the mosaic throughout the lifetime of the project. Because we used a mosaic approach that relied on converging evidence, when we got unexpected results in some cases, we had a more complete story to tell and a way to understand why this happened and what changes we needed to make in our program. Since we had clearly articulated strands (rows on the evaluation framework) and could show outcomes along a part of the strands, we could

Pieces that formed the evaluation mosaic

We developed a number of pieces to evaluate the effect of the Science Cases for Teacher Learning Project. The results of these pieces helped form the evaluation mosaic.

WRITTEN SURVEYS

All participating teachers received a beginning- and an end-of-year survey that included both closed and open-ended questions. The surveys contained questions about teachers' science backgrounds, preparedness, attitudes, pedagogy, and students' opportunities to learn. Post surveys incorporated items assessing teachers' perceptions of the value and impact of their participation and how they applied what they learned to their classroom instruction.

CONTENT ASSESSMENT

We developed an electricity and magnetism test for both teachers and students. Some of the questions on the 30-minute assessment appeared on Trends in International Mathematics and Science Study and National Assessment of Educational Progress tests. Participating teachers took the content test at the beginning and end of the project year. Students took the test before and after they were taught a unit on electricity and magnetism.

TEACHER INTERVIEWS

A subset of nine participating teachers was interviewed in depth at the beginning and end of the year to measure the project's impact on teachers' science content knowledge and pedagogical content knowledge (both understanding of student concept knowledge and instructional practices). The interview contained questions about teachers' perceptions of student difficulties, approaches to addressing those difficulties, and instructional approaches to helping students understand a specific problem. This combination of questions elicited detailed information about teachers' content knowledge, instructional strategies, reasoning about student knowledge, and pedagogical content knowledge. Interviews were analyzed using a rubric developed by reviewing the transcripts.

provide convincing evidence that change was happening, for both teachers and their students.

The mosaic approach also helped us allocate our resources to best document the complexities of our results.

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