Lesson Study for Preservice Teachers

Jennifer M. Lewis

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Abstract The research lesson sets lesson study apart from most other forms of teacher learning. The observed interactive, real-time lesson puts theories about learning, expressed as a lesson plan, to the test of practice, in the company of one's professional peers. In a cycle of lesson study, the research lesson sits between the planning that teachers do in preparation for interactive work and the analysis that teachers do after a lesson with students. As such, lesson study holds particular promise for preservice teacher education because it can serve as a bridge between theory and practice, a divide that has confounded teacher education for decades. Typically, preservice coursework provides opportunities for planning before lessons and analysis of artifacts coming out of lessons, but the actual interactive work with children is distant—and it is precisely this interactive work that most concerns preservice teachers. Thus, lesson study, with its inclusion of the research lesson, provides a promising model for preservice teacher learning. This chapter presents a case of lesson study carried out in a methods class for elementary preservice teachers. Analyses of data in this case study show that preservice teachers developed an expansive disposition of *mathematical care*, a repertoire of *pedagogical*

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moves linked to research and children's learning, and an expanded *sense of the teaching self* from their participation in a cycle of lesson study.

Keywords Lesson study · Teacher preparation · Preservice teacher education

1 Introduction

One of the enduring challenges of preservice teacher education is the perceived disconnect between teacher preparation coursework and the realities of classroom life (Lortie 1975; Clift and Brady 2005). Lesson study is a promising addition to common activities in teacher preparation, because it links study and investigation (Grossman and McDonald 2008) to an actual lesson taught in real time and observed in the company of one's colleagues. But lesson study is typically conducted with inservice teachers or a mix of preservice and inservice teachers. Although lesson study was not developed for preservice teachers *per se*, this form of professional development addresses some of the perennial challenges facing preservice teacher education. This chapter begins with an enumeration of some of those perennial challenges and how lesson study might address them directly. The chapter then presents a preservice lesson study experience, describing the ways in which a cycle of lesson study was modified for use with preservice teachers. The chapter then presents the outcomes from a case study (Yin 2017) that examined this lesson study cycle for preservice teachers to determine what preservice teachers stand to learn from their participation in a modified form of lesson study.

2 Challenges of Preservice Teacher Education in the USA

Preservice teacher education in the USA is regarded by its participants and the schools that employ them as inadequate, "too theoretical" on the one hand, and too easy on the other. The coursework is often critiqued as "too ivory tower" and remote from the needs of the classroom; teachers report that most of what they learned came from their field experiences and not from their teacher training program, which is often regarded more as a rite of passage than a true professional preparation. The standards of entry are quite low—teachers are taken from the bottom quartile of college graduates (Lortie 1975). Teacher education has been critiqued as distant from clinical practice (Alter and Coggshall 2009; Grossman et al. 2009). Whether these perceptions of teacher preparation are true or not is beside the point; teacher education is not viewed as a rigorous, worthwhile experience that prepares its participants with practical know-how or the intellectual hardware to help children achieve (Lortie 1975). Perception is reality.

Against this backdrop, lesson study offers features that address some of the challenges of preservice teacher education enumerated above. Here I want to argue

that it is the research lesson that distinguishes lesson study from other forms of teacher education. The research lesson provides the sense of time and urgency that is otherwise absent in preservice education (Zeichner 2010). Lesson study's apex is the research lesson, the actual enactment of a lesson with real children in a chosen classroom. The planning beforehand is the lead, and the reflection and revision afterward its denouement. That all elements build toward a publicly viewed live lesson anchors lesson study in practice. Other instructional designs in teacher education may encompass the planning phase of teaching or the defining of a problem of practice. They may include reflection on a videotaped excerpt of classroom teaching and suggested revisions. But the centerpiece of lesson study that lends time and urgency so integral to practice is the research lesson. This is where the fruits of reflection, deliberation, and practical judgment are reintroduced into the test of real-time work. In this sense, lesson study inquiry is driven by practice, and the standards to which its outcomes are judged are practice-based (Stigler and Hiebert 1999).

Lesson study is typically conducted with inservice teachers or predominantly inservice teachers with a few preservice teachers mixed in. Because teachers drive so much of the lesson study process, preservice teachers' relative lack of experience with children and their thin knowledge of curriculum are limiting factors. Also, preservice teachers are not always cohorted long enough to constitute a stable community of practice that can build knowledge and experience together over time, a hallmark of lesson study. Yet some of lesson study's virtues are especially relevant for preservice teachers. The research lesson and the fact that the collaborative planning beforehand and the analysis afterward are anchored to an actual lesson with real children in real time lend a verisimilitude to "real teaching" that captures the urgency of teaching work and the essential feature of teaching—that all one's cases are present simultaneously. These features of lesson study make its constituent activities more credible for preservice teachers than other practices conducted at a remove from classroom life. And lesson study intervenes on the notion that teaching is a private affair. Teaching is, in lesson study, very much a public enterprise. Planning for a lesson is collaborative, and the actual teaching of the lesson is conducted in the presence of a roomful of colleagues. This is not trivial in a culture where the norm is for teaching to proceed behind closed doors (Lortie 1975).

3 Conducting Lesson Study in a Preservice Methods Class

A single cycle of lesson study was conducted within the confines of a semester-long preservice mathematics methods class at a large public university. All preservice teachers in this class were undergraduates nearing the end of their teacher preparation program; none had any formal experience as teachers although they may have had informal experiences volunteering in schools, working in summer camps, and tutoring. There are special logistical and substantive challenges to manage lesson study in the context of a university course:

1. Coherence with methods curriculum: a university preservice math methods class has its own curricular demands, so it is not self-evident how lesson study can be woven into the fabric of such a class and whether it adds intrinsic value to students' experience.
2. Access to a classroom of children: Preservice methods classes that meet at the university must find a willing classroom of children, arrange ways to get there, and become sufficiently informed about the learning needs of a class virtually unknown to them.
3. Knowledge base of preservice teachers: Preservice teachers by definition have relatively little knowledge or experience with children and curriculum. Because participants typically drive so much of the lesson study goals and lesson design, for preservice participants, accommodations are necessary. This involves some modifications to the canonical form of lesson study that some might say constitute deviations from its essential features.
4. Time. In a course that is already short on time for covering the content preservice teachers need, carving out time for lesson study is a challenge. This is especially acute because lesson study is not the completion of a single lesson study cycle; the power of lesson study is typically realized in its continuing conduct through multiple cycles. The timeline for the lesson study cycle is shown in Fig. 1.

In this lesson study cycle, preservice teachers were invited to prepare an introductory lesson on decimal numbers, with an emphasis on conceptual understanding, by the teacher of a local fourth grade class. There was almost no contact between the school, classroom teacher, instructor, and students in preparation for the research lesson. All 23 preservice teachers in the methods class participated in all aspects of the lesson study cycle described here.

To plan a lesson for the fourth grade class, preservice teachers studied the children's textbook materials introducing decimal numbers in *Everyday Mathematics* as well as sections of other textbooks on the same topic, including *Mathematics* published by Scott Foresman–Addison Wesley. The preservice teachers also examined where this lesson fell in the textbooks' scope and sequence of curriculum in Fourth Grade *Everyday Mathematics: Teacher's Manual and Lesson Guide, Volume A*, to see its introductory presentation of decimals. To better understand the topic, preservice teachers also studied a relevant chapter in their course textbook (Van de Walle et al. 2004) as a resource.

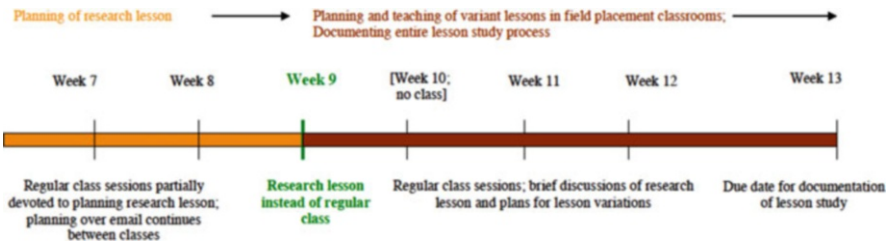

Fig. 1 Timeline for modified lesson study in preservice mathematics methods class

In contrast to the shared goal setting that inservice teachers determine as part of standard lesson study practice, in this case the classroom teacher set the goals for the lesson: fourth graders "will gain a conceptual understanding of part-whole idea in decimal numbers." The preservice teachers then spent about two hours in each of three class sessions talking about the mathematical topic of decimal numbers and considered various possible contexts for teaching this idea. The preservice teachers worked in small groups to generate possible decimal representations or story contexts and as a class explored each one in depth. For example, one preservice teacher suggested that times in sporting events are reported in tenths of a second, and this context was thought to be an engaging one for fourth graders. An athlete's achievement in a race, for example, is reported in seconds: 10.7. This was a context in which children would understand that the small differences in time represented by the decimal numbers matter. Another part of the reasoning here was that children like sports and this would be a familiar context. On the other hand, preservice teachers noted that a possible source of confusion could be that running times can be expressed in minutes and seconds (fractions of one-sixtieth), as in the following: 35:58, which represents 38 min and 58 s, not tenths or hundredths of minutes. Another suggestion was to have children create a situation that would generate statistics with decimal numbers in them—this suggestion involved launching toy cars from ramps of different heights to see the time and distance traveled. These would be measured in decimal numbers as well. This was also thought to be an engaging context for children and familiar to them as a game. The physics of the activity and how well the cars could be controlled and measured were presented as possible drawbacks. There were many such possible contexts explored. Here one preservice teacher recalls the planning phase:

> Before deciding on these types of problems, we contemplated several other ideas. One was to use money. We knew from our interviews in project one that fourth graders were able to "understand value and purpose with converting dollars into cents." While money is an easy topic to use in story problems, money would be difficult to translate into thousandths. The language difference between decimals and money may also have to be explained. For example, $4.46 would be read differently than 4.46. These are good points to raise about the use of money. Another idea was to use a number line. We thought that students could use a number line to find where certain decimal numbers fit in relation to one another. The difficulty with using a number line is that it doesn't lend itself easily to story problems that would be engaging to fourth graders. Another was to use a stopwatch to measure time. We were unsure to which place stop watches measure time, so we were hesitant to use it in our story problems. (Lara[1])

Three sections of this mathematics methods course were being offered during the same semester; all sections followed a common curriculum with instructors from all three sections collaborating a great deal, although only this one section included a cycle of lesson study. The instructors from the other two sections attended a single class session to contribute to the discussion of lesson planning that focused on learning the terrain of the topic. Later, a group of mathematicians and mathematics

[1] All names are pseudonyms.

educators in a university study group in mathematics education provided feedback to lesson plan ideas via email as the preservice teachers developed the research lesson.

Transcripts from the class' planning sessions document the preservice teachers' proposed approaches to teaching decimals. Mostly they were searching for a real-world context in which decimals appear. In one brief class discussion, the following possible contexts were mentioned: finish times for race cars, elapsed times for Olympic sporting events, money, bank balance sheets, digital thermometers, linear measurement using meters and centimeters, and odometer displays of mileage. For each context, the preservice teachers would consider its appeal to children, the complexity of the representation, the display of decimals, and feasibility. So, for example, the children's textbook, *Everyday Mathematics*, employed the odometer as one context where decimals are found. The preservice teachers in this discussion raised the following questions: "How many fourth graders have been behind a steering wheel? Does every child have a car in their family?" As one preservice teacher observed, "This just doesn't seem very 'everyday' for a fourth grader." There were similar deliberations around bank balance sheets: "You'd have to understand this format. How many kids would be familiar with a bank balance sheet?" Another added: "The context [of a bank statement] plus the decimals seems overwhelming." There was a very interesting exchange around how race times are displayed and whether this would be confusing or helpful: "There are multiple ways that race times are shown on a stopwatch. There's zero, zero, zero, and the decimal point. We'd have to do something that wouldn't go into minutes so that you'd have decimals." "The display is zero zero colon zero zero." "No, the display goes colon zero zero minutes colon seconds point decimal points." In reading over this transcript, the preservice teachers were concerned about the authenticity of the contexts and the representations of mathematical ideas. Does a context appeal to children and make use of their life experiences? Are decimals displayed in a clear and comprehensible way? In contrast, the comments of the mathematicians and mathematics educators who came to visit the methods class brought the preservice teachers back to mathematical concerns that were more pedagogical in nature. One asked whether the representation of base-ten blocks in *Everyday Mathematics* would confuse children about part and whole when the unit switches between a unit cube and a larger cube representing 1000. Another instructor asked a parallel question regarding measurement with centimeters and meters: What would count as one whole? These kinds of questions had not been raised by preservice teachers. The questions raised by the mathematicians showed how robust mathematical knowledge can make possible the consideration of pedagogy in new ways. If this single joint meeting with the preservice teachers and the mathematicians and mathematics educators is representative, it was clear that knowledge of teaching techniques is limited absent what Ma has called "profound understanding of fundamental mathematics" (Ma 1999).

The preservice teachers continued to weigh different approaches in the design of the research lesson. As the research lesson date approached, there was a flurry of email between class sessions as participants were still deciding what tasks to try and in what sequence. In the end, the instructor chose the "broken calculator" idea that is

Mrs. Hayward's calculator is broken. The problem is that the 6 key doesn't work. I
you type 6, it doesn't show anything in the display.
Is her calculator useless now, or can she figure out a way to use it to do any problems she wants?

Can she still display any number she wants into her calculator?
We are going to explore this and decide.
My prediction and reason:

My conclusion and reason:

Can she get her calculator to show these numbers? Try each one, and write down the steps you think she can take.

406	4.06
.65	1.065
3.640	6.000
5.62	6.66

Fig. 2 Research lesson handout

shown in Fig. 2 and formulated a few "warm-up" exercises to precede that central task.

On the day of the research lesson, the entire class met at a local elementary school instead of the university classroom. The university instructor taught the lesson designed by the class; preservice teachers and other university instructors observed and took field notes. The research lesson was videotaped and transcribed; all children's work was collected and scanned so that all preservice teachers could analyze the children's work. As seen in Fig. 1, for 2 weeks following the research lesson, homework assignments included reflections on the research lesson including examination of all records of practice, and class meetings devoted an hour each week to sharing analyses of the research lesson.

4 Participation Structures in Lesson Study

Figure 3 notes the ways in which participants' roles were modified for the conduct of lesson study with preservice teachers. In lesson study with inservice teachers, facilitators or teacher leaders endeavor to cede authority to the teacher participants (for more on this, see Lewis, J., Chapter "Learning While Leading Lesson Study," this volume). Teachers are meant to lead all aspects of lesson study: select the learning goals for students, drive the study toward that goal and devise a research lesson plan, teach the lesson in front of peers, and collect and analyze the data from the research lesson. In a preservice context, these roles are modified by necessity. The instructor plays a more dominant role, leading with a stronger hand than a facilitator might with more experienced teachers. The instructor's knowledge and experience with children, curriculum, and teaching dictates that the preservice participants lead less and observe more, although all are able to participate to varying degrees. The exception to this rule is in the post-lesson analysis and reflection, when data from this cycle of lesson studied showed that preservice teachers and their instructor were able to contribute nearly equally. And in fact, because the instructor taught the research lesson and the preservice teachers observed and collected data, in many ways their reflections and analyses were stronger and more evidence-driven than the instructor's. This inversion of the typical asymmetry between instructor and students in a university class is a noteworthy feature of lesson study; we will return to this later in the chapter.

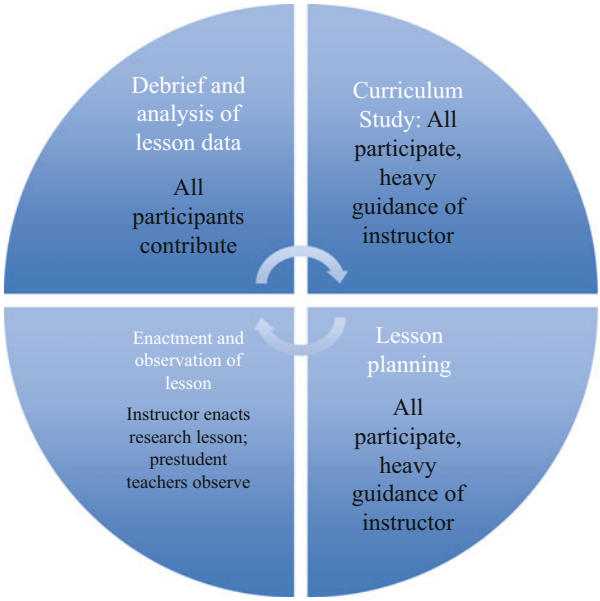

Fig. 3 Roles for inservice versus preservice participants in a cycle of lesson study

5 Method and Data Sources

This study followed the tradition of teacher research as "systematic self-critical enquiry" (Stenhouse 1985, p. 8) to generate knowledge *for practice*. For this specific study, the intent was to generate knowledge for teacher educators and for preservice teachers, to be used in practice (Lampert 1985). Brown (1992) described how her work as a researcher-teacher allowed her to develop "a theoretical model of learning and instruction rooted in a firm empirical base" (p. 143). Brown's work demonstrated the ways in which a researcher-teacher could create or design teaching and learning situations that she may not find in the field or laboratory. This kind of research is problematic, Brown says, because one cannot control variables, but it is useful because it captures the realities of classroom life, and it projects what is possible in the classroom with all its complexity and variability and unpredictability.

For this research, the primary data sources would be the preservice teachers' work in multiple forms and other artifacts of classroom practice. These data sources include transcriptions of class videotapes, lesson plans, and field notes, instructor's field notes following each class meeting and the field notes of observers, and the written notes and assignments of the preservice teachers in this cycle of lesson study. Children's written work from the research lesson was also collected. Preservice teachers in this university methods class kept a class journal that contained responses to specific writing prompts assigned during each class session. In addition, an extensive assignment that required the preservice teachers to document their experience of the lesson study cycle was also analyzed.

Following Glaser and Strauss (2017), the purpose of data collection and analysis for this research was to develop theory that would contribute to our understanding of preservice teacher learning in lesson study. It is important to note that preservice teachers learn from many experiences in and out of their coursework, and it is impossible to attribute their learning exclusively to lesson study. By comparing preservice teachers' spoken and written artifacts from their methods course before, during, and after the lesson study cycle, we are able to generate some hypotheses about how lesson study may have contributed to their evolving views about teaching, learning, and mathematics.

All data sources were analyzed using QSR NVivo software for qualitative data analysis, with more careful inspection of data from four focal preservice teachers. Preservice teachers' written work and all relevant transcribed talk were coded at the sentence level or greater, labeled with themes that stood out for each passage. The qualitative analysis software allowed for open coding without any hierarchy or order at first; codes were later grouped and reordered as needed. Passages of written work or transcribed talk could be coded such that they appeared in multiple categories. Several rounds of qualitative coding were conducted to analyze the data: first, using open coding (Corbin and Strauss 2008), one researcher coded all the data. Open coding produced 107 codes at the outset. These were grouped into five focused codes. These five focused codes were identified through inspection of the coded data, naming emerging themes and noticing categories and patterns (Corbin and Strauss 2008). Following open coding, the researcher recoded all the data with the focused codes.

6 Results

Five broad categories of preservice teacher learning are apparent in the data from this study: mathematical care, general pedagogical concerns, views of mathematical pedagogy, beliefs about instructional design, and development of the teacher identity. In this chapter, we will examine three of these themes: the disposition of *mathematical care* evident in preservice teachers' discussions of the lesson and in their planning for other lessons; the refinement and expansion of possible *pedagogical moves*, where mathematics, children, and pedagogic design are seen to compose an interdependent and dynamic system; and the emergence of *teacher identity*, a teaching self that is clearly developing over time. Each represents a domain of teaching practice. *Mathematical care* is a disposition in teaching, a way of approaching the work, a cognitive state that organizes how a teacher thinks about what comes at her. *Pedagogical moves* are acts that teachers perform; they are driven by dispositions perhaps but visible as actions. The language of "move" recalls chess moves or dramatic moves that are contingent, conscious responses to earlier events and that occasion events to follow. *Development of teacher identity* is located in the domain of self as instrument in instruction and is an emerging awareness and cultivation of the self in a professional role; it is a form of embodied knowing (Belenkey et al. 1986). Taken together, these domains constitute a whole of practice by including dispositions, ways to act, and knowledge of the self. The table below shows some of the categories of preservice teacher learning revealed in the data and discussed in this chapter (Table 1):

Table 1 Selected categories of preservice teacher learning in lesson study

Mathematical care (*dispositions*)
Specific numeric considerations
Analysis of math processes
Mathematically worthwhile
Math taught to self
Children's perceptions of math
Pedagogical moves (*actions*)
Meticulous use of language
Teaching for understanding
Precision in representations
Linking classroom management to content learning
Attention to time allocation
Teacher identity (*self-knowledge*)
Own math knowledge
Personal needs vs student needs
Emotions in teaching
Confidence and vulnerability

6.1 Mathematical Care

"Mathematical care" is the name for an umbrella category encompassing 20 different subcategories coded under mathematical capacities, such as "the use of actual number examples," "mathematical analysis," "mathematically worthwhile," or "taught self this math." Preservice teachers' writing and discussion surrounding lesson study was remarkably full of mathematical concerns expressed in such subcategories—this constituted 40% of the text units in the preservice teachers' writing, up from 27% in their previous work in the methods class. And the level of detail was striking. In the passage below, Ariana describes her teaching a lesson in her field placement classroom following our research lesson. She designed a lesson also on place value but modified for first grade. Note her careful consideration of numeric choices in the lesson:

> For the first number, 12, almost everybody used one long and two cubes.[2]
>
> Many may have "borrowed" this idea from their neighbor, but I think that's ok.
>
> The important thing was that everybody could count the long as ten and add eleven, twelve for the cubes.
>
> For the next number, 21, answers varied a bit more. One student demonstrated two longs and a cube at the overhead and another showed one long and eleven cubes. Both counted longs as ten and cubes as singles.
>
> The final number they made was thirty-four and it was wonderful to see one of my "struggling" math students put three longs on her mat, count ten, twenty, thirty, and then add four cubes! The student who was picked to demonstrate her answer on the overhead, however, showed she wasn't quite getting it. She put down two longs and four cubes. When asked to count her number, she reverted back to one-to-one correspondence and counted twenty-four. We asked, "You've got twenty-four, how can you make it thirty-four?" She added a cube instead of a long. Because she is not yet counting by tens, it is not surprising that she did not automatically add ten. She counted her total again and got twenty-five. (Ariana)

There are a number of points to note in this passage. One is the mathematical detail that she provides in her description. Ariana references actual numbers, repeatedly, and she provides specific detail about how children composed and represented those numbers: "The final number they made was thirty-four and it was wonderful to see one of my 'struggling' math students put three longs on her mat, count ten, twenty, thirty, and then add four cubes!"

Why does this matter? How is this different, and more helpful in teacher education, than simply asserting that one child, who usually struggles in math, seemed to understand? This preservice teacher's discussion of mathematical details matters for a number of reasons. Reflections on teaching rarely include the kind of detail about content, and about children's encounter with content, that allows for teacher growth. The recounting of precise details about how the content can be represented—longs and cubes here—and how children think about them, "ten, twenty, thirty, and then add four cubes" here, provides a window onto the minutiae of practice that so often

[2] A "long" is a rod of 10 units in length; a "cube" is one unit.

fly by in practice and therefore elude consideration outside of a structure like lesson study, where observation of instruction in the company of one's colleagues is the norm.

"Mathematical care" was supported by preservice teachers' use of academic resources on and about teaching, which otherwise seem so remote from the "real work" that teachers do. Lesson study builds a credible context in which these academic resources on teaching suddenly strike preservice teachers as valuable. A classic example is the struggle in teacher education for students to find relevance in the readings and assigned exercises they do in coursework to their work vis-à-vis their fieldwork. This lesson study cycle prompted participants to draw upon readings from their methods course to explicate what they saw in the field. In papers the preservice teachers wrote about the lesson study cycle, readings were referenced extensively, without any prompting. This contributed to their growing "mathematical care." Excerpts from two preservice teachers' papers below show this:

> The course readings have given me a strong idea of what children are expected to learn in place value. According to one reading, students should develop a full understanding of number meanings from their transition through K to 5, as well as begin to experience some number sense for large numbers. Ideally, students will be able to perform and understand the following:
>
> 1. Perceive sets of ten (and tens of tens) as single entities. These sets can then be used to describe how many. This is the main principle of base ten numeration.
> 2. The positions of digits in numbers determine what they represent – which size group they count. This is the main principle of place-value numeration.
> 3. There are patterns to the way numbers are formed.
> 4. The groupings of ones, tens, and hundreds can be taken apart in different ways.
> 5. "Really big" numbers are best understood in terms of familiar real-world referents. (Van de Walle et al. 2004). (Alissa)

> "A full understanding of place value includes a complex array of ideas and relationships that develop over the K-6 grade span." (Van de Walle et al. 2004, p. 149)
>
> Place value concepts build on earlier number ideas (Ibid. 150). While children in kindergarten begin to count beyond the primary numbers and up to 100, it is counting by ones, based strictly on one-to-one correspondence with no conception of place-value ideas. They can neither sort by tens for counting purposes, nor explain the value of the tens place (Composite Picture of What Children Know About Place Value, handout, ED 518, October 10, 2002). It is a "pre-base ten understanding" of numbers referred to by some researchers as "unitary." (Van de Walle et al. 2004, p. 150) (Malorie)

"Care" in the term "mathematical care" combines commitment to student learning with appreciation for mathematics, along the lines of what Bruner has called "intellectual honesty" (1960, p. 33): "Any subject can be taught effectively in some intellectually honest form to any child at any stage of development." It combines attention to the discipline with attention to the learner. Thus, mathematical care is comprised of both pedagogical attunements and mathematical attunements. Both are needed.

The following passage from the debriefing of the research lesson illustrates the intent focus on aspects of mathematical import. The preservice teachers are discussing how decimal numbers should be read and how much to press for conventions and accuracy when reading such numbers aloud:

PT[3]	Oh I have a question about Carolyn, and she was up there [in front of the class] with a calculator and then she was explaining how, what her thinking was and the reason that she was going to, she had the one point zero two five and that she was going to add four. And I wondered if that was going to get her in trouble and then I, you didn't talk about it at all or anything and it worked [inaudible] out but I wondered and everyone seemed to understand what she was talking about, I did too. But I –it's just one of those things that can be misinterpreted in a way.
I	I've found their oral language often [inaudible] will trip them up and they were trying to figure out what to call something that was like one point zero six five, how do you say that six five? You know we went through having them say them in a lot of different ways but in terms of how to quickly, explicitly say that number and use correct mathematical terms that wasn't something that the kids were really comfortable with oral language.
PT	Sometimes they said point six hundred and forty and that was [inaudible] is that, do you think that that's acceptable because I know you didn't, you said oh that's another way but you didn't make a note that you wouldn't want to say it that way.
I	What did I do, who knows what I did with those, there were a bunch of them?
PT	You'd say it, you'd say okay one hundred, or one point two [inaudible] thousandths should've corrected in saying it again but without bringing attention [inaudible].

In this exchange, the preservice teachers are wondering aloud about the accuracy of children's oral productions. They question how much adult correction is needed to make public utterances comprehensible and how this would make the child feel in public. There are at least three levels of possible intervention under consideration: (1) the teacher faithfully revoices the student productions, right or wrong; (2) the teacher restates, in correct conventional form, but without commenting on the change; and (3) the teacher restates correctly but makes public the nature of the change made, so as to make that an object of instruction.

6.2 Pedagogical Moves: Ways to Act

Preservice teachers showed an expanded facility with nuanced pedagogical moves through their work in lesson study. The data show an increased ability to notice and consider the manipulation of fine-grained teacher actions to occasion learning, and participants were more likely to approach instructional planning with an experimental stance. Prior to the lesson study, there was little mention of what a teacher would have to do to make a task work with children—that was taken for granted and therefore left invisible. It was not until the research lesson that the preservice teachers on their own would initiate conversations about what a teacher would have to do, in its most considered detail, and how such subtle teacher's moves could shape instruction differently. They wondered aloud about trying out a variety of moves and thought about the respective outcomes for children's learning. This heightened sensitivity, I should note, was the ability to consider or analyze what a

[3]PT = preservice teacher; I = instructor.

teacher would do or had done, either by observation or in an imagined future lesson; it is important to distinguish this from their ability to execute such actions in the flow of instruction. The preservice teachers' growing ability to notice, discuss, and dissect fine-grained teaching moves can be seen across a number of subjects: meticulousness regarding teaching language, commitment to conceptual understanding, design of instruction, and concern for management issues. Below I consider each of these four in turn.

Meticulousness Regarding Teaching Language From the research lesson forward, the preservice teachers demonstrated a newfound meticulousness regarding teaching language. For example, in the post hoc analysis of the research lesson, one of the preservice teachers began to play with alternative wordings of pivotal discussion questions in the lesson for fourth graders. Carly, one of the preservice teachers, asked the following in the post-lesson discussion:

Carly:	I wrote down, I heard you saying a lot of, "What do other people think?" to get other people involved and get their opinion. I was wondering if it helps or doesn't help to say, "Is anyone thinking something different?" Cause like I felt like when you said, "What do other people think?" they kind of just went along with what the first person said rather than finding other answers.

The conversation continued, with the instructor and the preservice teachers considering how different phrasings of this might play out. What would different wordings elicit from children? How would the substance of children's ideas be changed by alternative formulations of this prompt? This indicated a careful attention to nuances in lexical choice and inflection and how these choices shape what is learned. Again, what is remarkable here is the degree to which choices of language were understood to affect the mathematics and what children would learn, as well as how they would feel. This playing with alternative wordings does not appear prior to the research lesson.

Luke, another of the preservice students, picked up this same thread a few minutes later in the debriefing, following on Carly. Luke: "You could ask questions that distinguish between 'Does everyone agree?' and 'Does anyone think differently?'" He then continues, voicing the implications that may follow from these alternative wordings: "Kids will learn to read whether the teacher is signaling correctness. You would need to learn to question equally. What questions would you ask of right and wrong answers so that the kids don't guess from the way you ask if something is right or wrong?" The preservice teachers were experimenting with different possible teaching "moves" in the debriefing session that followed the observation lesson.

Emphasis on Conceptual Understanding The preservice teachers returned again and again to the idea that children should attain conceptual understanding of mathematics, and this appeared in their views of children and of instructional design. This is related to mathematical care but is expressed in a set of actions and thus is included as a pedagogical move rather than a disposition.

Often this commitment to conceptual understanding is stated as a kind of policy orientation regarding mathematics teaching, as Kayla has done below. She links what a child is learning now to that child's mathematical horizon.

> We were able to see that without a conceptual understanding or at least the beginnings of a conceptual understanding, students' difficulty in understanding Place Value appeared to increase as the grade level increased. For example, an area that strikes me as one that students have difficulty with is the idea of "applying" the concept of Place Value to math work. A student might be able to point to the ones or the tens place in a number, but he or she might not be able to transfer this knowledge to the organization of an operations problem, and might therefore come up with an incorrect answer or come up with an answer that he or she doesn't understand. A false sense of understanding will not be useful as the math being taught in school becomes more complex, and demands a conceptual understanding of Place Value. (Kayla)

Classroom Management Linked to Content Learning Like most preservice students, these students were greatly concerned with issues of classroom management. They worry about how they will lead children to do a particular task, pay attention to the learning at hand, follow directions, and maintain order. These are not simple demands for new teachers, though once overcome they are practiced with little self-awareness. These concerns occupy little of the teacher education curriculum at the university, and they are viewed as incidental and even a bit beneath the lofty goals of teaching content of intellectual heft. What was noticeable in the lesson study cycle is that the preservice teachers talked about management concerns in ways linked directly to ambitious learning goals for their pupils. There are numerous examples of this from the preservice teacher work; here is one:

> After watching the lesson taught at North Bluff Elementary, I immediately wanted to redesign the lesson to appropriately teach my Kindergarten class of 22. I felt that the lesson's overall goal of Place Value was very fitting to the learning needs of the Kindergarteners with which I work. Through the several lessons on Place Value that I have taught to this class, and through the information that I gathered as a result of [an earlier assignment], it has become clear to me that my students need as much exposure to Place Value as possible. As I thought about how to redesign this lesson for my class, I knew that I too, wanted to use a type of manipulative, and thought that I might also be able to include a part in the lesson similar to the work that was done with the "Broken Calculator." I chose to use Unifix cubes for the manipulatives, and I had made enough sticks of 10 for each student in the class. I decided to use Unifix cubes because they are easy to handle, brightly colored, and the students have worked with them before in a mathematical context. I chose to make sticks of 10 for them ahead of time not only to save time, but also to emphasize the importance of learning about groups of 10. By this I mean that I was able to make a big deal of the fact that I had made these special sticks which I think helped to get their attention focused on what we were doing. (Kayla)

Kayla has management concerns: she wants materials that are "easy to handle, brightly colored, and the students have worked with them before." But these management concerns are linked to mathematical learning goals she has for her kindergarteners: "I chose to make sticks of 10 for them ahead of time not only to save time, but also to emphasize the importance of learning about groups of ten . . .[this] helped to get their attention focused on what we were doing."

Awareness of Time The preservice teachers gave much attention to the issue of time in instruction. They were concerned about how much time tasks will take, how time can slip away, and how time is the enemy of understanding. Their lesson plans after the lesson study experience were filled with careful consideration of timing and of instructional sequence. This attention to time was not found in their prior work, and unlike the earlier issues that were on the table throughout the semester (children, mathematics), time was not explicitly asked about in course assignments or in my directions.

> Time is also a factor in my thinking these days. There is never enough of it when teaching a mathematics lesson, which basically means, that if you are going to be pressed for time, you need to be very certain that you are conducting a review and not presenting new information. Exploring new concepts in mathematics is something that requires a good deal of both time and patience. Being patient, seems almost impossible to me when I am constantly watching the clock. (Leah)

Related to time, the preservice teachers are very conscious of sequencing in lessons. A number of preservice teachers raise the issue of sequencing ideas in a lesson. Here is an interesting example below. Note the repeated use of the term "next step" and the mathematical details contained in this participant's comment from our post-research lesson discussion:

PT	The issue with the money, do you think the next step for that class would be that in order to add decimals you've got to be talking about the same type of unit? So that that way they'd know that to have cents that they would have to add one hundred and five cents to their one penny, one cent, that they would have to change just like they change fractions, that might be a next step to have to add similar units when you're talking about decimals.

6.3 *Attention to the [Teaching] Self: Embodied Professional Knowing*

The preservice teacher work in the lesson study shows a good deal of attention focused on the self as a developing teacher. In their writings more than in discussion, the preservice students talk about themselves in the guise of a teaching persona, and this was an unexpected finding. This is frequently cast in terms of an awareness of their own mathematical understandings:

> This lack of conceptual understanding might seem alarming, but, in fact, we have found in our own graduate-level course work that we college students have some of the same misconceptions. We could throw our hands up in frustration and continue to teach the same way that we were taught, but I believe it is this lack of conceptual understanding that allows even our most procedurally fluent students to make mistakes. As a new teacher, I have to tackle my own misconceptions, and use what I learn to help my students. (Ariana)

The preservice teachers make frequent reference to their insecurities about their mathematical knowledge. Interestingly, Leah ties this to what this means for

instruction, as many of the preservice teachers did. Seeing the teaching self in this way is challenging and takes courage. There were repeated comments in the preservice students' papers about the need to learn more mathematics so that they could teach well. There were also candid and critical portrayals of their missteps in teaching. See, for example, Leah:

> Unfortunately, I have to take some (or most) of the credit for my students' confusion. As noted in my lesson plan, I was supposed to start out by asking students to create some examples of their own, in regard to the thousandths place. I was then intended to ask how they knew it was the thousandths place. I was hoping for a very brief discussion that would allow me to assess where some of my students were in their abilities with place value in regard to decimals. I had also hoped that my questions would get them thinking about decimals, by activating their prior knowledge. (My cooperating teacher assured me that this would be a review for the majority of students; this was absolutely not the case.) Regardless of that setback, I blew it when I launched right into the "All-Star Runner" problem. I was so nervous about not having enough time, that I did not follow my lesson plan. Consequently, students did not have time to warm up to the problems I was about to present. Equally problematic was the fact that I did not clarify the objective for them. They were likely unprepared to thoughtfully participate as I said, "We will be working with decimals today" and then launched immediately into the worksheet. When we got to the part about ordering decimal numbers, I did not explain what that really meant. I should have given them a clear illustration, some examples to back up what I was trying to convey and then asked their thoughts on how to correctly order decimals. . . . So did I teach a lesson? Yes, I did. Did I "teach" my students? Unfortunately, the answer to that question is a resounding no. Additionally, I may have confused them in the process. Although this is very disappointing to me, it did cause me to learn a great many things about myself and the way that I need to "teach" mathematics in the future. (Leah)

Kayla, upon reflection, comes to see how her own needs for order may have cut off a child's opportunity to think out loud. She realizes this only upon listening to an audiotape of her lesson:

> I found it very difficult to handle students calling things out and was not happy with the way that I handled all the outbursts. For example, at one point, the boy who had been continually calling out shouted out an incorrect answer. In the split second that it happened, I reminded him that he needed to raise his hand. However, when I went back to listen to the tape, I realized that his calling out might have been an interesting teaching moment if I had let him expand upon his thinking. I felt badly listening to the tape when I realized this, but feel torn as to how to handle those situations. (Kayla)

The preservice teachers show a great deal of self-awareness throughout their written work. They even had an occasional positive thing to say about their teaching!

> I think because of my excitement about the use of a visual representation I have never had such energy or anticipation before a lesson. I could not wait to start. This was the first time I had ever had the feeling that I had something so great that everyone was going to learn. I learned about myself that day that if I design lessons I feel really good about my energy level and desire to teach skyrocket. I was so excited to be focused on the fact that I felt students were really going to learn today and I am sure that excitement came through in my teaching. My body language was more animated. My voice was not monotone and I was having fun; so were the students. We had some banter about how funny it would be to see me run. Students were laughing and having fun. This is how I imagined teaching could be. Maybe not everyday, but a great deal of the time. Throughout this semester this is what I had been trying to improve. In most of my lessons I felt boring and flat. I wanted to have more

> interactions with the students, but I could not engage them. Now I know why, I was not engaged in what I was teaching. (Thomas)

What is clear from the many examples in the preservice teachers' writing is a sense of themselves physically present in their work and the kind of knowing that devolves from their presence in the classroom and in the work. This produces knowledge that is inaccessible to them otherwise. To emphasize this point, I use the term "embodied knowing" (Belenky et al. 1986). Dispositions are essentially cognitive even when they imply action, and dispositions can be present outside the physical reality of the classroom. Pedagogical moves are about doing things interactively with children and materials. Moves follow from dispositions or may lead to the formulation of dispositions. Knowledge of the self can be present when doing pedagogical moves, but it entails an awareness and use of the self in role. This trio of domains functions as an interesting set that can help us organize our thinking about teaching practice and points to areas where interventions in teacher education may be fruitful.

7 Challenges and Affordances of Lesson Study with Preservice Teachers

Lesson study is typically practiced in inservice settings, with experienced teachers. Lesson study is meant to be collaboratively led and participation voluntary. Neither of these features was present in this lesson study: the composition of the group and its leadership was preordained. The students in the preservice methods class were required to participate, and the leadership was not shared as much as assumed by me as the instructor. Catherine Lewis writes: "Top-down mandates and high-stakes assessment have well-known disadvantages, and many common forms of professional development appear to have little impact on instruction. Lesson study provides a collaborative process for teachers to make sense of educational goals and standards and to bring them to life in the classroom" (2002, p. 7). Lewis implies here that voluntary participation in a lesson study group is one essential ingredient for improving practice. Typically, a school or school district plans a number of professional development inservice days that teachers are required to attend. Teachers experience these as a random collection of workshops taught by consultants that may or may not be relevant for instruction. They have little choice but to participate and exercise no control over the content or format of most professional development opportunities. Lesson study, along this dimension, is a stark alternative. Teachers choose to participate, and Lewis suggests that the absence of a "top-down" mandate is key.

In a required course in a preservice teacher education program, of course, participation was not voluntary. It was "top-down" in the sense that the instructor required participation, and it may even qualify as involving "high-stakes assessment," since participation in the lesson study was graded. Is the voluntary,

collaborative nature of lesson study one of its essential qualities, or would their absence undermine the possibility of instructional improvement?

Lesson study in an inservice setting presupposes a level of experience and knowledge that preservice teachers are unlikely to possess. While a lesson study group commonly includes outside experts—mathematicians, psychologists, and mathematics educators—the teacher participants are assumed to have a repertoire of teaching moves, knowledge of curriculum, experience with the subject matter, and a sense of the children for whom the research lesson is being designed sufficient to draw from in the design of the lesson. In a preservice methods class, this background knowledge simply could not be taken for granted. Typically, participants join a lesson study group out of interest and desire—again, decidedly not the case for a required project in a required course. Nothing about this lesson study was voluntary for participants. No one came to the work driven by a burning question from practice or seeking opportunities to work in a collaborative environment. Would this process then have little impact on instruction, as Catherine Lewis suggests?

It is important to emphasize here the extent to which this version of lesson study was not driven by the participants but rather by the instructor and by the classroom teacher. This was especially palpable in the planning phase of the research lesson. Although the planning of the research lesson is meant to be a collaborative effort where all participants contribute, in this version the participants, the preservice teachers in this class, contributed very little to the design of the research lesson. There are gestures made at soliciting their ideas, but ultimately the lesson was designed by a team of university instructors, choosing contexts and numerical examples to populate the full lesson plan. This contradicts a fundamental tenet of lesson study, even if it was a logical adaptation given the background of the preservice teachers.

A more fine-grained examination, though, reveals a range of collaborative structures across this lesson study. There were degrees of collaboration across this lesson study, ranging from the minimal collaboration between the instructor and the classroom teacher to the multiple and complex forms of collaboration between instructor and preservice teachers and among the preservice teachers themselves. The methods course instructor, in this instance, also played the roles of lesson study facilitator and the teacher of the research lesson. This entailed collaboration with the fourth grade classroom teacher, mostly via shorthand conveyed between teachers who typically have little time for conversations about practice but who have many shared understandings of teaching. The overt expressions of collaboration were minimal.

What of the collaborations between the preservice teachers and their instructor? The contributions to the design of the lesson study were differential, as mentioned earlier. The instructor provided background materials and ultimately chose the tasks for the lesson. But the preservice teachers were strong partners in considering carefully each possible task, doing analytical work together that is a nice example of the kind of collaboration that lesson study promotes. Similarly, the post hoc analysis of the lesson was highly collaborative in nature. These discussions,

anchored in facets of the mathematical tasks, how children would and did perceive them, and what a teacher might and did say, show no distinction between instructor and the preservice teachers. The preservice teachers interacted as equals with the university instructor in these discussions. Certain tasks in the process promoted a kind of work together that erased differences in experience and formal knowledge base, while others were less symmetrical in nature. Finding and posing possible tasks for the research lesson drew more heavily on an expertise that preservice teachers do not yet possess; analyzing how the lesson itself played out and what children did as they learned allowed everyone to participate as more equal participants. This leads me to suggest that the facets of lesson study that require knowledge of curriculum, of child development, and of pedagogical method cast the role of instructor as a more "knowledgeable other." The facets of lesson study that drew upon observation of the enacted lesson and its analysis allowed all of us to participate on a more equal footing. This was, after all, a class of fourth graders unknown to all participants. This contrasts with the typical work between supervising teacher and student teacher, where the supervising teacher is clearly more knowledgeable in nearly every aspect of the relationship.

The preservice teachers also had an opportunity to watch the collaboration between methods instructors, who came to help design the tasks for the enacted research lesson. The instructors batted around several candidates for tasks and talked through how each would play out. This was an example of distributed cognition in teaching work (see, e.g., Hutchins 1996): the group of instructors was able to do work that individually they might not have accomplished. Similarly, the post hoc analysis of the research lesson could in no way have been as rich or multifaceted without collaboration. Such work depends on careful observation from many angles and perspectives and *of* many subjects. Viewing teaching, in all its complexity, is greatly enhanced by the company of others, and even with 23 observers, one has the sense that not all was noted. Collaboration in this context is not for its own sake; it is essential to seeing teaching and learning with clarity. One strong message that participants could glean from this practice in lesson study is that teaching in general benefits from collaboration: teachers see more and better, they design thoughtfully, and they observe and analyze multiple perspectives that only others can bring.

8 Conclusion

Lesson study revolves around the performance of teaching a lesson. And lesson study manipulates the perception of time in instruction. The research lesson plays out in real time, pretending to have been present in the longer flow of instruction that teaching entails. Time is also suspended in the cycle of a lesson study: long study sessions lead up to a single research lesson, and records of the research lesson are kept and referred back to, stretching one lesson over time for the lesson study participants. Lesson study also makes human agency visible in practice. There are a number of facets to lesson study that engender agency: the collaboration among

participants, along with the kind of apprenticeship that is afforded in this particular version of lesson study between instructor and preservice teachers. The cycle of planning a lesson, observing it, and then refashioning it promotes a kind of agency. I emphasize here in particular the opportunity to refashion or revise what has been done before as an opening for agency: one is not simply left to repeat mistakes or mimic a form.

Lesson study with preservice teachers requires extensive adaptations and in this case study produced worthwhile gains for participants. The research into lesson study with preservice teachers shared in this chapter indicates that lesson study cultivates mathematical care, provides teachers tools to weigh possible pedagogical moves, and contributes to a developing sense of teacher self among participating preservice teachers. Although the lesson study experience steals precious hours away from the normal routines and curricular demands of a preservice mathematics methods class, these outcomes present a compelling case for including lesson study in preservice experiences.

References

Alter, J., & Coggshall, J. G. (2009). Teaching as a clinical practice profession: Implications for teacher preparation and state policy. Issue Brief. *National Comprehensive Center for Teacher Quality*.

Belenky, M. F., Clinchy, B. M., Goldberger, N. R., & Tarule, J. M. (1986). *Women's ways of knowing: The development of self, voice, and mind* (Vol. 15). New York: Basic Books.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences, 2*(2), 141–178.

Bruner, J. (1990). *Acts of meaning*. Cambridge, MA: Harvard University Press.

Clift, R. T., & Brady, P. (2005). In M. Cochran-Smith & K. Zeichner (Eds.)., *Studying teacher education Research on methods courses and field experiences* (pp. 309–424). Mahwah: Lawrence Erlbaum.

Corbin, J. M., & Strauss, A. L. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Thousand Oaks: Sage.

Glaser, B. G., & Strauss, A. L. (2017). *Discovery of grounded theory: Strategies for qualitative research*. New York: Routledge.

Grossman, P., Hammerness, K., & McDonald, M. (2009). Redefining teaching, re-imagining teacher education. *Teachers and Teaching: Theory and Practice, 15*(2), 273–289.

Grossman, P., & McDonald, M. (2008). Back to the future: Directions for research in teaching and teacher education. *American Educational Research Journal, 45*(1), 184–205.

Hutchins, E. (1996). Learning to navigate). In S. Chaiklen & J. Lave (Eds.), *Understanding practice: Perspectives on activity and context* (pp. 35–63). Cambridge, UK: Cambridge University Press.

Lewis, C. C. (2002). *Lesson study: A handbook of teacher-led instructional change*. Philadelphia: Research for Better Schools.

Lampert, M. (1985). How do teachers manage to teach? Perspectives on problems in practice. *Harvard Educational Review, 55*(2), 178–194.

Lortie, D. (1975). *Schoolteacher: A sociological analysis*. Chicago: University of Chicago Press.

Ma, L. (1999). *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States*. Mahwah: Lawrence Erlbaum.

Stenhouse, L. (1985). *Research as a basis for teaching: Readings from the work of Lawrence Stenhouse*. London/Portsmouth: Heinemann Educational Books.
Stigler, J. W., & Hiebert, J. (1999). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom*. New York: Summit.
Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2004). *Elementary and middle school mathematics*. Boston: Allyn and Bacon.
Yin, R. K. (2017). *Case study research and applications: Design and methods*. Thousand Oaks: Sage.
Zeichner, K. (2010). Rethinking the connections between campus courses and field experiences in college and university-based teacher education. *Journal of Teacher Education, 89*(11), 89–99.

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