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Improving Teaching Does Improve Teachers: Evidence from Lesson Study

Catherine C. Lewis[1], Rebecca R. Perry[1], Shelley Friedkin[1], and Jillian R. Roth[1]

Abstract

The authors comment on the article by Morris and Hiebert in three ways. First, they add thoughts about why improvement efforts often focus on teachers, rather than teaching. Second, they offer evidence from U.S. lesson study research that focus on teaching can improve both students' learning and teachers' learning. Finally, they suggest that the instructional products and common assessments advocated by Hiebert and Morris are not sufficient, and that they need to be accompanied by practice-based, collegial learning in which teachers build shared knowledge and commitments for the hard work of improvement. Their research indicates that lesson study focuses on teaching, but improves teachers as well, increasing mathematical knowledge and beliefs that support instructional improvement, as well as improving student learning.

Keywords

professional learning, teacher learning, lesson study, teacher's manual, scale-up

We comment on three aspects of Hiebert and Morris's article, "Teaching, Rather Than Teachers, As a Path Toward Improving Classroom Instruction." First, we add modestly to their ideas about why teachers, instead of teaching, receive so much attention. Second, we support their call for a focus on improving *teaching* (we suggest *teaching* and *learning*), and we discuss evidence that such a focus improves *teachers* as well. Finally, we argue that teachers need practice-based, collegial learning structures.

Hiebert and Morris advance several explanations for the dominant focus on improving *teachers* (rather than *teaching*). We add one more explanation: policy makers' disappointment with many results of investments in instructional materials and interventions. A number of curricula "proven" effective in rigorous small-scale research have not succeeded when tried more broadly (e.g., What Works Clearinghouse, 2009, 2010). So, the logic goes, the problem is the quality of the educators who use these "proven" curricula and programs. However, many U.S. educators lack three very basic supports needed to implement any program well: high-quality instructional resources (especially teacher's manuals), *practice-based* opportunities to learn, and collegial learning that enables development of shared knowledge and commitment among teachers. Our research on U.S. lesson study shows that when such supports are made available to teachers, they are able to improve their knowledge, to build habits and dispositions that support improvement, and to improve student learning (Perry & Lewis, 2011).

A Brief Background on Lesson Study

Lesson study is an inquiry cycle conducted by a team of teachers that is centered around a "research lesson"—an actual classroom lesson designed to investigate and improve the teaching of a particular topic (Lewis & Hurd, 2011). During the research lesson, team members gather data on student thinking and learning, studying selected students to see how their thinking evolves (or fails to), and what aspects of the lesson design enhance or pose barriers to learning. Team members present these data during a postlesson discussion, drawing out implications for teaching and learning the specific topic and for teaching and learning more broadly.

In Japan, lesson study occurs as a school-based, district-based, and national activity, with the different layers working synergistically, to allow innovations to spread across the country through live public research lessons (Lewis & Tsuchida, 1997). The Japanese mathematics teaching through problem solving that attracted such attention through the 1999 Third International Mathematics and Science (TIMSS; Stigler & Hiebert, 1999) video study was developed, refined, and spread through public research lessons. In addition to

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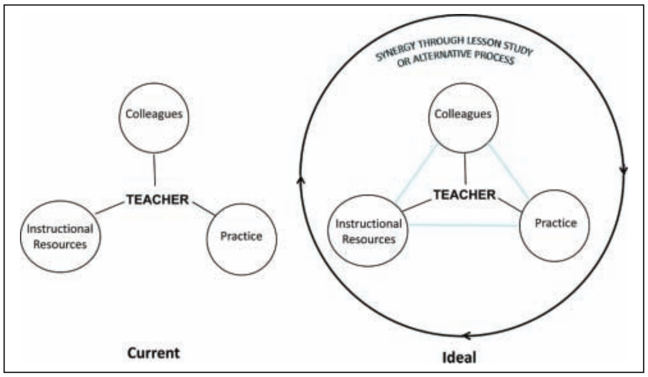

Figure 1. Resources for improving teaching: From disconnection to synergy

spreading the annotated instructional plans highlighted by Hiebert and Morris, public research lessons provide an opportunity to see, critique, and refine how the plans are actually brought to life, to meet colleagues who can be called on when questions arise, and to build a shared commitment to the ongoing work of changing one's practice. For teachers, watching lessons from the student's perspective can build knowledge of student thinking and motivation to improve their own instruction. A Japanese teacher in her 10th year of teaching recalls how, early in her career, she cried after seeing a research lesson taught by her fellow first-grade teacher:

> I felt so sorry for my own students. I thought their lives would have been so much better if they'd been in the other teacher's class. You realize you have had a big impact on your students. You see how authoritarian teachers have very quiet classes. Teachers who value students' ideas have very active classes. You see how teachers are creating a class, not just teaching a lesson. (Lewis & Tsuchida, 1997, p. 16)

Three Supports Needed to Improve Teaching

Although Hiebert and Morris make the case that annotated instructional products and common assessments are needed to improve teaching, we identify an overlapping and somewhat broader set of supports, illustrated in Figure 1: high-quality instructional resources (including teacher's manual and assessments), structures for learning *within practice*, and collegial learning. Although well-designed lesson study includes all three components, we break them out as separate components because lesson study is not the only way to address all three components (see, for example, National Writing Project [NWP], 2010). Figure 1 illustrates that teachers' opportunities to learn from these three supports are currently limited and often occur in isolation from one another. Ideally, the three elements are closely intertwined, so that teachers draw on one another's knowledge to bring to life high-quality instructional materials in the classroom.

High-Quality Instructional Resources (Including Teacher's Manual)

The first support we identify is high-quality instructional materials (including teacher's manuals and common assessments). The first part of lesson study is *kyouzai kenkyuu* (study of teaching materials), to examine what is currently known about the teaching and learning of a particular topic (Takahashi, Watanabe, Yoshida, & Wang-Iverson, 2005). In Japan, the teacher's manual is used for *kyouzai kenkyuu*. But when we first began to observe U.S. mathematics lesson study, we noticed that U.S. teacher's manuals did not reliably support mathematically rich discussions. To understand this difficulty, we took a closer look at U.S. and Japanese teacher's manuals for one mathematical topic—area of quadrilaterals—looking at one widely used textbook series from each country (*Harcourt California*, Maletsky, 2002; *Mathematics for Elementary School*, Hironaka & Sugiyama, 2006). We classified each sentence in the target units of the teacher's manuals using a coding scheme based on Ball and Cohen's (1996) ideas about the curriculum elements that support teachers' learning, such as providing a rationale for pedagogical decisions and information on student thinking. We found that the Japanese teacher's manual devotes proportionally more space to features expected to support teachers' learning. Whereas 10% of the statements in the Japanese units are devoted to providing a rationale for pedagogical choices, such statements are absent in the U.S. units (Lewis, Perry, & Friedkin, 2011). For example, the Japanese textbook's introduction to rectangle area asks students to compare the areas of two rectangles for which neither dimensions nor a grid is provided, and the teacher's manual provides the following rationale:

> In teaching area, it is important to take four steps, i.e., direct comparison, indirect comparison, [measurement with a] non-standard unit, and [measurement with a] standard unit. To promote taking these steps, a rectangle and square without grids are used. (Tokyo Shoseki Co. Ltd., 2000, p. 35, first author's translation)

In contrast, the U.S. text provides a rectangle predivided into square units with no rationale for this task design; it simply provides questions for teachers to ask students, such as "How could you count rows and multiply to find the area?" (Maletsky, 2002, p. 500; Grade 4, Volume 2).

Attention to student thinking is a second major difference between the examined units in the U.S. and Japanese teacher's manuals. Anticipation of varied student thinking accounts for 28% of the statements in the Japanese manual but only 1% of the statements in the U.S. manual. Figure 2 provides one example from the Japanese textbook and teacher's manual, showing three different ways that students might reconfigure a parallelogram to find its area. The teacher's manual provides the following explanation:

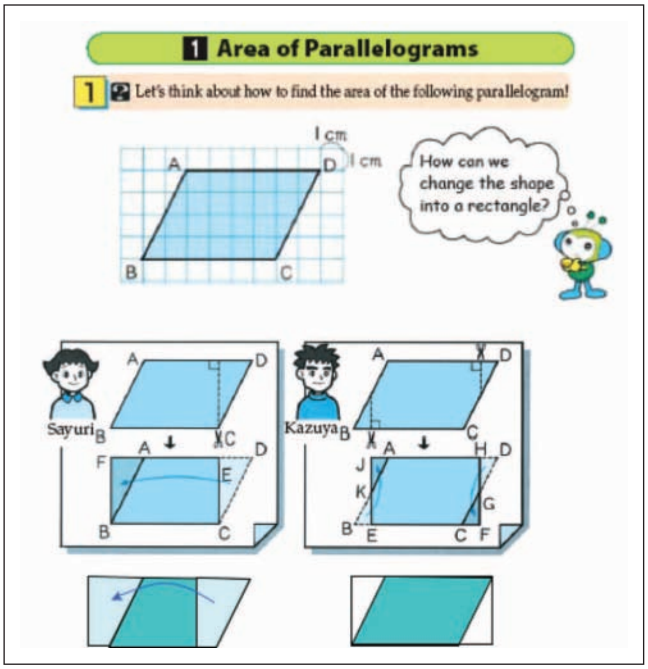

Figure 2. Excerpt from Japanese textbook
Source: Adapted from Hironaka and Sugiyama (2006), *5A*, pp. 69-70. Copyright Tokyo Shoseki, 2006, reproduced by permission. Available through Global Education Resources, www.globaledresources.com

> The three solutions . . . all involve cutting the parallelogram, but they each generate different pieces . . . But all these different pieces reassemble to give the same rectangle . . . Have the students pull together [the idea] that the area of a parallelogram can be found using area-preserving transformations to make the parallelogram into a rectangle. Stress that, in area-preserving transformation to a rectangle, it does not matter where within the parallelogram the perpendicular to the side AD is drawn. Cutting along that perpendicular generates pieces whose sizes and shapes do vary, depending on location. But those pieces always reassemble to give the same rectangle. (Tokyo Shoseki Co. Ltd., 2000, p. 112, first author's translation)

As Figure 2 and the above quote suggest, the discussion of varied student thinking in the Japanese teacher's manual provides a rich source of content knowledge for teachers. For example, one U.S. teacher who used the Japanese textbook and teacher's manual in lesson study on polygon area reported learning that "Using the area of a rectangle to solve other areas is the basis for most simple area formulas" (ID No. 323).

In contrast to the varied student thinking in the Japanese teacher's manual, the information on student responses provided in the U.S. teacher's manual was almost always a single correct answer. Such single correct answers account for 13% of statements in the examined U.S. text and 3% of statements in the examined Japanese text.

The Japanese teacher's manual appears to include all the elements of annotated instructional products that Hiebert and Morris call for, such as explicit learning goals ("To understand how to find the area of a parallelogram"), rationale for lesson design, student responses, and key mathematical ideas behind the activities, as well as practical guidance for conducting each lesson, such as the questions to be posed at each stage of the lesson (initially, "How do you suppose we might go about finding the area of this parallelogram?" and after students have shared their approaches, "Let's explain Sayuri's and Kazuya's ways of thinking"). The Japanese teacher's manual includes an overall unit plan for the four-lesson instructional unit on area of parallelograms, plans for each lesson, blackboard-writing plans, and discussion of key difficulties for students.

The Japanese teacher's manual also provides assessment items for each instructional unit. As the purpose of the assessment items is to understand whether students grasped the content of the unit, a modest set of items is sufficient. Because Hiebert and Morris's call for "common assessments" may suggest to U.S. audiences something much more elaborate (i.e., psychometrically valid item sets that can be used for high-stakes accountability), we do not break out "common assessments" as a separate item in our model. Rather, we consider common assessments as an integral part of high-quality instructional materials. As Stigler (2010) and others have pointed out, common end-of-unit tests enable teachers to investigate small variations in teaching that produce differences in learning by different classes studying the same curriculum. In addition to end-of-unit assessments, the Japanese teacher's manual provides guidance for formative evaluation of students during lessons. For example, "major assessment criteria" for the first lesson on area of parallelograms include whether students are "making connections to area of figures already studied" and whether they "notice that . . . once the figure has been made into a rectangle by an area-preserving transformation, formulas already studied may be used to solve the problem."

Hiebert and Morris may be correct that U.S. textbook publishers cannot be expected to create resources that accumulate and spread knowledge about how to teach particular content. We note, however, that Japanese teacher's manuals appear to serve this function, within a competitive commercial textbook publishing system similar to that of the United States (Lewis, Tsuchida, & Coleman, 2002).

Practice-Based Professional Learning

Instructional materials alone, however excellent, are often insufficient to improve instruction (e.g., Remillard & Bryans, 2004). Educators need opportunities to see and to try out new approaches *in practice*. A U.S. teacher whose lesson study group had a detailed instructional plan and video for a series of lessons on fractions mentioned the difficulty of conducting a lesson based on a lesson plan:

> I have a hard time reading other peoples' lessons in general. It's hard to visualize. The DVD is so much more useful to me because I can see what they are doing . . . . I can see why they are doing it. (IES No. 4, 1.13.10)

Teaching is an enormously complex endeavor of juggling many concerns simultaneously (Lampert, 2001). Out-of-classroom training can take an educator only so far—and then it is necessary to integrate a new approach into practice, see what happens to the juggling act, and recalibrate.

Despite the need to try out new approaches, practice-based professional learning is not common in the United States (Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009). Because educators have few opportunities to see each other's practice, they may use the same terms ("scaffolding," "group work") to refer to varying practices, masking critical sources of difference in practice. At a public research lesson on mathematical problem solving taught in California, we were stunned to find that educators who had been working together for many years had dramatically different images of the instruction called for by the term *problem solving* in the state mathematics standards and sharply different opinions on whether the research lesson supported the state standards (Lewis & Hurd, 2011). In contrast, Japanese teachers have frequent opportunities to observe and discuss each other's lessons and, thus, to develop shared instructional referents and shared know-how about goals like problem solving (Lewis & Tsuchida, 1997).

School-based lesson study allows teachers to build and spread "high-impact instructional routines" (Ball, Sleep, Boerst, & Bass, 2009; Grossman, Hammerness, & McDonald, 2009). Teachers at Matsuzawa Elementary School (2011) in Tokyo investigated teachers' questioning and students' note-taking (among other elements of teaching) over a 2-year period devoted to the schoolwide research theme, "Mathematics that supports students to explain their ideas to each other and learn from each other: Learning through problem solving." Teachers developed a school report describing what they learned from studying this theme, and they handed out the report at public research lessons at their school. The report included what to look for in students during each phase of a problem-solving lesson, teacher questions that support each stage of problem solving, and the desired development of note-taking by students over the elementary grades. For example, teachers look for whether students are "trying to solve the problem using knowledge they have already learned" and "always looking for a better or faster way of thinking" during the independent problem-solving phase of a lesson and look at whether students are "speaking in front of the blackboard, with their face and body looking toward the class" and "explaining using equations and diagrams" during the stage of the lesson when students present their explanations to each other. With respect to goals of note-taking, whereas early elementary students are expected to "write down what is written on the blackboard" and middle elementary students to "write down what the teacher and others said," upper elementary students are expected to "write down points that they thought were important by listening to their friends' ways of thinking." Examples of teachers' questions include "Let's think of other ways to solve it" for the individual problem-solving phase and "Which way of thinking can always be used?" for the discussion phase of a problem-solving lesson. These examples illustrate how teachers build shared knowledge about the specific teaching strategies and student behaviors that support learning through problem solving. They suggest the richness of studying "high-impact instructional routines" *in practice*, where teachers can notice what is working and what needs improvement through careful observation of teaching and learning.

Structures for Collaboration With Colleagues

Colleagues can help each other learn from both instructional materials and from practice (e.g., Grandau, 2005; Lewis, Perry, & Hurd, 2009; Peng, 2007; Schorr & Koellner-Clark, 2003; Ticha & Hospesova, 2006). Colleagues provide a need to make one's thinking visible and they offer ideas, questions, and challenges (Linn, Eylon, & Davis, 2004). For example, a U.S. group conducted lesson study on area of rectangles, using a task from a Japanese textbook that has students compare the size of two class newsletters posted on bulletin boards and surrounded by drawing papers. Not all teachers initially noticed that the drawing papers around the perimeter might encourage students to think about measuring side length and might surface important misconceptions about area and perimeter. When one teacher suggested that it was not necessary to use the task in the book, another disagreed, pointing out that the task was set up to elicit certain kinds of student thinking, to get

> kids to look at both things—the poster and the paper in the background because the kids might begin to get some ideas about how they could measure . . . . Some of the kids might be counting the . . . drawing papers and confusing the idea of perimeter and area.

As group members then took a closer look at the task and reread the teacher's manual, they gradually recognized the difficulty of "tweaking" the task and keeping it as mathematically meaningful. The teacher who had originally suggested that it was not important to use the task in the textbook said, "Now it seems harder and harder to create our own thing . . ." (Lewis, Perry, & Friedkin, 2011).

In addition to building teachers' knowledge, collaboration can build shared professional norms and motivation. Richard F. Elmore (1996) makes the case that U.S. education suffers not from inadequate supply of good educational programs but from inadequate demand for them on the part of practicing teachers: "The primary problem of scale is understanding the conditions under which people working in schools seek new knowledge and actively use it to change the fundamental processes of schooling" (p. 4). In a lesson study community, it is not unusual for teachers to take initiative to build, test, refine, and spread instructional improvements through their collegial networks. For example, educators in the Silicon Valley Mathematics Initiative lesson study network developed and spread a technique called *reengagement*, that presents strategically selected examples of student work from a prior lesson for students to analyze to reengage in thinking about a topic for which student thinking is fragile or problematic (Lewis et al., in press). Reengagement addresses a persistent problem of practice—how to make students' thinking visible and available for close examination. So it is not surprising that teachers have taken the initiative to develop the reengagement strategy and spread it across the boundaries of classrooms, schools, and districts.

Although some teachers manage to invent such techniques on their own, many more teachers could probably learn them if they had systematic opportunities to learn from colleagues. In addition to lesson study, another example of a collegial, practice-based learning structure is the NWP, a network that has grown from one site in 1974 to almost 200 sites across all 50 states today and includes explicit attention to building collegial networks, practice-based learning (e.g., demonstration lessons), and use of research-based resources (Gallagher et al., 2011; NWP, 2010).

What Happens When U.S. Teachers Have These Three Supports for Learning?

School-based lesson study, in which all teachers at a school conduct lesson study around a shared research theme chosen by the staff, is rare in the United States (see, for example, Lewis & Hurd, 2011). One U.S. elementary school case shows that, over an initial 3-year period of schoolwide lesson study, teachers increasingly drew on external intellectual resources (e.g., research, local experts) and internal resources (e.g., each other's practice, student thinking), and that students' standardized test scores in mathematics increased at nearly 3 times the rate of the district as a whole (Lewis, Perry, Hurd, & O'Connell, 2006; Perry & Lewis, 2010). Analysis of discourse in selected lesson study groups in years 1 and 3 of the schoolwide effort indicates that teachers increased their focus on student thinking and student work (from 18% of statements in year 1 to 43% in year 3) and decreased their use of global and fixed-ability evaluations (from 8% in year 1 to less than 1% in year 3).

Recent results from a quasiexperimental study and a randomized-controlled trial conducted by our team (Perry, Lewis, Friedkin & Baker, 2012; Perry & Lewis, 2011; Perry & Lewis, under review) also find that lesson study supported by mathematical resources increases teachers' and students' mathematical knowledge. Small teams of teachers conducted lesson study on a selected mathematical topic (area of polygon, proportional reasoning, or fractions), using translated excerpts from the Japanese teacher's manual, as well as other mathematical resources (e.g., mathematical tasks to solve and discuss). Participating groups organized themselves locally and applied to participate, and our staff provided little guidance other than to design and send out the mathematical resources along with a suggested process for conducting lesson study. As the quantitative findings are under review, they will not be presented here, but across studies they indicate an impact of lesson study with mathematical resources on teachers' mathematical knowledge for teaching (on established and/or project-developed or established measures), on teachers' beliefs (such as perceived efficacy to influence student learning and collegial learning effectiveness), and on student learning itself (looked at only in one study). In other words, a focus on improvement of teaching improved not only student learning but also teachers' knowledge and efficacy beliefs. Some excerpts from the teachers' written reflections on lesson study illuminate the power of collegial, practice-based work and the ripple effects beyond a single research lesson.

> I . . . realized that students have many misconceptions about fractions. We never would have understood how many misconceptions there were if we hadn't done this lesson and had extra eyes to observe this lesson and gain that insight. [10-556]

> Since the lesson study I have been much more aware of the ways in which I tend to focus too much on completing the activity or playing the game, and my math teaching has become more purposeful and focused as a result. [5-739]

> I was surprised at how many students in each class, including my own, did not successfully complete the objective of the lesson. This made me think not only about math, but about how often students do not understand what is being taught in other subject areas as well. Having the opportunity to observe students in class, examine their work afterwards and discuss it was also valuable because we typically do not operate like that, but the knowledge we gained from that process was critical and worthy of our time. [15-620]

> I need to spend more time at considering the lessons I plan from the perspective of my students. I need to put myself in their shoes. (ID No. 312)

Final Thoughts

Supporting Teachers' Motivation for the Ongoing Work of Improving Teaching

Discussions about improving teaching often neglect teachers' motivation or conceive of it only in terms of extrinsic rewards (e.g., monetary bonuses for student performance). Improving teaching requires ongoing effort, as teachers try out new approaches, observe the effects, and refine their strategies. What motivates teachers to continue this "steady work?" (Elmore & McLaughlin, 1988). The satisfaction of seeing students learn and the identity and support gained as part of a professional community devoted to improvement are, we think, two powerful and sustainable sources of motivation that are often neglected by current policy and research. Theories of motivation suggest that intrinsic motivation is fostered in contexts that meet three basic human needs: *agency* or self-determination, *competence* (developing skill at tasks one values), and *human connection* (belonging, in mutually valued relationships; Deci, Koestner, & Ryan, 2001; Deci & Ryan, 1985). Contexts that meet these needs elicit persistent, high-quality, self-sustained work, rather than perfunctory work that is designed primarily to meet minimum standards and fades when external pressure or rewards are not salient. Well-designed lesson study (and other forms of teacher-led learning) provides opportunities for practitioners to experience *agency* as they choose the topic to work on and the methods to improve its teaching, *competence* as they improve skills directly applicable in their classroom teaching, and *human connection* as they work on "our" lesson for "our" students, in a professional community that expects and values contributions from every member.

How Can We Build Attention to All Three Conditions?

We know of few U.S. sites where collegial, practice-based learning, using high-quality instructional materials, is routine. Simultaneous, close attention to all three conditions is needed, we think, for teachers to be able to improve teaching. So how can these three conditions be established more broadly? The good news is that public research lessons are a natural way to spread improvements in practice, and lesson study networks in several regions of the United States now regularly hold public research lessons (e.g., http://www.svmimac.org/lessonstudy.html, http://www.harlemvillageacademies.org/pages/pd2/, http://www.lessonstudygroup.net/, http://www.scoe.org/pub/htdocs/lesson-study.html). The teacher-led growth of these networks suggests a powerful potential for spread that has not been systematically tapped, or noticed, by many policy makers.

In Japan, lesson study is strongly linked to national and local policy through a system of small grants to schools to study a teaching innovation and share their work through public research lessons (Lewis, 2010). For example, during the 2 years before solar energy would become a new part of the elementary science curriculum in Japan, hundreds of Japanese schools applied to become designated research schools to develop materials and strategies for teaching solar energy. Often working in collaboration with university-based educators, they tested approaches through lesson study, culminating in public research lessons attended by tens of thousands of educators, policy makers, and researchers. Through these activities, knowledge about how to teach solar energy spread rapidly across the country—knowledge about the practical aspects (such as which toys best make key ideas visible), the student thinking to expect, and the scientific content itself. In addition, policy makers who attended the public research lessons could see how teachers and students were enacting the new curriculum.

When we have pitched a similar idea to U.S. funders—to use lesson study to build and spread knowledge about implementation of the Common Core Standards—we have been rebuffed on the grounds that model lesson plans and model lesson videos are already being developed, and that these will be safer than having teachers "mess around" with a lesson that is already well designed. This reaction suggests an insufficient grasp of the actual classroom experimentation needed to master a new approach. We would not expect surgeons or tennis pros to learn just from books or videos, and we should not expect teachers to learn without actual practice and feedback from colleagues.

Too many policies assume that teaching can be improved by weeding out low-performing schools or teachers without changing substantially the opportunities that all teachers have to learn. It is time to change that.

Authors' Note

Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the funders.

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References

Ball, D. L., & Cohen, D. K. (1996). Reform by the book: What is or might be the role of curriculum materials in teacher learning and instructional reform. *Educational Researcher, 25*(9), 6-8.

Ball, D. L., Sleep, L., Boerst, T. A., & Bass, H. (2009). Combining the development of practice and the practice of development in teacher education. *Elementary School Journal, 109*, 458-474.

Darling-Hammond, L., Wei, R. C., Andree, A., Richardson, N., & Orphanos, S. (2009). *Professional learning in the learning profession: A status report on teacher development in the United States and abroad*. National Staff Development Council (NSDC) and the School Redesign Network at Stanford University.

Deci, E. L., Koestner, R., & Ryan, R. (2001). Extrinsic rewards and intrinsic motivation in education: Reconsidered once again. *Review of Educational Research, 71*, 1-27.

Deci, E., & Ryan, R. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.

Elmore, R. F., & McLaughlin, M. W. (1988). *Steady work: Policy, practice and the reform of American education*. Santa Monica, CA: RAND.

Elmore, R. F. (1996). Getting to scale with good educational practice. *Harvard Educational Review, 66*(1), 1-26.

Gallagher, A., Woodworth, K. R., Bosetti, K. R., Cassidy, L., McCaffrey, T., Yee, K., . . . Penuel, W. (2011). *National evaluation of writing project professional development*. Menlo Park, CA: SRI International.

Grandau, L. (2005). Learning from self-study: Gaining knowledge about how fourth graders move from relational description to algebraic generalization. *Harvard Educational Review, 75*(2), 202-221.

Grossman, P., Hammerness, K., & McDonald, M. (2009). Redefining teaching: Re-imagining teacher education. *Teachers and Teaching: Theory and Practice, 15*, 273-290.

Hironaka, H., & Sugiyama, Y. (2006). *Mathematics for elementary school, grades 1-6*. Tokyo, Japan: Tokyo Shoseki. Available from www.globaledresources.com

Lampert, M. (2001). *Teaching problems and the problems of teaching*. New Haven, CT: Yale University Press.

Lewis, C. (2010, September 15). A public proving ground for standards-based practice. *Education Week, 30*, 28-30.

Lewis, C., & Hurd, J. (2011). *Lesson study step by step: How teacher learning communities improve instruction*. Portsmouth, NH: Heinemann.

Lewis, C., Perry, R., & Friedkin, S. (2011). Using Japanese curriculum materials to support lesson study outside Japan: Toward coherent curriculum. *Japanese Journal of Educational Research, 6*, 5-9.

Lewis, C., Perry, R., Friedkin, S., Fisher, L., Disston, J., & Foster, D. (2012). Learning to use student thinking: Development and spread of "re-engagement" strategies through lesson study. In J. Bay-Williams & W. Speer (Eds.), *Professional collaborations in mathematics teaching and learning: Seeking success for all* (74th Yearbook; pp. 245-258). Reston, VA: National Council of Teachers of Mathematics.

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.

Lewis, C., Perry, R., Hurd, J., & O'Connell, M. P. (2006). *Lesson study comes of age in North America*. Phi Delta Kappan, December 2006, 273-281.

Lewis, C., & Tsuchida, I. (1997). Planned educational change in Japan: The case of elementary science instruction. *Journal of Educational Policy, 12*(5), 313-331.

Lewis, C., Tsuchida, I., & Coleman, S. (2002). *The creation of Japanese and U.S. elementary science textbooks: Different processes, different outcomes National standards and school reform in Japan and the United States*. Columbia University, NY: Teachers College Press.

Linn, M., Eylon, B., & Davis, E. (2004). The knowledge integration perspective on learning. In M. Linn, E. Davis, & P. Bell (Eds.), *Internet environments for science education* (pp. 29-46). Mahwah, NJ: Lawrence Erlbaum.

Maletsky, E. M. (2002). *Harcourt math California teacher's edition*. San Diego, CA: Harcourt School Publishers.

Matsuzawa Elementary School. (2011). *School research report by the Matsuzawa Elementary School*. Retrieved from http://www.impuls-tgu.org/cms/uploads/File/resource/MatsuzawaLeafletDec12011.pdf

National Writing Project. (2010). *Writing project professional development continues to yield gains in student writing achievement*. Retrieved from http://www.nwp.org/cs/public/print/resource/3208

Peng, A. (2007). Knowledge growth of mathematics teachers during professional activity based on the task of lesson explaining. *Journal of Mathematics Teacher Education, 10*(4-6), 289-299.

Perry, R., & Lewis, C. (2010). Building demand for research through lesson study. In C. E. Coburn & M. K. Stein (Eds.), *Research and practice in education: Building alliances, bridging the divide* (pp. 131-145). Lanham, MD: Rowman & Littlefield.

Perry, R. R., & Lewis, C. C. (2011). *Improving the mathematical content base of lesson study summary of results*. Retrieved from http://www.lessonresearch.net/IESAbstract10.pdf

Perry, R., & Lewis, C. (2012). *Randomized trial of lesson study with mathematical resources: Measuring the impact on fractions knowledge.* Manuscript submitted for publication.

Perry, R., Lewis, C., Friedkin, S., & Baker, E. (2012). *Building a knowledge base for teaching: Design and test of research-based toolkits for lesson study.* Retrieved from http://www.lessonresearch.net/NSF_Abstract_01.25.11.pdf

Remillard, J., & Bryans, M. (2004). Teachers' orientations toward mathematics curriculum materials: Implications for teacher learning. *Journal for Research in Mathematics Education, 35*(5), 352-388.

Schorr, R. Y., & Koellner-Clark, K. (2003). Using a modeling approach to analyze the ways in which teachers consider new ways to teach mathematics. *Mathematical Thinking and Learning, 5*(2-3), 191-210.

Stigler, J. W. (2010). *Needed: Fresh thinking on teacher accountability. Education week*. Retrieved from http://www.edweek.org/ew/articles/2010/06/09/33stigler_ep.h29.html

Stigler, J. W., & Hiebert, J. (1999). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom*. New York, NY: Summit Books.

Takahashi, A., Watanabe, T., Yoshida, M., & Wang-Iverson, P. (2005). Improving content and pedagogical knowledge through kyozaikenkyu. In P. Wang-Iverson & M. Yoshida (Eds.), *Building our understanding of lesson study* (pp. 77-84). Philadelphia, PA: Research for Better Schools.

Ticha, M., & Hospesova, A. (2006). Qualified pedagogical reflection as a way to improve mathematics education. *Journal of Mathematics Teacher Education, 9*(2), 129-156.

Tokyo Shoseki Co. Ltd. (2000). *Atarashii sansuu: Kyoushiyou shidousho kenkyuuhen* [New mathematics: Teachers guide, research volume]. Tokyo, Japan: Tokyo Shoseki.

What Works Clearinghouse. (2009). *Intervention: University of Chicago school mathematics project (USCMP) algebra*. U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, What Works Clearinghouse.

What Works Clearinghouse. (2010). *Intervention: Carnegie Learning Curricula and Cognitive Tutor® Software*. U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, What Works Clearinghouse.

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