"Situating the Learning" of Teaching: Implementing Lesson Study at a Professional Development School

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ABSTRACT: This paper examines how Lesson Study (Lewis, 2002) was used in an elementary mathematics methods course held at a Professional Development School and intended to support pre-service teachers to become reflective practitioners while working alongside clinical faculty. Attention is given to detailing the features of Lesson Study that situates the learning in a job-embedded setting and joint reflection as endorsed by the recommendation for *Clinical Preparation and Partnerships for Improved Student Learning* (NCATE, 2010). Findings highlight how Lesson Study at the PDS site impacted the "multi-tiered" professional development of pre-service teachers and clinical faculty, as they collectively focused on student learning, research, and inquiry. In addition, this article examines how the unique model and outcomes of Lesson Study in a Professional Development School (PDS) enhanced teacher preparation. The study offers a process for teacher educators and Professional Development Schools to use Lesson Study as a collaborative learning structure to promote reflective practice in developing effective teachers.

NAPDS Essential(s) Addressed: #4/A shared commitment to innovative and reflective practice by all participants; #5/Engagement in and public sharing of the results of deliberate investigations of practice by respective participants; #7/ A structure that allows all participants a forum for ongoing governance, reflection, and collaboration; #8/Work by college/university faculty and P–12 faculty in formal roles across institutional settings

Leading advocates of clinically-based teacher preparation programs from colleges, universities, and P–12 schools recently formed the Blue Ribbon Panel on Clinical Preparation and Partnerships for Improved Student Learning and released a report entitled *Transforming Teacher Education through Clinical Practice: A National Strategy to Prepare Effective Teachers* (NCATE, 2010). The Panel calls for clinically-based preparation that fully integrates content and professional coursework around a core of clinical experiences (p. 8). In this report, the Blue Ribbon Panel made five major recommendations: 1) more rigorous accountability and

monitoring of how teacher education programs meet the needs of schools and help improve PK-12 student learning; 2) strengthening candidate selection and placement into schools where candidates are supervised and mentored by effective practitioners, coaches, and clinical faculty; 3) redesigning preparation programs to support the close coupling of practice, content, theory, and pedagogy; 4) supporting partnerships; and 5) expanding the knowledge base to identify what works and support continuous change (NCATE, 2010, p. 4).

This paper reports on an innovative model where university coursework was situated in clinical experience at a Professional Development School (PDS) using the Japanese practice of Lesson Study (Fernandez & Yoshida, 2004; Lewis, 2002; Lewis, Perry, & Murata, 2006; Murata & Takahashi, 2002; Perry & Lewis, 2003; Stigler & Hiebert, 1999), a teacher-led professional development model. We propose that this project demonstrates attributes of the model that the Blue Ribbon Panel Report would define as "the model we need." Specifically, Lesson Study at the PDS site modeled "a partnership of preparation program" that includes university faculty and school-based faculty collaborating to "design coursework and clinical preparation" in tandem so that the translation of knowledge into practice was explicitly demonstrated in a PDS classroom setting (NCATE, 2010, p. 4). Although several studies have focused on using Lesson Study in a mathematics methods course (Burroughs & Luebeck, 2010; Fernandez & Yoshida, 2004; Marble, 2006; Parks, 2009), these studies have not focused on embedding Lesson Study within a Professional Development School program. Our study proposes a model that uses Lesson Study as a *sustainable* feature of Professional Development Schools that not only focuses on pre-service teacher development but supports the four missions of PDSs: teacher development, professional development, student learning, and collective inquiry and research (NCATE, 2000).

Theoretical Framework

Situated Learning, Reflective Practice and Lesson Study

Research has shown that teachers engaged in collective inquiry on their teaching and content knowledge provides one of the most effective forms of experiential learning and supports the adoption of new instructional practices (Desimone, 2009; Porter, Garet, Desimone, & Birman, 2003; Putnam & Borko, 2000). Situating professional learning in classroom contexts adheres to the model of learning that Lave and Wenger (1990) call *situated learning* where learning takes place in the same context in which it is applied and takes place through participation in a *community of practice* (Putnam & Borko, 2000). Developing reflective practice is one of the key dispositions and characteristics of effective career educators. Multiple opportunities for reflection are needed to build teachers' capacity for critical reflection.

Lesson Study (Lewis, 2002; Lewis, Perry, & Murata, 2006) is a model of professional learning that offers situated learning through collaborative planning, teaching, observing, and debriefing that affords opportunities for teachers to reflect individually and collectively. Lesson Study, originating from Japan, has been embraced by teacher educators because it empowers teachers and provides a collaborative structure that promotes reflection and critical dialogue about pedagogical content knowledge among teachers (Lewis, 2002; Lewis, Perry, & Murata, 2006). When pre-service and in-service teachers participate in a Lesson Study Cycle (see Figure 1) that involves collaboratively planning a research lesson, teaching and observing the lesson, reflecting on and revising the lesson, and repeating the cycle, all members of the group benefit from the professional inquiry (Fernandez & Yoshida, 2004; Suh & Parker, 2010).

Lesson Study involves many of the practice-based skills for teaching that Ball (2003) calls *mathematical knowledge for teaching*, which include the ability to pose rich, meaningful problems; represent ideas carefully with multiple representations; interpret and make mathemat-

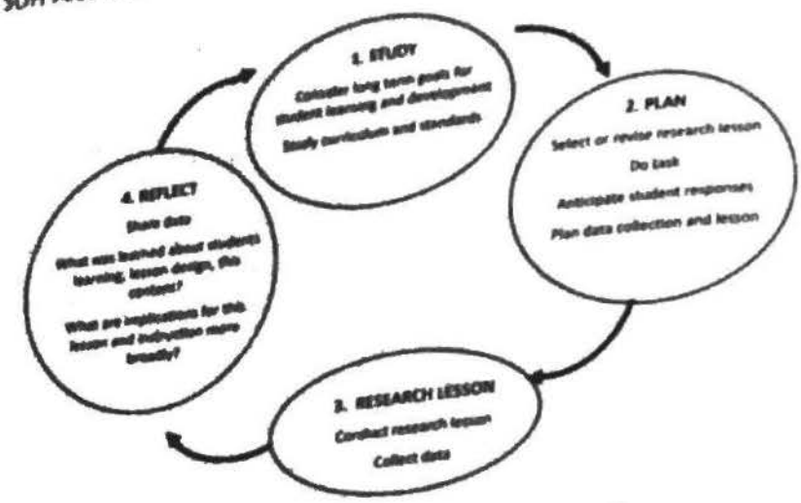

Figure 1. Lesson Study Cycle (Lewis, 2002)

ical and pedagogical judgments about students' questions, solutions, and problems; evaluate instructional materials; and determine how to assess student understanding of mathematical concepts. All these tasks provide opportunities for individual and collective reflection on content and pedagogy and have the potential to deepen a teacher's pedagogical content knowledge. However, pre-service teachers generally have limited experience with students and in planning lessons and often are not adept at performing these tasks. The benefits of collaboratively planning lessons with both novice and experienced teachers include exposure to multiple perspectives and new ideas that result from sharing experiences and expertise.

Professional Development Schools and Lesson Study

Professional Developments Schools (PDS) are innovative institutions formed through partnerships between professional education programs and P-12 schools (NCATE, 2000). Through a sequence of coursework and an internship program, pre-service teachers have extensive experiences in diverse K-6 schools, in which they are placed with clinical faculty who are prepared to mentor interns and are committed to the PDS mission. The design of the Professional Development School provides an ideal environment for Lesson Study with the necessary infrastructure to maximize the professional development of teachers at all levels, from novice to experienced. The fundamental design principle of PDS partnerships is one in which school and university partners together emphasize improving teacher education, the professional development of practicing teachers, and student learning within an inquiry-based environment (Castle, Fox, & Fuhrman, 2009; Hammerness, Darling-Hammond, Grossman, Rust, & Shulman, 2005; Holmes Group, 1986; NCATE, 2010; Zeichner & Conklin, 2008).

Castle and Reilly (2011) identified several key PDS structural features that positively influence teacher candidate outcomes: earlier, longer, and more structured field experiences; greater school-based and university-based faculty collaboration on coursework and field experiences; greater integration of coursework and field experiences; more exemplary models of teaching along with more trained mentors; more frequent and sustained supervision and feedback from more people in a wider variety of roles and more time on-site by the university supervisor; more exposure to diverse, school-wide authentic learning experiences; more supportive and reflective discussion and dialogue around issues of practice and professionalism within a learning community; and more interconnections between teacher preparation, professional development, student learning, and inquiry. These compelling benefits outlined in recent research guided us to implement Lesson Study in our PDS program.

Context of Our Study

Our PDS schools are carefully selected for diverse student populations, technology integration, faculty commitment, and coherence with the university's teacher education program. At our PDS sites, we address four purposes: 1) teacher education, 2) professional development of all constituents, 3) research/inquiry, and 4) student learning at the center. With a growing demand for teacher licensure courses and a call for a model that closely ties clinical practice to coursework, the authors—a mathematics educator and a PDS site facilitator—co-designed a unique mathematics methods course that focused on "situated learning" through Lesson Study. This pilot course was conducted during the summer and, unlike most teacher preparation courses, was based at a PDS site where invited students from this Title I community school attended primary and upper grades enrichment math lab. This allowed us to weave the methods course into field experiences with diverse learners. This arrangement also introduced pre-service teachers to Lesson Study as a form of teacher-led professional development and enabled them to learn more about mathematics content and pedagogy. In addition, the clinical faculty who led the summer lab school for students and modeled lessons for our pre-service teachers had prior clinical faculty training on strategies for being a master teacher, mentor, coach, and a professional resource to pre-service teachers.

Ultimately, it became clear to us that this mathematics Lesson Study course was more powerful in the PDS site because our model incorporated multi-tiered coaching. The math educator used content-focused coaching as a way to guide the pre-service teachers and clinical faculty, and the clinical faculty members had a chance to observe other more experienced clinical faculty give constructive feedback to the pre-service teachers. This innovative redesign served as a pilot to leverage the structures of our existing partnership and provide more mathematics learning opportunities for elementary students at the PDS site. This paper will focus on how Lesson Study structured an opportunity for pre-service teachers to engage in situated learning alongside clinical faculty during a summer PDS Math Lab.

Research Questions

The following research questions guided our study:

1. How does Lesson Study in a PDS site impact the development of pre-service teachers and clinical faculty?
2. What are unique outcomes of Lesson Study in a PDS that enhance teacher preparation beyond general field experiences?

Study Design

Participants. For this study, we focused on the development of 21 pre-service teachers and four lead clinical faculty, concentrating on their mathematics teaching and reflective practice. In relation to the pre-service teachers' preparation, this mathematics methods course was in the second semester of their five-semester program. In the first semester, pre-service teachers began their foundations courses with 30 hours of classroom observation and fieldwork but had limited experiences in planning and teaching lessons. Following the summer during which this project was implemented, pre-service teachers were immersed in year-long, two-semester internships in diverse PDS sites with clinical faculty members who served as their mentors for the academic year. Following these internship experiences, in their final semester in the program pre-service teachers focused on action research projects related to student learning.

Scope and setting of the study. Pre-service teachers were enrolled in a university mathematics methods course during the summer semester. The course met for five weeks, Monday through Friday, for three hours. During the last two weeks of the course, pre-service teachers were fully immersed in a summer internship at a PDS math enrichment lab for second to sixth grade students in a Title I school. The summer math lab program was a

free summer enrichment opportunity offered to 50 students from this school, which was located within a major metropolitan area. The school population included approximately 600 diverse students during the academic year, 51% of whom were Hispanic, 24% Asian, 16% Caucasian, 3% African American, and 6% classified as "other." Over 50% of the student population received either free or reduced lunches.

Procedures. The three-credit methods course connected with this Lesson Study project addressed mathematics content and pedagogy with a focus on designing mathematics lessons, using technology effectively in mathematics instruction, and assessing student learning through performance-based assessments. Pre-service teachers in the course were required to plan, deliver, and reflect on three one-hour lessons during the course of the semester. Two were individually-planned lessons with input from the clinical faculty and the final lesson was the research lesson for the Lesson Study, where pre-service teachers collaboratively planned with a team. The PDS clinical faculty and Lesson Study facilitator team included the mathematics educator and four trained clinical faculty who jointly provided feedback to the pre-service teachers.

The Lesson Study Process at the Professional Development School

To begin collaborative planning, pre-service teachers engaged in planning research lessons for diverse learners in small Lesson Study teams. Each of the Lesson Study teams—comprised of four pre-service teachers and a clinical faculty member—developed five research lessons focused on number sense, data analysis, and probability. The five teams completed two full Lesson Study cycles, teaching a lesson in two diverse classrooms, one multi-age primary (grades 2–3) and one upper (grades 4–6) grade placement. We used the Lesson Study Protocol (Lewis, 2002) to structure the planning process, which included four phases: collaborative planning, teaching and observation, debriefing and reflecting, and refining and enhancing the lesson. Each research lesson was implemented in two cycles of teaching, observations, and debriefs in both primary and upper grade bands, and pre- and in-service teacher participants thus had a chance to teach the topic vertically across grade levels.

In the collaborative planning phase, pre-service teachers and the PDS clinical faculty cooperated on the lesson planning. The topics for the lessons were determined by examining the standards for the grade bands and considering a pre-assessment that was given on the first day of the summer math lab. The second phase of the cycle—teaching, observation, and debriefing—took place on the research lesson day. Each team of pre-service teachers team-taught the focus lesson while the other pre-service teachers observed and recorded student discussions and classroom discourse. In the debriefing phase, the lesson study teams met immediately to reflect on the lesson with the PDS faculty to collectively consider the lesson design, the task, student engagement and learning, and future steps including revisions. The university-based mathematics educator served as the "knowledgeable other," an essential role in Lesson Study, who prompted teachers to think more deeply about the mathematics in the lesson. In subsequent cycles, the pre-service teachers revised the lesson to differentiate it for the other grade band. The pre-service teachers again served as observers and debriefed with the clinical faculty and mathematics educator.

Data Collection and Analysis

Data sources included pre-service teachers' reflective journal entries, transcribed notes from the video clips of the planning and debrief meetings, researchers' memos, classroom observations, and planning documents. Using the constant comparative method (Strauss & Corbin, 1994), we used open coding techniques and tested for recurring themes and patterns. We identified common themes in the pre-service teachers' written reflections and the video recordings from the Lesson Study experience. Recurring themes from the debriefings and reflections were categorized into three dimen-

sions: knowledge about teaching mathematics, knowledge about student learning, and collective inquiry into practice.

Using an observational approach to capture phenomena as they occurred, we kept researchers' memos, which were anecdotal notes and in-depth information about teacher behaviors and comments. In addition, we collected the pre and post surveys—the *Self -Assessment of Preparedness on Mathematics Practice-based Teaching Skills*—from all the pre-service teachers; this instrument allowed them to self-assess their level of preparedness with twelve practice-based skills as described by Ball's (2003) *mathematical knowledge for teaching*. We determined the mean for the pre and post survey but also matched pre-service teachers' pre and post surveys ratings and ran a paired sample *t*-test to determine if there were significant differences in their self-assessment on preparedness for the specific practice-based skills. We used the data of these memos and surveys to triangulate and verify the common themes.

Results

With the first research question, with regard to how Lesson Study in the PDS site impacted the development of pre-service teachers and clinical faculty, we discovered findings that related to three emerging themes: one, engaging in multi-tiered teacher development through shared experiences; two, learning focused on fine-grained analysis of teaching; and, three, student learning and development of professional dispositions through collective inquiry.

Engaging in "Multi-tiered" Teacher Development Through Shared Experiences

Lesson study collaboration, observations, and debriefing gave us an opportunity to analyze specific teachable moments, not just for the elementary students but also for the pre-service teachers, clinical faculty, and the university-based mathematics educator. In this way, we found that the teacher development was "multi-tiered." During the joint reflection, pre-service teachers and clinical faculty were able to take advantage of a shared experience like the observed lesson to bring up important components of the lesson where they learned more about teaching mathematics.

At another level, the mathematics educator served as the Lesson Study "knowledgeable other" to push all of the teachers to think more deeply about the mathematics involved. One of the recurring themes during the lessons was how the pre-service teachers had to reconcile their intended lesson plans with the instructional realities and how they had to make pedagogical content decisions based on students' responses to and understandings of the lessons. In the following excerpt, during a debrief of an observed lesson, a pre-service teacher questions the clinical faculty member's decisions to devote more time to a game that was supposed to be a short warm-up:

> Pre-service teacher (PST): So as I was observing today, I noticed that the warm-up game was only supposed to be 10–15 minutes but you seemed to take more time with the activity? Why did you do that?
>
> Clinical Faculty (CF): Our warm up with the "Triple Compare" game was supposed to be just 10–15 minutes but as we were engaging students, it took a totally different direction. Students were using strategies like comparing each of the three cards (addends) that they pulled out to see which one had more or using estimation skills. We really wanted to capitalize on this idea. During your internship, you will have to think on your feet and make instructional decisions. Instead of saying "Oh my gosh, this is only supposed to take 5 minutes," if you get the feeling that the students are engaged in important mathematics that you want to bring out, you *have* to take that time. It's

> important to take advantage of the opportunity when students are showing important mathematics like they did as they played "Triple Compare." You are assessing all the time as you are teaching your lesson. This is what I have told all my interns before.... they are so set on a schedule with their lesson plan written so beautifully and with estimated time written for each activity that they are afraid to veer off course... but when those teachable moments come, you really have to build on it.

This excerpt was notable in that it revealed to the pre-service teachers that multiple processes were going on in the clinical faculty members' minds as they were co-teaching. First was the importance of having rich mathematics activities that are worthwhile to engage students in mathematics discourse. By debriefing "out loud" with the pre-service teachers, this clinical faculty also had an opportunity to provide a rationale for her instructional decisions and link it to research-based practice. For example, the clinical faculty commented, "Having a discussion that reveals important strategies students were using as they were playing a game of comparing sums, was more important to developing their understanding than just covering more and rushing through the activity."

Through the four phases of the Lesson Study process, pre-service teachers experienced the complexity of teaching. They encountered how carefully clinical faculty select and set mathematical tasks; support student exploration of the task through questioning; use representations and extensions; orchestrate rich discussions to share ideas; and identify next steps to build upon student mathematical understanding. One teacher candidate commented on her learning experience with the clinical faculty and the intentionality in the sequencing of tasks and questions during the lesson and the choice of mathematical tasks:

> I learned a lot about how teachers think deeply through the lesson objective to decide on the sequence of lessons within a unit. It's not like they just go by the textbook. They use data from student work to see where the gaps are and sequence and pace lessons according to their needs. Like for the probability lesson, they discussed how some of the students might not have a solid understanding of fractions and how that was an important foundation for talking about the possible outcomes.

This experience revealed to pre-service teachers the importance of in-the-moment pedagogical decision-making. Teaching strategies and research-based instructional methods were introduced in the content course and modeled in the classroom. Pre-service teachers found direct links between the coursework and the realities of an actual classroom, which made their learning more powerful and connected.

On the last day of the course and lab school immersion, the clinical faculty, university faculty, and pre-service teachers debriefed about the benefit of the model and ways we might improve it for the next cycle. The course focused on the use of questioning to promote rich math talk in the classroom. This practice was a novel one for the pre-service teachers in their development and it was not until the summer lab school that these pre-service teachers really considered how levels and styles of questioning elicited different thinking and pushed mathematical ideas forward. One of the pre-service teachers stated,

> The first benefit was being able to see teachers in action with concepts that we were reading and discussing. I started seeing those "teacher questions" that were being used to spark students' understanding and focus them on creating a deeper connection with the material. I also enjoyed seeing teachers working with one another. This was something that I have not seen in past observations. I saw them bounce ideas off of one another and great collaboration. I also

saw this in my own group when we worked together for the lesson plan. This experience really showed me on the first day that teaching can often require improvisation.

This pre-service teacher commented on the value of shared experiences and situated learning and seeing how research-based practices are implemented in the classroom context, including questioning to elicit student thinking, navigating math discourse in the classroom, and improvising and responding based on what students reveal during a lesson. This experience, situated in an authentic teaching context, produced a level of understanding about the complexities of lesson planning that is difficult to generate in a methods class alone.

Learning Focused on Fine-grained Analysis of Teaching and Student Learning

The collaborative nature of Lesson Study allowed for experienced teachers to plan side-by-side with novice teachers situated in practice. The Lesson Study four-column lesson plan format emphasized *anticipating student responses and possible student misconceptions*, which was challenging for pre-service teachers with limited experience working with actual students. However, with the input from the clinical faculty, pre-service teachers were given more insight into how to gauge the appropriate cognitive demand of the mathematics. For a money lesson, pre-service teachers reflected on how they modified an existing lesson with the feedback from the mathematics educator and the clinical faculty to make it more engaging for student learning:

> Pre-service teacher 1: For the lesson, we decided to take out the coin identification part of the lesson because after talking to the CF, we learned that these students were past that level. Instead, we wanted to see how flexible they could be with finding different combinations of coins to equal a given value.
>
> Pre-service teacher 2: This made it definitely more engaging and more challenging. Yet it still allowed for differentiation because there were many ways they can make up the combination.
>
> Pre-service teacher 3: One thing important that we needed to focus on was how students can use an organized list or table to keep track of coin combinations.
>
> Pre-service teacher 4: It was interesting to note that one group, as soon as we gave them the problem, delved right into using the money as manipulatives and started to make combinations.
>
> Pre-service teacher 5: I was glad that we had them work in partners because they explained to their partner how they made up the value and the partner seemed to verify the mathematics before they recorded on paper. Having them do "partner talk" seemed to help when we brought them together at the end of the lesson.

Throughout the Lesson Study, we continued to hear and read in these pre-service teachers' reflections about the pedagogical dilemmas they were facing and how they were navigating them. Some of these pedagogical dilemmas related to specific mathematical knowledge for teaching such as knowing how to select among student strategies and posing questions to extend students' thinking. The pre-service teachers shared during their debrief how it was challenging for them to think on their feet and respond to some unanticipated students' strategies.

Developing Professional Dispositions Through Collective Inquiry and Shared Experiences

The collective inquiry promoted through the school- and university-based faculty collaboration around this coursework and summer lab

school provided a positive experience for the pre-service teachers and an opportunity to develop their professional dispositions as career educators. Pre-service teachers developed a vision of a "community of practice" with reflective practitioners as they watched practicing teachers negotiate, problem solve, assist each other, and elaborate on each others' ideas. One of the professional dispositions nurtured was teachers' need to collaborate with other professionals and to seek advice and expertise from others without being shy or afraid to learn or receive feedback. One of the pre-service teachers working in a collaborative lesson study group commented,

> When Peter, Susan, and I taught our lesson the first day, I thought that I would bust due to the feeling of failure that I could not help experiencing. However, through thoughtful guidance from our instructor and one of the clinical faculty and in-depth reflection and discussion in our group, we were able to teach our lesson the next day so much more skillfully. After that second lesson, I understood that teachers must know how to improvise, reflect, be flexible, and accept constructive criticism. It taught me a lot about the importance of collaboration and not being shy to ask others for help, suggestions or working with them. As our instructor has been stressing to us, we don't have to work in isolation.

Developing effective teaching dispositions—such as the ability to critically reflect—is one of the most important components in teacher candidates' development. One of the goals of our PDS program is to nurture and develop teachers who are reflective practitioners who will continue to hone their professional practices. A common theme in pre-service teachers' reflections was the desire to learn more to become better mathematics teachers, as expressed by this teacher candidate, who shared her mathematics avoidance:

> Most of my life, I have tried to avoid math and anything having to do with math. I was convinced that, since I did not excel at math in school, there was no way that I could be competent at it as an adult. I have come to realize that, although most people are not perfectly mathematically inclined, as teachers, we can re-learn what we need to know in order to positively engage our students.

This excerpt reveals her desire to relearn mathematics to become more skillful and have a positive disposition toward mathematics.

The pre and post survey revealed an increase in pre-service teachers' awareness of the complexity of teaching. This survey was created to capture teachers' awareness of the complexity of teaching mathematics before and after the PDS Lesson Study experience. Pre-service teachers rated themselves on these 12 items along a Likert scale where "1" indicated "no experience," a "2" meant "novice" or "new to this skill, a "3" represented an "apprentice" or "developing" understanding, a "4" stood for a sense that one was "skillful," and a "5" meant that this individual perceived herself or himself as "highly skillful."

Pre-survey results indicated that on average pre-service teachers rated themselves as "novices" in many of the practiced-based skills, with some practices being more unfamiliar to them than others. Some items that had an average mean less than 1.5 included "understanding learning progression to *differentiate* and respond to individual learners" (M=1.13); "use *questioning* to effectively probe mathematical understanding and make productive use of responses" (M=1.38); and "teach and model effective *problem solving strategies*" (M=1.43). However, after the course and the Lesson Study experience, pre-service teachers consistently rated themselves as "apprentices" who felt like they were developing these skills.

A paired-sample *t* test was calculated to compare the pre self-assessment scores to the post self-assessment scores and indicated a significant increase in all criteria at the

Table 1. Pre and Post Survey Means on the Self-assessment of Preparedness for Practiced-based Skills Survey

	Criterion	Presurvey mean	Postsurvey mean
1	Understanding mathematics content in grades K–6 specialized topic of teaching math.	1.95	3.29
2	Uses multiple strategies, including listening to and understanding the ways students think about mathematics, to assess students' mathematical knowledge.	1.57	3.43
3	Analyze, diagnose and evaluate mathematical misconceptions and errors and design appropriate interventions/responses.	1.57	3.24
4	Choose and/or design rich tasks to support the learning of new mathematical ideas or methods	1.80	3.57
5	Orchestrate math talk in class to elicit, test, and extend students' thinking	1.62	3.24
6	Understand learning progression to differentiate and be responsive to individual learners.	1.13	3.24
7	Construct, evaluate and connect multiple representations of mathematical ideas or processes	1.57	3.52
8	Use questioning to effectively probe mathematical understanding and make productive use of responses.	1.38	3.38
9	Teach and model effective problem solving strategies	1.43	3.10
10	Use various instructional applications of technology, judiciously, in ways that are mathematically and pedagogically grounded.	1.62	3.19
11	Articulate the vertical sequencing and development of mathematical ideas, concepts, and skills in the preK–6 curriculum.	1.57	3.14
12	Create open-ended assessment as a formative assessment cycle	1.57	3.14

*A scale of 1 to 5 where 1=no experience; 2=novice (new to this skill); 3=apprentice (developing); 4=skillful; and 5=highly skillful.

$p<.000$ level. The significant result is not surprising since the pre-service teachers had limited experience planning and teaching mathematics prior to this experience. The interesting aspect of employing this survey was how it allowed for the clinical faculty, university faculty, and the pre-service teachers to name some of these important practices more explicitly, as we discussed and identified these practices in the observed lessons. These discussions from the shared experience of Lesson Study allowed pre-service teachers to become more aware of the specific pedagogical knowledge needed for effective teaching.

An Examination of Lesson Study at a PDS Site for Teacher Preparation

To address our second research question, related to the unique outcomes of Lesson Study in a Professional Development School (PDS) that enhances teacher preparation, we referred to Castle and Reilly's (2011) key PDS structural features and how features of Lesson Study at the PDS site enhanced teacher development for both pre-service teachers and clinical faculty. Our pre-service teachers experienced an "earlier more structured field experience" in the second semester of coursework prior to their full year-long internship with the mathematics Lesson Study course. This class also provided "more exemplary models of teaching along with more trained mentors" where pre-service teachers were able to collaborate with other specialists like a special education support faculty member, in addition to the university math faculty.

In addition, Lesson Study and projects like ours clearly support many of the National Association of Professional Development Schools' Nine Essentials (2008), which articulate the essential components of PDSs. In particular, to paraphrase the Essentials, our project was designed around a shared commitment to innovative and reflective practice by participants, and engagement in and public sharing of the results of deliberate investigations

of practice by respective participants. In support of other Essentials, our project and study included structures that allowed all participants a forum for ongoing reflection and collaboration, as well as work by college/university faculty and P–12 faculty in formal roles across our institutional settings. The design of the mathematics course with the Lesson Study allowed for innovative reflective practice, and the clinical faculty made their teaching public while pre-service teachers observed and then switched roles when the pre-service teachers engaged in the teaching and debriefed with the faculty. These activities provided structures for ongoing reflection and collaboration by all members involved.

Lesson Study encompasses best practices for teachers such as teacher research, instructional rounds, examining students' work and analyzing common misconceptions, and modeling and providing feedback for pre-service teachers. One pre-service teacher revealed how learning about problem-based learning in this course was brought to life after seeing it in practice during this intensive summer experience. She admitted that she was skeptical about problem-based learning at first, but after observing it implemented successfully she knew she had encountered evidence that it worked. This "evidential learning" was voiced in her reflection: "I liked how we saw the clinical faculty model teaching through the problem solving approach. They were like 'living examples' of what we were learning in class." "Living" examples were the result of a tighter integration of coursework and field experiences.

Some of the outcomes of Lesson Study in our PDS site that were unique compared to traditional field experiences were the pre- and in-service teachers' opportunities to experience collaborative mentoring, co-teaching, and participating in a shared professional learning experience. Typically, pre-service teachers are assigned to work with one clinical faculty member during their student teaching and experience just that single mentor-mentee relationship. The collaborative mentoring approach we utilized in this summer model combined Lesson Study (Lewis, 2002) and the professional learning community approach (DuFour, 2004), thus providing opportunities for new and experience teachers to engage in professional and shared learning.

The Lesson Study experience also provided for differentiated levels and types of mentoring and sharing of expertise for pre-service and in-service teachers. Pre-service teachers were mentored by several clinical faculty with a variety of backgrounds ranging from special education to advanced content knowledge, who shared their understandings of potential barriers to learning, common pedagogical misconceptions, and how to anticipate student responses—all knowledge they had acquired through years of training and experience working with diverse learners. In addition, pre-service teachers experienced co-teaching environments that are prevalent in many of our PDS sites in inclusive classrooms and serve to jump-start teacher-led professional learning communities. We believe that the mutual exchange of ideas and instructional strategies among this range of teachers will help prepare pre-service teachers to participate and flourish in a more sustainable teacher-led professional learning community.

Concluding Thoughts

Teachers, new and experienced, need more time for professional learning, to understand new concepts and skills and to receive support and feedback while trying new approaches and integrate these strategies into their practices (Cambone, 1995; Corcoran, 1995; Zeichner & Conklin, 2008). Donahoe (1993) suggests that such set-aside "collective professional time" is particularly important for significant school improvement. The Lesson Study in our PDS provided this collective professional time. Giving pre-service teachers an opportunity to collaborate with practicing teachers at a school site supports Lave and Wegner's (1990) notion of situated learning: knowledge needs to be presented in authentic contexts, settings, and situations that normally involve that knowledge. Social interaction and collaboration with practicing teachers in a PDS site allowed pre-service teachers to integrate classroom realities with the

theories they were learning in their university classes.

The Lesson Study process also provided a unique opportunity for pre-service teachers to experience an authentic professional learning community with a set of established norms that ensured the success of this exploration for both pre-service teachers and clinical faculty. The first norm was establishing trust and safety. The Lesson Study experience was free from and not linked to any form of evaluation of teachers or teaching for either the pre-service teachers or the clinical faculty. This safe environment allowed individuals to reveal insecurities and any fragile understandings of mathematical concepts, thus lessening their anxiety. The second norm was acknowledging the desire for increased knowledge and competencies in teaching. Pre-service teachers were invested in the learning because they knew that their careers depended on it and recognized that different members of the Lesson Study team had varied expertise and competencies, which allowed for the development of a collective and shared mission. The third norm that was established was being committed and making contributions to shared experiences. Because pre-service teachers were in small teams who were collectively responsible for student learning, they all contributed and actively engaged in the reciprocal exchange during the Lesson Study process.

Implications for Professional Development Schools

Lesson Study supported the structural features attributed to successful Professional Development Schools. As Castle and Reilly (2011) identified, the key PDS structural features were complemented by the features of Lesson Study that amplified and provided explicit experiences that connected successful teaching to research-based practices. Our experience demonstrates that PDS sites are ideal environments to embrace Lesson Study activities that offer "multi-tiered professional learning." Such activities encompass NCATE's standard for establishing a learning community where field experiences and clinical practice in the PDS provide candidates full immersion in the learning community; where work and practice are inquiry-based and focused on learning; with common and shared professional visions of teaching and learning grounded in research and practitioner knowledge; where inquiry-based practice in the PDS sits at the intersection of professional education reform and school improvement; and where all members engage in joint work with an extended learning community (NCATE, 2000).

In our project pre-service teachers developed the specific pedagogical knowledge needed for teaching, via situated learning contexts and Lesson Study. Collaboration and collective reflection helped to instill in pre-service teachers the professional dispositions necessary for them to continually reflect on practice and share learning with colleagues. Lesson Study within the PDS program provided an opportunity for collaborative reflection where teachers openly shared instructional practices while developing relationships and an appreciation for a continuous collaborative mentoring community. In many ways, our experience with Lesson Study at the PDS site enacted the saying, "Teach a man to fish, and you feed him for a lifetime." In our case, we used Lesson Study in our PDS program to teach teachers how to work and reflect collaboratively with their colleagues in the contexts of their own classrooms so that they might become lifelong learners and continue to reflect on their practice beyond their preparation program and throughout their teaching careers. SUP

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