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Developing Reflective Practitioners through Lesson Study with Preservice and Inservice Teachers

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This case study describes pre-service teachers collaboratively planning and reflecting with cooperating teachers and other educators at their clinical site. Using lesson study as the professional development structure, preservice teachers worked with classroom teachers, resource specialists and mathematics educators while being immersed in authentic teaching situations that revealed complex pedagogical issues and factors impacting the teaching and learning of mathematics. Qualitative analysis of teacher interviews, reflections, classroom observations, and planning documents revealed several unique outcomes including developing mathematical knowledge for teaching through a reciprocal learning process; revealing specific gaps in mathematical knowledge for teaching among preservice teachers and increasing preservice teachers' awareness of the complexity of teaching and reflective practice. Finally, the study identifies specific critical norms for ensuring the success of lesson study among preservice and practicing teachers.

Contributing to the understanding of how lesson study supports preservice and inservice teachers in developing mathematical knowledge for teaching and reflective practice, this case study describes preservice teachers collaboratively planning

and reflecting with cooperating teachers and other educators at clinical sites. Through engaging in lesson study with practicing teachers, preservice teachers were exposed to authentic pedagogical issues situated in the context of teaching using discussions of students' common misconceptions and factors related to specific student populations (i.e., English language learners and special needs students) that influenced instructional decisions and professional learning.

Research on Reflective Practice and Lesson Study

Ma (1999) stated that American teachers believe they need to know mathematics to plan lessons, whereas Chinese teachers think they can learn mathematics through planning lessons. Learning through collaborative planning, teaching, observing, and debriefing affords opportunities for teachers to reflect individually and collectively. Kolb (1984) described an experiential learning cycle that begins with a concrete experience and moves on to reflective observations about that experience, which in turn guide a stage of active experimentation continuing the cycle. Reflective practice is a cornerstone of best practices in teacher education that develops the analytical and inquiring disposition of teachers. Multiple opportunities for reflection are needed to build teachers' capacity for critical reflection. Some traditional methods of fostering reflection have been through journaling, video recording class sessions, and conferences with mentors or colleagues. Lesson study as a collaborative structure for developing reflection has drawn attention and become a catalyst for critical dialogue about mathematics teaching and learning among teachers (Lewis, Perry, & Murata, 2006).

A growing body of research (Chazan, et al., 1998; Fernandez & Yoshida, 2004; Roth & Tobin, 2004) supports collaborative inquiry in teaching and learning as a highly effective component of professional development for teachers. As a result, preservice and inservice teachers are urged to participate in lesson study (Fernandez & Yoshida, 2004) involving a cycle of collaboratively planning a research lesson,

teaching and observing the lesson, reflecting on and revising the lesson, and repeating the cycle.

Lesson planning involves establishing lesson objectives, evaluating instructional materials, determining how to assess student understanding, reviewing one's understanding of mathematical concepts, and situating an instructional experience in the curriculum. All these tasks provide opportunity for individual and collective reflection on content and pedagogy and have the potential to deepen a teacher's mathematical knowledge for teaching and pedagogical content knowledge. However, preservice teachers have limited experience in planning lessons and are not adept at performing the task. Therefore, it is critical for mathematics educators to design experiences that allow preservice teachers to take advantage of the opportunities presented by lesson planning.

Benefits of collaborative lesson planning include exposure to multiple perspectives and new ideas that result from the pooling and sharing of experiences. Teachers engage in discussions about mathematics content involving mathematically accurate explanations that are comprehensible and useful for students and represent ideas clearly and precisely. Smith, Bill, and Hughes (2008) use the "Thinking Through a Lesson Protocol," which prompts teachers to think deeply about a specific lesson to be taught. Teachers use the protocol to move beyond structural components of lesson planning to a deeper consideration of how to advance students' mathematical understanding during the lesson.

Some research (Fernandez and Yoshida, 2004) on collaborative planning emphasizes using a lesson-plan format, particularly a four-column plan, including sections for instructional activities, anticipated student responses, teachers' proposed reactions to student responses, and assessment. Others, such as Hawbaker, Balong, Buckwalter, and Runyon (2001), describe a four-component method for planning: identifying the big ideas, analyzing areas of difficulty, creating strategies and supports, and evaluating the process. These researchers consider the role of the actual lesson plan when they describe the benefits of collaborative planning. And yet others (Chazan, et al., 1998;

Walther-Thomas, 1997) note advantages resulting from collaborative planning without identifying a specific lesson plan format.

This paper explores how collaborative reflection through lesson study supported reflective practice and mathematical knowledge development for preservice and inservice teachers. Attention is given to detailing the process for other mathematics educators to use the collaborative learning structure in their work.

The Lesson Study Project

Using case study methodology, the researchers focused on five of 22 preservice teachers in a professional development school who participated in a yearlong internship while concurrently taking a university mathematics methods course meeting one day per week. The 3-credit methods course 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. Preservice teachers in the course were required to plan, deliver and reflect on three lessons during the course of the semester. As a pilot project, the instructor (and one of the researchers) supervised five preservice teachers at a professional development school and created opportunities for the preservice teachers to participate in lesson study, collaborating on the research lesson design with cooperating teachers and other practicing educators.

Context for the Lesson Study

To begin collaborative planning, the instructor engaged both preservice and inservice teachers, teachers of English language learners, and special educators in planning a lesson for a diverse student population in a Title One school. Three preservice teachers placed in a primary internship participated in one lesson on subtraction with regrouping which took place in a second grade class, while two others joined a research lesson on decimal place value for a fifth grade class. Both groups of teachers used a

four-column lesson plan format (see Figure 1) to structure the planning process. In this model, Column 1 outlines the flow of instruction in detail; Column 2 maps out anticipated student responses and solution strategies; Column 3 details teacher responses to differentiate for diverse learners; and Column 4 addresses assessing student understanding.

Title: _____ Content Area: _____
Teacher name: _____ Grade Level: _____ Lesson Study Date: _____

OVERARCHING GOAL FOR THE LESSON STUDY:	LESSON OBJECTIVES and STANDARDS:
IMPORTANT MATHEMATICS CONTENT BACKGROUND: Describe the important mathematical concepts related to this lesson that a (teacher/ students) have as prior or future math concepts to (teach/learn).	
MATERIALS: List the texts, equipment, and other materials to be used by the students. List the materials, including equipment or technology used by the teacher in presenting the experiences.	

Steps of the lesson: learning activities and key questions (and time allocation)	Anticipated Student Responses and solution strategies : (Potential Barriers & Misconceptions)	Teaching notes: DIFFERENTIATION: List adaptations for GT, ESOL, LD	Evidence of learning Evaluation points or assessments questions
LINK PRIOR KNOWLEDGE. Outline procedures for activating prior knowledge and student interest.			
INSTRUCTIONAL STRATEGIES. Outline what the teachers and students will do to Engage & Educate. Active learning tasks.			
REFLECT and SUMMARIZE. Outline how you will close.			
EXTENSIONS/CONNECTIONS: What other lessons does this lesson connect to?			
REFLECTION: After the lesson, reflect on what went well and what didn't go well. Write changes you might implement the next time the lesson is taught.			

Figure 1. Four-column lesson plan format modified from Lewis (2002).

The two groups created concept maps (see Figure 2) illustrating identified mathematical ideas related to the lesson. These tools allowed all to discuss students' prior knowledge and future mathematical building blocks, important vocabulary, and prerequisite knowledge necessary for students to access the lesson.

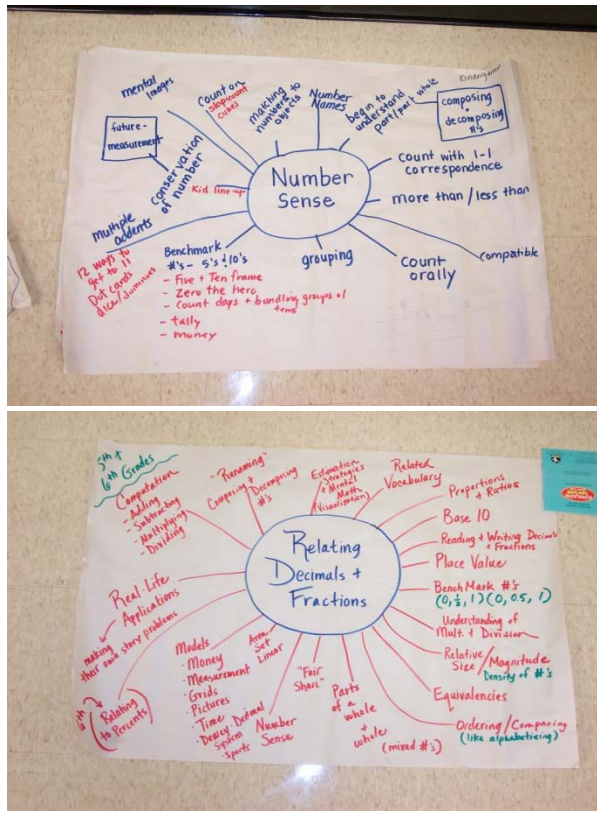

Figure 2. Mathematical concept maps from 2nd and 5th–6th grade groups.

The lesson study process involved four phases, spanning four two-hour after school sessions and one release day. It included collaborative planning, teaching and observation, a debriefing and reflecting phase, and refining and enhancing the lesson. In the collaborative planning phase, all participants collaborated on lesson planning during after school sessions. Theteaching and observation phase and the debriefing phase, took place on the release day. The host, a cooperating teacher, taught the focus lesson while observers wrote individual reflections and notes. In the debriefing phase, the lesson study

teams met again as a group to reflect on lesson design, the task, student engagement and learning, and future steps including revisions. In subsequent cycles, preservice teachers taught the revised lesson with observers watching and helping debrief the experience.

Some guiding questions crucial to the teaching and learning processes were: What is the important mathematical understanding that students need to learn? What are potential barriers and anticipated student responses? What conceptual supports and instructional strategies can best address our students' learning? How will we respond when students have difficulty? How will we know when each student has learned the mathematics?

Following the lesson study, teachers were asked to respond to two prompts: Describe your experience with lesson study in terms of personal and professional gains, challenges and "aha" moments; and, Which column of the four-column lesson plan was most helpful, and in what ways? Additionally, preservice teachers wrote a summative reflection of the process. Finally, two preservice teachers from each group were interviewed individually by researchers about the experiences.

Learning Outcomes from the Project

Using the constant comparative method (Strauss & Corbin, 1994), researchers identified common themes in the preservice teachers' written reflections. Data sources included transcribed interviews, reflective journal entries, classroom observations, and planning documents. The qualitative data were analyzed using open coding techniques and tested for themes and patterns. Emergent ideas were categorized into themes and crosschecked with teachers' comments and researchers' notes. Three key learning outcomes were recurrent in the analysis and are discussed in the following sections.

Developing mathematical knowledge for teaching through reciprocal learning. A reciprocal learning relationship among all participants was evident in the discourse that occurred during the planning phase. Different levels of mentoring and expertise were revealed as each contributed to the group's knowledge.

Preservice teachers were mentored by experienced teachers and special educators, who shared their knowledge of potential barriers to learning, common misconceptions, and anticipated student responses acquired through years of training and experience working with diverse student populations. For example, when planning for a fifth and sixth grade lesson on decimal numbers, practicing teachers discussed common student misconceptions about decimal place value. A preservice teacher wrote the following journal entry after a planning session:

> I did not think that when some kids see a decimal number like .79 and .8, that they might think that .79 is greater because they are disregarding the decimal point and merely thinking 79 versus 8 as whole numbers. We had a lengthy discussion about how we can develop a lesson that would reveal this misconception. We decided that the Decimal Draw Game would bring this out by having students create the largest decimal numbers to win a game using the digits that they would roll [on a die]. I think this will be a great way [for] them to have to argue why one number is greater than the other.

In contrast, preservice teachers working with second grade teachers most frequently shared their knowledge of strategies, curriculum and technology tools. Initially, preservice teachers were passive; however, as the sharing continued, they developed confidence and felt their voices were validated. During a follow-up interview, one preservice teacher reported:

> In the beginning, I did not really participate because I was a little intimidated to be surrounded by so many teachers with years and years of experiences. I was not sure about in what way I could contribute to the planning of the lesson. But as the planning processes continued, I was encouraged to share some of the new ways we have been incorporating technology in mathematics instruction through our methods class. There were many teachers who were not aware of the base ten virtual manipulatives website that had great

> interactive virtual manipulatives to teach addition with regrouping. In this way, I was able to bring to the table a new innovative teaching strategy and tool to enhance the lesson.

By working with special educators and instructors for English language learners, teachers discussed how to adapt tasks to meet students' Individualized Education Program goals, giving them access to meaningful mathematics. To generate ways to differentiate and scaffold instruction, teachers created a concept map outlining key components of prerequisite mathematics and interrelated concepts that might be future knowledge building blocks. A teacher with eight years of classroom experience reported:

> The mapping of prior knowledge needed and future knowledge was illuminating – it just got me thinking more deeply about the concept. The brainstorming helped to see what kids need to know and where they are headed. It makes it easy to see all of the standards that are tied into one concept. I learned about multiple models of representations and strategies.

The reciprocal learning allowed for everyone to build mathematical knowledge for teaching in terms of concepts, models, strategies and representations.

Revealing gaps in mathematical knowledge for teaching. Using an observational approach, researchers took anecdotal notes and collected in-depth information about teacher behaviors and any comments during the collaborative planning and debriefing sessions. To overcome researcher bias, the researchers used an observation checklist to document the level of input from all during collaborative planning (see Figure 3). The observation checklist included many of the practice-based skills identified as mathematical knowledge for teaching (Ball, 2003). Using tally marks, observers marked when preservice or practicing teachers made contributions to add to the mathematical knowledge for teaching.

	Practice based skills focused on during collaborative planning	Preservice teachers	Inservice teachers
1	Developing students' understanding of mathematics beyond algorithms.		
2	Taking students' prior understanding into account when planning curriculum and instruction.		
3	Engaging students in inquiry-oriented activities.		
4	Designing the instructional sequence that is appropriate and meaningful		
5	Assessing students' mathematical learning through questioning and take the next steps.		
6	Posing good mathematical questions and problems that are productive for students' learning.		
7	Making judgments about the mathematical quality of instructional materials and modify as necessary.		
8	Anticipating students' mathematical questions, curiosities, and misconceptions.		
9	Using mathematically appropriate and comprehensible explanations for students.		
10	Use technology with students.		
11	Giving access for mathematical learning to all members of a diverse population.		
12	Identifying and make connections among various mathematical topics.		
13	Representing mathematical ideas and concepts carefully in multiple ways.		
14	Making connections between physical, graphical models and symbolic notation.		
15	Generating novel teaching strategies		
	Use tally marks as contributions are made by preservice and inservice teachers		

Figure 3. Observation checklist used during lesson study sessions

In addition, the checklist served as a systematic way to discuss the planning process with the preservice teachers during a separate focus interview after the collaborative planning session. One researcher had the preservice teachers consider the 15-practice-based skills listed in the observation checklist and discuss what seemed most challenging or surprising. Although instructional practices and skills were discussed in the methods class, preservice teachers had not fully understood what practice-based skills were involved in the actual act of planning and teaching until the lesson study experience. They expressed that limited prior experiences with students made it challenging to anticipate students' mathematical questions, curiosities, and misconceptions and to take students' prior understanding into account when planning lessons. Other notable challenges were assessing and posing good mathematical questions and problems. As novice teachers, many had limited vertical mathematical knowledge and understanding of scope and sequence in mathematics. For example, in a conversation where teachers mapped prior and future mathematics learning, one preservice teacher asked such questions as, "When do they learn to divide by decimals? Should they be able to convert fractions to decimal by this grade?" The necessary depth of content knowledge and sequencing of mathematical ideas are generally learned as teachers gain experience in multiple grade levels or through vertical articulation across grade levels. Preservice teachers benefited from having the experience of collaborative planning with practicing teachers who helped them recognize practice-based skills using concrete examples.

Increasing awareness of the complexity of teaching and reflective practice. Through the collaborative reflection process, preservice teachers experienced the complexity of teaching firsthand. They experienced how carefully teachers select and set mathematical tasks; support student exploration of the task through questioning, use of representations and extensions; orchestrate a rich discussion to share ideas; and identify next steps to build upon student mathematical understanding. One preservice teacher commented on the sequencing and planning of activities:

> I was amazed that even experienced teachers wrestle with the ideas that we do when we plan lessons, like how to hook the students and link and engage the students. I thought it just came to them so naturally since they make it seem so easy when I observe them teach. Now I see how much thought is put into the actual sequencing of a lesson.

Another noted the attention paid to choosing appropriate mathematical tasks:

> It was really eye opening to see how the teachers had to pick and choose which mathematical model to use for the lesson and how to design the task sheet so that students could reveal their learning. There were even times when teachers questioned each other about the use of certain models fearing that it may confuse students down the road and whether using multiple models might actually confuse the special needs learners.

As they watched practicing teachers negotiate, problem solve, assist each other, and elaborate on each other's ideas, preservice teachers developed a vision of a community of practice with reflective practitioners. This experience, situated in an authentic teaching context, produced a level of understanding about lesson planning difficult to generate in a methods class. Preservice teachers wanted more opportunities to collaborate in such meaningful ways as reflecting on lessons, participating in joint problem solving, and collaborative planning.

Norms to Ensure Success in Lesson Study

During the lesson study process, a critical set of norms were established to ensure the success of the study for both preservice and inservice teachers:

- Trust and safety. The professional learning environment had to be free from and not linked to any form of evaluation of teachers or teaching for both preservice and practicing teachers. This safe environment allowed

individuals to reveal insecurities and any fragile understanding of mathematical concepts, thus lessening anxiety. The safe environment raised teachers' productive disposition towards exploring their craft and analyzing student learning.

- Knowledge and competencies. Teachers recognized that different team members had different expertise and competencies, which developed a sense of collective efficacy; i.e., the team had a confident expectation that it would successfully achieve its intended goal.
- Shared experience and language. Their common experience helped teachers build collective knowledge as they worked together to understand and to make sense of challenges and appreciate the "aha" or surprise moment while analyzing student learning and seeing instructional improvement with new eyes.
- Lesson study facilitation. Designating a lesson study facilitator (a researcher) who could continue to engage teachers in studying the complex nature of teaching and learning mathematics, despite all the demands of teaching, helped sustain the learning enterprise.

Final Thoughts

Giving preservice 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 normally involving that knowledge. Social interaction and collaboration with practicing teachers allowed preservice teachers to integrate classroom reality with the theory they learned in class. As a result, discussions during the lesson study sessions were qualitatively different than discussions typically found in the researchers' methods class. For example, preservice and experienced teachers alike struggled with effectively differentiating lessons for individual students. In the methods class, preservice teachers tended to discuss differentiation strategies with a general group of students (e.g., "English

language learners" or "special needs learners"). However, during the lesson study experience, specific students with specific needs gave preservice teachers first-hand experience with how a lesson must meet those needs.

Additionally, preservice teachers' reflections indicate that anticipating student responses was the most challenging aspect of the four-column lesson plan. One preservice teacher stated, "I have never taught elementary students before so I am not sure what they will have challenges with in the following lesson." Another preservice teacher commented, "Hearing…teachers who taught this in previous years describing in detail what students had misconceptions about, and listening to how they talk about the common mistakes they make on assessments, helped me see how important assessment is to planning for instruction."

To help preservice teachers develop the mathematical knowledge needed for teaching, it is important that mathematics educators place them in situated learning contexts like this lesson study experience. Collaboration and reflection help preservice teachers develop professional dispositions as career educators who will continually reflect on practice and share learning with colleagues. This lesson study provided an opportunity for collaborative reflection where teachers openly shared instructional practices while developing relationships and an infrastructure for a continuous collaborative mentoring community.

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