A Study of Japanese Lesson Study With Third Grade Mathematics Teachers in a Small School District

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This paper describes implementation of a Lesson Study project with third grade teachers in a small school district to study the development of the critical lenses (perspectives) necessary for meaningful lesson study work. Adapting the Lesson Study process to meet school system needs, two outside facilitators stimulated teacher thinking with math explorations and probing/what if questioning. Using a qualitative methodology and the group as the unit of analysis, data were coded for evidence of and change in the lenses. After one year, the 8 participating teachers showed a qualitative difference in two of the three lenses: the student lens and the curriculum developer lens.

Responding to the plethora of research from cognitive science on learning (Siegler, 2003), much of the reform effort in mathematics education in the United States has focused on changing the way mathematics teachers practice their profession in K-12 classrooms. Spearheading this effort in the U.S., the National Council of Teachers of Mathematics (NCTM) has provided a framework for change (NCTM, 2000). Books have been published (Fennema & Nelson, 1997; Heaton, 2000; Stigler & Hiebert, 1999), major teacher enhancement projects have been implemented (Cognitively Guided Instruction, the Atlanta Math Project, Summermath for Teachers), significant curricula have been developed (Mathematics in Context/Wisconsin, Everyday Mathematics/Chicago, Connected Mathematics / Michigan State) and, most importantly, a considerable amount of research has been conducted on the process of teacher change both inside and outside the U.S. (e.g., Borko & Davinroy, 2000; Campbell, 1996; Chapman, 2002; Clarke & Hollingsworth, 2002; Hart, 2002; Llinares, S., 2002; Smith-Senger, 1998/1999). Even with all this, many mathematics classrooms remain numbingly the same. Teacher-directed activities and lecture are frequently the primary delivery models for instruction. As a result, researchers continue to search for better understanding of the process of change and for models that support significant and lasting change in teacher behavior. One model that is gaining interest is Lesson Study, a teacher development process originating in Japan (Lewis, 2002).

After results of the Trends in Mathematics and Science Achievement Study [TIMSS] (Boston College, 1999) showed Japanese students better prepared in mathematics than students in the United States, mathematics educators in the U.S. sought to learn more about the Japanese educational system. Articles and books on Japanese education appeared in the literature (Curio, 2002; Fernandez, Cannon & Chokshi, 2003; Ma, 1999; Watanabe, 2002) and much was learned. Of particular interest was the process for inservice teacher education that is the major form of professional learning for Japanese teachers. The process is called Lesson Study.

The Lesson Study Model

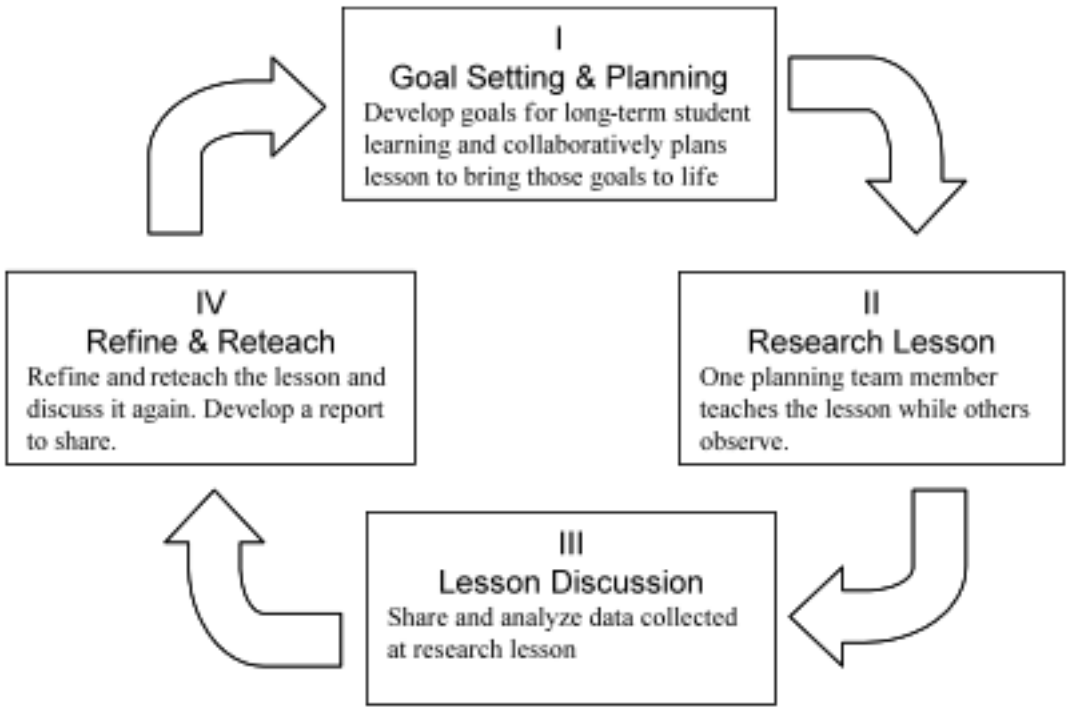
At first appearance Lesson Study is a relatively simple idea. Teachers come together by

grade level, by school, or by district to set goals for their students. They use these goals to collaboratively plan a unit of study, which contains a research lesson (a lesson that will be carefully studied by the group). A teacher from the planning team teaches the research lesson while others observe. The team debriefs on the lesson. Finally, the group rewrites and adapts the lesson making improvements and changes noted during the debriefing, producing a finished document that can be shared by the teachers. Lewis (2002) provides the following figure to illustrate the cycle of experiences (see Figure 1).

The process of Lesson Study is, however, more complex than it first appears. Lesson Study is a comprehensive and well-articulated process for examining practice that engages teachers in setting broad-based educational goals for their students and brings those goals to life in lessons. Lesson Study targets student learning and promotes data-based improvement made from lesson observations. And, perhaps most importantly, Lesson Study values teachers and the knowledge and experience they bring to the table. Lesson Study is about more than producing excellent lessons. It is the experience of collaborative goal-setting, planning, observation and lesson discussion that contributes to the professional growth of teachers.

Significant differences, however, in the curricula and approaches to teacher development of Japanese and U.S. teachers, together with a lack of experience with Lesson Study by U.S. teachers, makes developing and maturing as a productive Lesson Study community a challenging process. The entire national Course of Study for elementary schools in Japan is contained in a 100 page volume which lays out the hours, goals and content for all 12 areas of study (including mathematics), allowing for invention and interpretation of best practice. In contrast, U.S. curricula cover many pages of objectives and skills for each con-

Figure 1
Lesson Study Flowchart



tent area for each grade level, allowing little interpretation for implementation by teachers. Also, teacher development activities that are designed to improve instruction are in stark contrast in the two countries. Lesson Study, the primary model in Japan is a teacher-driven and teacher-directed model. U.S. teachers experience most activities as top-down, outside-expert directed.

Conceptual Framework

This research benefits from the work of Fernandez, Cannon and Chokski (2003). In their study of implementation of Lesson Study in an urban, public school in New Jersey, they found that "substantial challenges . . . must be overcome to make this practice [Lesson Study] purposeful and powerful" (p. 181). In their project, Japanese teachers from a nearby international school collaborated with U.S. teachers attempting to form a Lesson Study community. The research team noticed that the Japanese teachers approached Lesson Study very differently than U.S. teachers. In their analysis of the data they labeled three critical lenses (perspectives) used by the Japanese teachers that guided their development and discussion of lessons. They labeled these lenses as the researcher lens, which teachers use to organize, sequence, and connect learning experiences; the student lens, which teachers use to understand student thinking and examine all aspects of the lesson through the eyes of the student; and, the curriculum developer lens, which teachers use to organize, sequence and connect learning experiences. They suggest that the absence of these critical lenses prevents lesson study discussions from moving into rich arenas and therefore teachers do not benefit fully from the Lesson Study process. These differences are important if Lesson Study is to become a viable model of change in the U.S.

In this project we attempted to encourage the development of the critical lenses identified by Fernandez, Cannon and Chokski (2003) with third grade teachers in a small southern school district and to study the effect of the intervention by looking for evidence of development of the critical lenses.

The School System

The school system in this study is a small urban system in the south with six elementary schools. Thirty-eight percent of their students are on free or reduced lunch. Fifty-three percent are African-American or other minority and 47% are Caucasian. For many years, the system has been proactive in educating its teachers on reform mathematics as advocated by NCTM; however, attrition continuously diminishes the number of teachers who are prepared to teach from a reform perspective. Many of the new teachers, both new to the system and new to teaching, bring a traditional way of thinking about the teaching of mathematics. According to the system mathematics supervisor, the curriculum and text support the philosophy of reform, but a teacher-directed model often remains the primary mode of instruction (district mathematics coordinator, personal communication, March 27, 2003).

The JELS Project

The Japanese Elementary Lesson Study Project (JELS) was supported during the 2003-2004 academic year by a small external grant and funds from the school system. The project was conceived, organized and facilitated by the mathematics coordinator for the school system and a local university mathematics education faculty member.

The Participants

Third grade teachers from the system were asked to participate in JELS. With only two teachers who were new to the system, but not new to teaching at that grade level, and a strong group of experienced teachers, third grade was a relatively stable grade level. Participation was voluntary and eight of the ten teachers opted to participate in the project, representing five of the

six elementary schools. There were two African-American females, one Asian male, and five Caucasian females. Teachers ranged from 3 to 30 years experience in the elementary classroom.

Adapting Lesson Study

In the spring of 2003, the two project facilitators (the system mathematics coordinator and the university mathematics educator) came together to organize the project. It was immediately apparent that they would need to make adaptations to the Lesson Study process as it was described in the literature. There were several issues to be considered.

First, the teachers would have to study and learn about the Lesson Study process. Unlike Japanese teachers who experience Lesson Study as a regular and on-going part of their professional development, U.S. teachers' staff development experiences are usually quite different, following a top-down approach with an expert facilitator. The facilitators also held concerns about the readiness of the elementary teachers for deep, substantive discussions about content and pedagogy with limited prior experience or support. To encourage profound, thoughtful discussion, the facilitators planned to be more active members of the Lesson Study group than described in much of the Lesson Study literature. They would provide scaffolding through prompting comments such as what if and did you notice observations. This was supported by Fernandez, Cannon and Chokshi (2003) when they stated "lesson study . . . must include room for knowledgeable coaches who can stimulate the thinking of groups so they can rise beyond their own limitations" (p.182).

Second, the Everyday Mathematics (EM) Curriculum used in the system did not lend itself to unit planning as outlined in Lesson Study. The EM curriculum is relatively scripted and lessons are sequential and developmental. To accommodate the existing curriculum, the group would develop single lessons to be inserted before topics that were difficult to teach and difficult to learn. The teachers would identify which concepts they felt were most troublesome and develop a lesson to introduce students to each of those concepts.

Third, no common planning time was available for the teachers and numerous after school conflicts prohibited using that time. Out of school time would be necessary and substitutes would be required. Lesson study cycles would need to be compressed over two days (one day to plan the lesson and one day to teach or observe, debrief and revise the lesson.)

Finally, there existed a wide range of mathematical backgrounds of the elementary teachers in the project. To engage in substantive discussions, substantive mathematics needed to be understood. It was decided that the mathematics educator would develop a mathematics activity for each session that would allow the teachers to explore the mathematics concept in the lesson before they planned a lesson for third graders. The exploratory activity would help the teachers become immersed in the concept before they planned the lesson for students.

Summer Sessions

The first of three summer meeting days was held at the beginning of the summer, 2003 to provide an overview of Lesson Study. The teachers observed a video example of a Lesson Study research lesson *Can You Lift 100 Kilograms?* (Research for Better Schools, 2000). They developed group norms for how the group would work together; they developed a common vision of good teaching; and, they developed a list of long-term goals they had for their students. In preparation for the two meeting days in August, the teachers were asked to read Lesson Study: A Handbook of Teacher-led Instructional Change (Lewis, 2002). Finally, they identified the four troublesome topics they wanted to address from Everyday Mathematics, Grade 3. They were addition/subtraction word problems, the language

of probability, compare and order decimals, and fractions (naming parts of the whole).

In August the teachers came together for two days to discuss the book, develop their research theme for the year and to plan the initial research lesson. Over the period of the two days, the mathematics educator and the system mathematics coordinator participated as members of the group, scaffolding teacher thinking as needed with prompting comments. This was not easy as the teachers were not use to being in a professional development activity where they were expected to not only share the authority but also to take the lead. They were not use to being asked to consider what they thought were the important, overarching learning goals for third grade students.

The research theme

The development of the research theme (a shared goal for growth for their students) was the teachers' first deep immersion into the Lesson Study process. The experience took half of the first day. They looked at research themes developed at other sites. They discussed the purpose of a research theme. Finally, they began to brainstorm ideas. They wanted their students to be problem solvers. They wanted their students to be able to work collaboratively with other students and to be respectful to their fellow students and teachers. They wanted their students not to forget what they had learned previously and to be able to use their prior knowledge. The list continued. Finally, they produced a statement which everyone agreed to and would guide their planning for the year. They agreed upon: Third graders will use prior knowledge and critical thinking skills to become problem solvers in mathematics.

Planning the initial research lesson

Planning the research lesson consumed all of the second day. The process began with the mathematics educator facilitating a discussion on the mathematics that would be the center of the research lesson on thinking models for addition and subtraction word problems as introduced in Everyday Mathematics (joining, separate, part/part/whole, and comparison). After the activity, the teachers examined existing Everyday Math curricula and materials, shared ideas from their own classrooms, and collaboratively worked on developing a lesson. Again, this was a difficult process. These teachers had never formally shared pedagogical knowledge, negotiated teaching strategies and discussed student learning and outcomes with colleagues. A teacher might present an idea that was not well received by the group. Group norms had to be constantly revisited. How will we deal with differing opinions? How will we decide which strategy to use?

The teachers were concerned with how much third graders struggle when the addition and subtraction operations are in the context of a word problem. The EM curriculum introduces four models (join, separate, part-part-whole, and comparison), but does not contrast them. The teachers decided to develop one problem for each type of thinking models and have the students discuss the similarities and differences across the problems.

They developed the following problems.

- There were 16 students in Mr. Bob's third grade class. After winter break, he got three new students. How many students are in the class now?
- Mr. Bob had 16 students in his third grade class. three students moved away. How many students are in the class now?
- Of the 16 students in Mr. Bob's class, seven are boys. How many girls are in the class?
- There are seven boys and nine girls in Mr. Bob's third grade class. Of all the students in the class, how many more girls are there than boys?

The teachers chose to use the same basic scenario and similar, simple numbers for the problems because they did not want the students

to get lost in the computation. They wanted the students to focus on the differences in the thinking involved in the four problem types.

They planned for students to be divided into four small groups and each group to have a piece of chart paper divided into four sections. The four problems would be posted at four tables. The students would rotate from table to table with their chart paper and record their work on the problem in the appropriate section of the chart paper. Colored counting chips would be available at each table. When the rotations were complete the four chart papers would be posted on the board and discussed, first across all the solutions for each problem number and then across the four different problem types. Two questions were developed to spot light the comparison. The teacher was to ask: What is alike about the problems? What is different?

As described in the Lesson Study literature, the teachers planned that the observers would not interact with the students. However, there was a good deal of discussion about whether the observers would stay at a table or rotate with a group. Pros and cons for both methods (understanding how all the children thought about one problem versus how one set of children thought about all the problems) were discussed. In the end, the group opted to stay at one table.

Once completed, a typed version of the lesson plan was prepared. The lesson plan included teacher activities and strategies, anticipated student responses and thinking, and points for the observers to notice.

Organizing observation of the initial research lesson. Lesson Study in Japan often results in many teachers being present to observe a lesson. Unlike Japanese classrooms where Lesson Study is the norm, having ten adults (eight teachers and two facilitators) in the room during a lesson concerned the teachers since their students were not use to similar situations. The group decided to amend the process and divide into two teams of four where one teacher would teach the lesson and her three team members and the two coaches would observe. Each team would debrief and revise the lesson after it was taught. The lesson and the debriefing would be videotaped. The other teachers on the team would teach the revised lesson to their class. After everyone on both teams taught the lesson, the group would reconvene after school to reflect on the lessons and to review segments of the videotapes.

Organizing debriefing of the initial research lesson. The group decided on the following debriefing format. They would take a break immediately after the lesson to allow everyone to make notes and collect their thoughts. Once convened, the teacher who taught would begin the debriefing and share his or her observations and thoughts. The observing teachers would then share the data they had collected while observing the children. The facilitators would summarize the discussion, noting themes that emerged. Finally, the lesson would be revised based on observations shared during the debriefing.

School-Year Sessions

Planning for the first research lesson occurred during the last day of the summer meetings. The teaching of that initial lesson occurred three weeks after the school year began. All other planning-teaching-debriefing-revising cycles occurred within 2-3 days period.

Teaching the initial research lesson. When the observers arrived each adult took a chair near one of the student tables. Students were seated on the carpet to receive instructions about the lesson. Groups of four had already been organized. The teacher, Peg, explained to the students that they would have four problems to solve (one at each table) and that the groups would rotate from table to table when directed by the teacher.

The observers remained at a table and took notes as the students rotated. They did not interact with the students. The teacher listened to student discussions, encouraged students, and responded to questions. After all the groups had rotated the teacher put the chart paper from each group on the board and brought the students to the rug to discuss the results.

Debriefing the initial research lesson. The teaching teacher, Peg, began the debriefing. She expressed overall satisfaction with how the lesson proceeded, but acknowledged she was "more nervous than she expected to be" with all the observers in the room. She was concerned about the trouble she had during the final discussion because some of the groups had not put their problems in order on the chart paper, making it harder to see the relationships visually on the board. After she was done, each observer shared his or her observations. The facilitators moderated the discussion so each teacher had a chance to complete his or her observations. After all the teachers had shared their comments, the facilitators raised questions to stimulate further discussion on how the lesson might be revised. They asked:

- How did the assignment of roles impact the groups?
- What do you think about the difficulty level of the problems?
- Did you notice any difference in how the girls and boys interacted in the groups?
- Do you think the organization of the chart paper affected the students' ability to contrast the problems?
- As observers, how do you feel about staying with the problem vs. staying with the group?

None of these questions had been addressed directly in the discussion and were important to motivate teachers to move beyond the limits of their own understanding. After they were discussed and the debriefing ended, the teachers planned the revised lesson. They re-organized the chart paper to encourage the contrasting of problems. They decided not to change the difficulty level of the problems to see if the observation that the problems were too easy was peculiar to this class or would be true across all the classes. They decided to move with the group. No consensus could be reached on gender issues and the use of manipulatives. One teacher volunteered to try using same gender groups with her class and another volunteered to not assign roles, but rather to put chips in the center of the table and see if they were used. At the final meeting the results from these changes would be discussed.

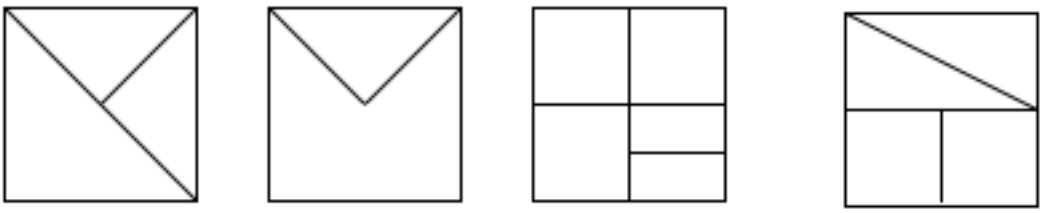
Before closing the debriefing, the facilitator asked if anyone wanted to make a comment or reflect on the process of Lesson Study. Teachers commented on how hard it was to watch and not interact with the children when they were on the wrong track. At the end Peg made a statement that helped to develop the culture of Lesson Study within the group. She said,

> A couple of times during the discussion today I was getting defensive about what was being said, but I realized that everyone was taking responsibility for the lesson, and it wasn't about me, it was about the lesson. It was hard, but I think I understand better about the process and what we are trying to do.

There were four Lesson Study cycles conducted during the school year. The final cycle was the lesson on fractional regions of a whole in which the students were asked to name the fractional part of each region in each square (Figure 2).

Each of the remaining cycles followed the format of the first, i.e., the teachers spent one day planning the research lesson, and one day teaching the lesson, debriefing the results and revising the lesson. Individual teachers taught the revised lesson in their classrooms and shared results with the group.

Figure 2
Figures for Last Lesson Study Problem



Problem 1 Problem 2 Problem 3 Problem 4

Data Analysis

In order to answer the question of whether the group developed the critical lenses (Fernandez, Cannon and Chokshi, 2003) needed to benefit fully from the Lesson Study process, a qualitative methodology was employed using enumerative analysis (Lincoln & Guba, 1985) in which previously defined units or categories are subjected to systematic counting or identification. The first and last cycles were videotaped and carefully supported through field notes. The videos were transcribed and using the group as the unit of study were coded for evidence of a researcher lens (R), a curriculum developer lens (C), or a student lens (S). Since prompting from the facilitators was used to encourage development of the lenses, only discussion prior to the facilitators comments was coded, i.e., discussion prior to prompting. Both the frequency and nature-quality of the comments were noted. For the student lens, coding was made for any comment about students: what they did, what they said or what they appeared to understand. Likewise, any comment about how the lesson was implemented or ordered was coded as curriculum developer lens. Since no evidence of the researcher lens was found on the beginning or the end videos, that lens is not included in the discussion of the results.

Results

Results from analysis of the data show that over the course of the year the teachers' developed qualitatively richer student and curriculum developer lenses. While comments about students were found at both the beginning and the end of the year, the substance of the comments was quite different. Quotes coded as the student lens from the beginning of the year, showed teachers primarily talking about what the students did during the lesson and how they behaved. By the end of the year teachers were commenting on what students appeared to understand about the mathematics and what was confusing them. The teachers began to look at problems through the student's eye, acknowledging what learners were unfamiliar with or struggling with, e.g., 'not having parts shaded-in' and 'unequal fractional regions.' They discussed how the way a problem was presented would impact student thinking. They began to unpack the mathematics in a problem and ponder about how students would approach the different parts.

Changes in the comments coded as the curriculum developer lens also changed qualitatively over the year. Initial comments focused more on how the organization of a lesson or materials aided in management issues so the students would stay on task or not get confused. By the end of the year, comments focused more on how the organization of the lesson supported or hindered student understanding and development of the concept being taught. Not only did the teachers point out specific ideas that were difficult (the use of unequal regions and the lack of any shading), but they made suggestions for how the lesson should or could be changed to scaffold understanding.

A sample of typical comments that were coded in the categories Student Lens (S) or Curriculum Developer Lens (C) from the beginning of the year cycle and the end of the year cycle follow. The comments are presented to provide evidence of the change observed through the analysis of the data.

Table 1
Typical Comments Coded Student Lens: Looking through the eyes of the student

Beginning of the School Year	End of the School Year
• The children were so cooperative. • They responded well. • They listened attentively to responses of the other children. • Only Molly played with the manipulatives in my group. • My group shared the jobs equally. • Megan drew a picture to answer the questions. • My group was very calm and respectful. • I did notice they played with their name tags. • I don't think they noticed the differences in the problems. • Only one boy said "all these are about Mr. Bob" • My boys spoke more than my girls.	• I have down the word denominator in big letters because I really think that the concept of denominator is just hard for them. • I think that when they see that larger region -- that in their minds they put those ones together and make it two-fourths instead of one-fourth and one-fourth. • It's hard for them to jump from the one in the numerator to anything beyond one in the numerator. • India saw it right away -- which was 'this is one-fourth, one-fourth, one-fourth.' When she looked at that large space, she actually saw that. But then Steven said 'there's no line here' so they erased those lines and had their one-fourth, one-fourth, one-fourth but when they went up there to discuss it they said three-fourths instead of really thinking about what the three-fourths meant, they just changed them all to three-fourths. . . . • Briana . . . she just drew that, one-third, one-third, one-third, and so she used her diagonals. • Yeah, at the beginning I thought it was great they said equal a lot, they said one-third because three makes a whole so that made me think -- that child obviously knew denominator • I still don't know if they really know what the denominator represents, though, or they're not there yet. I mean I think they know they can divide things up, but I don't think they know what that denominator really is- and are able to connect that to what they're writing to what the figure is and, and what you're representing with the figure.

Table 2
Typical Comments for the Curriculum Developer Lens

Beginning of the School Year	End of the School Year
• I think your giving an overview of the lesson was helpful. • I think turning over the bags helped so kids wouldn't play. • I am not sure about the manipulatives. They just played with them.	• I wonder about shading. A lot of their history is with shading and the way they've learned to identify parts is by what's shaded. We had no shaded parts and they had to just label from that. • I'm thinking how we could have done #2-- adjusted it to make more sense or was there something we could have worked up to do #2? • Because that did make it more challenging, not being shaded. • I guess it was two things, though, not shading it was trying to get them familiar because they're used to shaded, but also we're giving them a large region, so maybe one or the other would have been good to do for #2. • Or in the large group discussion when you're talking about the thirds, could you shade, two of those thirds, and say 'o.k., well what part of the circle is that?' So then that maybe they could take that piece of the discussion and transfer it to the problem.

Final Discussion

This paper describes development, implementation and teacher change in a Lesson Study project with third grade teachers in a small urban school district. The Lesson Study model was adapted by the facilitators of the project to fit the special circumstances of the system. This decision was supported by the research of Fernandez, Cannon and Chokshi (2003), who stated that adaptations to the Lesson Study process are necessary for U.S. teachers to "move beyond the popularized view that currently exists in the US of lesson study as a completely teacher-led and teacher-run activity" (p. 183). There is no doubt that the differences in curricula and in experience of the Japanese and U.S. teachers impact the successful adaptation of lesson study. However, this study suggests that knowledgeable facilitators can support Lesson Study communities in developing the critical lenses necessary to "push their Lesson Study practice into rich arenas" (p.182). There is room for the active support of external coaches who are knowledgeable about the Lesson Study process and who embrace the values of Lesson Study: a culture of self-criticism, openness to the ideas of others, and willingness to embrace mistakes.

While the U.S. teachers in this study made progress toward developing two of the three critical lenses necessary to benefit from the Lesson Study process, the questions around Lesson Study as a useful professional development model are

still numerous. Clearly there is still much to be learned. Why did the teachers show no evidence of the researcher lens? What was done or not done by the facilitators to prevent its development? What resources are needed to support U.S. teachers in developing the deep content knowledge and pedagogical knowledge needed in a lesson study approach to professional development? How will participation in lesson study impact student learning? Research in this arena is still in its infancy. These questions are just of few that need to be explored as we study the lesson study model of professional development and attempt to implement it with U.S. teachers.

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