

Lesson Study: A Professional Development Model for Mathematics Reform

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In this action research report 4 teachers and 1 teacher educator use the Japanese lesson study model of professional development for 15 months in rural Carlinville, Illinois. In March 2001, 4 teachers identified a goal to improve their students' understanding of two step word problems in 2nd grade elementary mathematics. Teachers completed three cycles of researching, planning, teaching, evaluating and reflecting. They were motivated, empowered, and found lesson study effective professional development in their rural setting. It focused on the classroom lesson; provided an effective lesson plan and hours of focused professional development; supported attempts to put into practice best professional knowledge of reform mathematics; and developed a professional community among them.

Recent mathematics reform efforts attempt to unite mathematicians, math educators, administrators, and teachers to focus on two clear goals: (a) to increase mathematical knowledge of teachers, and (b) to improve methods of teaching mathematics. In 2001, the Conference Board of the Mathematical Sciences published their report, *The Mathematical Education of Teachers* (2001), emphasizing the significance of high quality mathematical preparation by teachers in all levels of school mathematics. A year earlier, *Before It's Too Late: A Report to the Nation* from the Glenn Commission (also known as the National Commission on Mathematics and Science Teaching for the 21st Century), identified the solution to the problem of students' low achievement in mathematics as "better mathematics and science teaching"(National Commission on Mathematics and Science Teaching for the 21st Century, 2000, p.7). To achieve this goal they advocated stronger initial teacher preparation and "sustained, high quality professional development" (p.5), which they believe can be facilitated by, among other strategies, "building- and district-level Inquiry Groups ...for teachers to engage in common study to enrich their subject knowledge and teaching skills"(p. 8).

How can those responsible for professional development in rural areas follow through on such recommendations while facing additional challenges like geographic isolation from large numbers of colleagues and remoteness from specialist professional development opportunities? In this paper, we, four rural elementary teachers and one teacher educator, will first introduce ourselves and our methods and then describe one model for "inquiry groups" --the Japanese "lesson study" model. We then share our 15 month long

experience conducting lesson study in rural Carlinville, Illinois, before concluding with some discussion of the strengths of the lesson study model for rural education. We believe lesson study offers a way to systematically address many of our professional development needs.

Introductions and Methodology

In January 2001, a teacher education faculty member at the nearest state university, taught a graduate math education class on-site at a public elementary school in Carlinville, Illinois, 50 miles from the university. Carlinville, with a population of 7000, is the seat of Macoupin County in west central Illinois. As such, it is the prosperous center of a largely poor agricultural region. Lesson study was introduced as a small part of that class, and that is how these authors came together to work on this project.

As classroom teachers we represent a profile characteristic of one part of the rural teaching force – stable, hard working, experienced professionals thoroughly embedded in the lives of our communities. We have lived and taught in Carlinville for between 10 and 25 years. Our own mathematical education, mostly in rural schools, was dominated by traditional memory and drill work. One of us particularly enjoyed this approach and was successful through high school, whereas the other three reached a point in junior high or high school where mathematics lessons left us confused, anxious, or bored. Notwithstanding our responses as learners, our own math teaching began by replicating the traditional methods the four of us had experienced. But as serious professionals we began to make

changes, and with the help of new textbooks and workshops our teaching began to include connections to literature, use of manipulatives, and integration of writing activities. Change was difficult. Attempts to break away from the text and allow for more discussion and open-ended problem solving work seemed to conflict with the need to cover the curriculum. Pressures of standardized testing kept us from straying too far from our set curriculum. We were generally satisfied with our mathematics teaching prior to taking the graduate course and we did not always think deeply about our teaching. However, we were intrigued by the idea of lesson study and decided to take this on as a class project.

Our work as a lesson study group of four began in March 2001 and continued through May, 2002. To document this systematic inquiry into improving classroom practices we used an action research approach (McNiff, 1988; Elliott, 1991; Mills, 2000). Carefully recorded field notes, meeting summaries, video recordings, and interviews provide the data points for this paper. We write here in a way that includes our collective and individual voices as our narrative of experience (Riessman, 1993; Richardson, 2000), recording some of the richness of our learning about lesson study. The writing was a joint effort reflecting an iterative cycling between university and school personnel that was collaborative and mutually supportive; however, the lesson study work was done exclusively by the four of us, who are currently 2nd and 3rd grade classroom teachers. We hope we will entice, educate, and stimulate other groups to try this approach. We should add that our understanding of lesson study is deepening all the time but we do not consider ourselves experts, and this paper is not intended to be a definitive statement of the process.

What is Lesson Study?

Lesson study is one component of a system designed for continual professional development in Japan. Introduced to a United States audience during the last 3 to 4 years, the most widely read source on the model is Stigler and Hiebert's *Teaching Gap* (1999), although other scholars are also engaged in independent research on the topic (Fernandez, Chokshi, Cannon, & Yoshida, In press; Lewis & Tsuchida, 1998; Lewis, 2000; Yoshida, 1999). In Japan, lesson studies are either done by teachers across a district, or by teachers within a school. The topic for the lesson study is chosen by the teachers but is linked to larger national, district, or school goals. For example, as part of a goal to improve children's independent problem-solving, teachers may work on a lesson study topic of subtraction with regrouping. Teachers, usually of the same grade level, meet weekly to design, teach and evaluate one research lesson. Their next steps are to revise the lesson, reteach it, evaluate, reflect on the lesson again, and share their results. This process may take up to a year. Stigler and Hiebert (1999) noted that lesson study empowers individual teachers and leads to steady incremental improvement in teaching, rather

than fast reform which is often the unachieved goal of American approaches to change. Stigler and Hiebert (pp. 112-116) summarize lesson study through an eight step problem-solving process, although others divide this process differently (Lewis & Tsuchida, 1998). The next section of the paper describes our work as we proceeded through each of these steps.

Lesson Study in Carlinville

Preparation for Lesson Study

Having chosen to participate in lesson study as part of the graduate class, our group of four set to work. Initially, readings from our graduate class about Japan (Stigler & Hiebert, 1999) and interviews from China (Ma, 1999) made us feel defensive. As experienced teachers who are typically American in outlook, we found the idea that schools and teachers in other countries might be doing a better job teaching mathematics than we were a bit disturbing. As we pursued our study we began to focus on the ideas presented in *The Teaching Gap* (Stigler & Hiebert, 1999).

One aspect of the book that took us some time to accept was the authors' description of teachers in a culture as "homogeneous." We had assumed that the personality of a teacher was what made the difference in a classroom and that the four of us had very different and distinct teaching styles. What we eventually realized, however, was that we were confusing personality with teaching style. Despite our different personal characteristics, we found our teaching styles were more similar than we had expected, in such ways as how we plan our lessons and our expectations of students. Even more interesting to us was the fact that our teaching styles were very similar to the way we were taught as students, despite our belief that we had made significant changes in our math teaching throughout our careers. What we realized was that consistently we have been involved in superficial changes that did not bring about true reform. As Stigler and Hiebert (1999) described, "American mathematics teaching is extremely limited, focused for the most part on a very narrow band of procedural skills" (p. 10). After struggling with this concept for many months, we agreed that, "teaching is a cultural activity [and that] we learn how to teach indirectly, through years of participation in classroom life, . . . largely unaware of some of the most widespread attributes of teaching in our own culture" (p.11).

As we continued our dialogue, we came to the realization that Stigler and Hiebert's portrayal of teaching in the United States as limited was a fair representation. However, although we could see the need for change, the idea of spending an entire year focused on one lesson, as recommended in the lesson study literature, seemed impossible. We seriously doubted that real change could take place by studying just one lesson over such an extended period of time, but we were willing to try.

Step 1: Defining the Problem

The first step of lesson study is to decide on a general goal. Over the years, we have found two-step word problems to be both difficult to teach and confusing for many second and third grade students. Typically when we taught two-step word problems in our classrooms, we expected the students to follow steps we designed in a specific order. We decided to use lesson study to shift our methods to better take into account what we had been learning about mathematics teaching and learning. Hence, our goals for our lesson study were: (a) to allow students to do their own thinking and design their own way of solving a two-step word problem; (b) to give students time to share their math thinking with their classmates; and (c) to listen to our students' math thinking and become more flexible in our approaches to teaching two-step word problems.

Step 2: Planning the Lesson

Having decided on the general goal, we moved on to plan the specific lesson we would teach. In March of 2001 we naively expected that it would take about twenty minutes at most to produce a written plan. We joked about the readings' description of Japanese lesson studies lasting an entire year when we could surely produce the same results in a mere fraction of the time. This turned out to be American efficiency--and arrogance--at its finest! An hour and a half into that initial meeting we were still talking math, and we haven't stopped since. We have met regularly, about once a week for the last 15 months, with the sole purpose of discussing this project as well as its implications beyond our own classrooms.

The decision about exactly what lesson to present was, of course, the primary topic of discussion at those early meetings. We spent much time narrowing our focus to one simple problem, a difficult task when we have been accustomed to assigning entire worksheets from a text containing ten or fifteen of those same types of problems. It heightened our awareness that more is not necessarily better, and that one problem in depth could be far more beneficial than a whole page of problems that divide one's attention and effort for the sake of "getting it done." Once we focused on one problem, a two-step story problem, we had further questions. What operations to use in the problem? Should it be printed using numerals or number words? Should the problem use names of our own students and the name of our school to increase interest, or would that sidetrack the easily distracted students?

In addition to the question of what to teach, we discussed many other points, categorized loosely into four groups: logistics, materials, teacher script, and time management. For example, logistics problems included where and when to do the lesson, how to display the problem for the whole group, whether to have the group

gather on the rug or stay at their seats for the introduction, whether to have students bring their papers with their solutions to the rug with them, how to pair them up (teacher's choice or students), and numerous other similar discussion points.

Materials to be used created another set of questions to solve. Do we display the problem on the overhead or white board? Do we hand out individual copies to each student? Do we give them scratch paper, and hand out manipulatives, or simply have them available for whomever would choose them? Would large sheets of Post-It paper be better for recording ideas because it could hang on the board and then be moved as needed and saved? Such questions as these led to an amazing amount of discussion over decisions we all, out of the interest of time-efficiency, were accustomed to making instantly and taking for granted every minute in the classroom.

Time considerations were heavily discussed. How much time to allow for the entire lesson, and for each section of the lesson? Should students have equal time to work independently and with partners? Is five minutes enough time for the independent work, and again for the partner work? Is fifteen minutes long enough for the class to gather and discuss their solutions at the end of the lesson? Should the teacher cut it off when the allotted time is up, or continue as needed for the flow of the lesson?

The teacher script itself was another area of extreme significance. We agonized over the exact words the teacher would use, and over how necessary it was to even script it so closely. We debated over whether the teacher should read the problem, or whether the students should read it on their own. We eventually decided to do both, which is what we would normally do in the classroom anyway. Should the teacher give clues as students worked? Should she answer questions as she circulated, or just encourage students to keep thinking? Sometimes we simply said we'd just try it one way and change it later if we needed to--which of course is exactly what lesson study is all about! At times we made it harder than it needed to be, probably because we each, in our own ways, are perfectionists, and we wanted to do it "right" the first time. We eventually learned to accept the fact that it was okay to leave room for improvement in the re-teaching, which helped us relax a bit.

Steps 3 and 4: Teaching and Evaluating the Lesson and Reflecting on its Effects

With the lesson planned, the next step was to teach and evaluate the lesson, which we completed on March 27, 2001. Shari taught the lesson using the following story problem: "A South School 2nd grade class has been studying about ocean life. They will be taking a field trip to the aquarium. The class will be divided into six groups. Each group has 3 girls and 2 boys. How many more girls than boys are going?" Karen, Mary Kay and Chris observed, took careful notes, and video-taped the lesson to supplement the

observations. A video recording cannot adequately capture much of what happens in a classrooms, but it did provide a helpful additional source of data for us, particularly as we studied the solutions students shared publicly to the class. Our colleagues covered our classes to enable us to do observe the lesson. We met and discussed our observations immediately after the lesson.

Step 5: Revising the Lesson

We had completed the first four steps of the lesson study process during Winter and Spring semester. With school back in session in August 2001, we moved on to Step 5, which was to revise our original lesson. We began meeting once a week again, reviewing what we had done the previous winter and spring, and planning our reteaching. We felt that we had put so much thought and care into our first scripting of the lesson that we didn't think we would be able to find anything that needed changing for the re-teaching of the lesson. Hah! All it took was one initial question: "Are we going to re-teach the lesson to the same students as last winter, or to our new group of second graders?" and others flowed like syrup on a hot cake! If we teach it to the same students, how many will remember--or *will* they remember?--not so silly a question, knowing some of our students! If we teach it to the same students, how should we change the problem? Keep the same story but change the numbers? Change the story but keep the same numbers and operations? And if we teach it to our new second graders, it will be six months earlier in the year than our first attempt. How do we account for that difference ?

What we returned to again and again was this question: What is the purpose of our lesson study? Is it to show growth in our students? Is it to test their ability to follow our directions, to do the thinking, to come up with correct solutions? Or is our purpose at this time to refine our own attempts to provide work that is challenging, thought-provoking, and able to develop mathematical thinking. With that question in mind, we made some minor adjustments to the lesson, shifting the time frames involved in each part of the lesson, the way manipulatives were to be used, and our observation methods. We also added a written student reflection.

Steps 6 and 7: Teaching the Revised Lesson and Evaluating and Reflecting Again

In October, we completed the final steps in Stigler and Hiebert's eight step model for lesson study. Shari retaught the lesson on October 4, 2001. Once again, Karen, Mary Kay and Chris observed and took notes. As we evaluated this second teaching we came up with even more changes we would make upon a third teaching of the lesson. This was an epiphany of sorts for the four of us, as we began to realize somewhat sheepishly that the more we teach it, the

more we find room for improvement—a far cry from the original "American efficiency" agenda we joked about earlier! As our understanding of lesson study grew, we also realized that rather than having the observing teachers circulate and interact, the lesson study process is designed to enable the teachers to do just the opposite – to stay separate from the concerns of the lesson and carefully observe and record what is happening.

From February 2002 through May 2002 we repeated the whole process one more time. This time substitute teachers taught our classes, and we had the benefit of observations and comments from a mathematics educator (Ann) as well as a university mathematician. This significantly enriched our learning. We also understood more clearly the benefits of a detailed lesson plan that included our goals and predictions for students' responses to the problem. This enabled us all to take more detailed observation notes during the lesson, which supported a more thorough debriefing session. As we repeated the lesson study process, we continued to learn more about our teaching, and more about the lesson study process.

Discussion

The lesson study model focuses on one of the areas recommended for math reform, the professional development of teachers, and is one version of an "inquiry group" recommended by the Glenn Commission (National Commission on Mathematics and Science Teaching for the 21st Century, 2000) as a way to improve mathematics teaching. However, providing effective professional development for teachers is a challenge in any setting, urban or rural. We recognized, as a result of our experience with lesson study, that our previous years of professional development, while helpful, had not led us to significantly change our mathematics teaching from what we ourselves had experienced in school. However, through our version of the Japanese lesson study model, we identified a significant number of benefits.

1. Meeting regularly to plan and teach a research lesson focused on an identified classroom need (improving our teaching of two-step word problems) resulted in an **effective detailed lesson plan** that to a large extent achieved its goal of more effective student learning.
2. The lesson study model provided a **highly motivated structure for planning and teaching a lesson** in which we talked for hours about subject matter, curriculum, research, materials, logistics.
3. Given time to reflect and think in the company of other teachers, we were able to **share, interact, question assumptions, and reassess common practices** in light of our best professional knowledge. This enabled us to

- align our practice more closely with this professional knowledge base.
4. Observing a lesson enabled us to **shift our thinking from a teaching focus to a learning focus** as we recorded and puzzled over our students' mathematical thinking. As observers, we were free to be focused on the actual work the students were doing and the thought processes involved.
 5. Focusing on student thinking provided us with more **feedback to support the goals of reform mathematics that** we had been trying to implement. For example, when we added an opportunity for students to write a journal response to the lesson. We were reminded of the importance of really listening to our students. Challenging students, giving them time to solve the challenge, listening to their thinking, allowing them time to share their thinking verbally and in writing takes time, time that we often feel we don't have as we push to complete our given curriculum.
 6. Lesson study has **transformed our working relationships** and conversations with each other. In addition to what we learned about mathematics teaching, we found that lesson study has shifted our paradigm completely.

Overall, the lesson study process has empowered and motivated us. Rather than hearing from an outside expert about an ideal situation or a "new method", we have been able to shape our own professional development according to our interests and needs, albeit provoked and guided by research (Ma, 1999; Stigler & Hiebert, 1999). We experienced an immediate impact on our thinking and teaching as we talked and worked with colleagues in our school.

In spite of our success with lesson study, we identified four areas of concern about the use of lesson study in American schools. First, the more we worked on what appeared to be empowering, significant professional ideas for our classroom, the more frustrated we felt about the extent to which our professional lives are controlled by external mandates, many of which act counter to the best learning interests of students and the best practices of teachers. Second, the process of shifting our focus from traditional practices to considering new ideas was at times very difficult. Third, understanding the goals of lesson study took time and experience. There were obstacles and we were learning as we went through the process. Finally, administrative support is necessary for lesson study. Although we managed with the help of our colleagues for the first and second lesson teaching, we would strongly recommend having substitute teachers for the day the lesson is taught. This allowed us to really focus on the lesson study and engage fully in the debriefing session afterwards.

To us, as experienced teachers and a teacher educator, lesson study seems very suitable for rural settings because it does not require a complex or expensive infrastructure, either in terms of resources (texts, manipulatives) or personnel. It requires only a group of teachers talking and thinking together. Conversation can be stimulated through the discussion of books, such as The Teaching Gap (Stigler & Hiebert, 1999) or Knowing and Teaching Elementary Mathematics (Ma, 1999). Supporting materials, videos, and discussion groups are available on the web (see websites), thus enabling rural communities to collaborate with others. The stability of the teaching force and the strong social relationships which often exist in rural areas provides a ready foundation for the close work this model orchestrates. Teachers can extend these existing relationships into systematic professional exchanges. Our case demonstrates how veteran teachers who already "know" a lot, can be reenergized and refocused by using this model.

Clearly, no one single event brings reform to mathematics teaching. However, the lesson study model provides a structure within which small changes gather and flow together to become the substance of new conversations and discussions. Over time, these small changes add up to significant changes in classroom practice. The lesson study structure enabled our group of experienced teachers to engage in significant professional development with a minimum of resources. Lesson study seems to offer possibilities for rural educators to use the resources they already have to further reform elementary teaching of mathematics.

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