Mentor-Guided Lesson Study as a Tool to Support Learning in Field Experiences*

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Field experience can be a rich site for intern teachers to develop the knowledge and skills they need for effective teaching. Lesson study has been shown to be a powerful form of professional development that enhances practicing teachers' mathematical knowledge for teaching through collaborative inquiry with their peers. In this article, we discuss the use of mentor-guided lesson study to support mentor and intern collaboration in the field and share what we have learned about its potential to support interns' attention to student thinking. We will also share insights from the field for those interested in implementing this activity in teacher preparation coursework.

Key words: Preservice teacher preparation–secondary; Lesson study; Mathematical knowlege for teaching

One common feature of both traditional and alternative teacher certification programs is the experiential learning structure known as "student teaching," "field experience," or "internship." Regardless of what this structure is called, the purpose of the apprenticeship experience is for a novice teacher to take on increasing responsibility for instructing learners in actual classroom environments with mentoring from a more experienced teacher. The National Council on Teacher Quality reports more than 1,400 institutions of higher education require completion of a student teaching experience for teacher candidates (Greenberg, Pomerance, & Walsh, 2011). Moreover, teachers cite the field experience as the most valuable part of teacher preparation (Lortie, 1975).

The field experience provides prospective teachers with opportunities not only to engage in supervised practice but also to observe practice. How well prospective teachers learn by observing practice, however, is unclear (Brophy, 2004); in particular, novices may not yet have skills to notice key features of classroom instruction to support their learning (Star & Strickland, 2008). Given the recent attention to the role of mathematical knowledge for teaching (MKT) needed for mathematics teachers to engage in what Lampert, Beasley, Ghousseini, Kazemi, and Franke (2010) call ambitious mathematics teaching, we were interested in investigating whether structures supporting collaboration between prospective teachers and mentor teachers could focus prospective teachers' attention on student thinking during classroom instruction and therefore support their development of MKT.

Recent research has examined the effects of action research on prospective and mentor teachers (Levin & Rock, 2003). Lesson study, a particular form of action research, has been shown to develop teachers' MKT (Fernandez, 2005). Over the past 2 years, we have developed an assignment called mentor-guided lesson study for our secondary mathematics pedagogy courses to encourage collaboration between mentors and prospective secondary teachers (PSTs) and to focus prospective teachers on salient features of classroom instruction such as student thinking, thus heightening the knowledge and skills candidates develop in early field experiences. In this article, we will share findings from a mixed-methods study exploring the efficacy of the mentor-guided lesson study assignment in achieving these goals. Specifically, we will discuss: To what extent does mentor-guided lesson study support PSTs in noticing features of instruction relevant to developing knowledge for mathematics teaching?

Mentor-Guided Lesson Study

Initially used in Japan and widely used in other countries, lesson study is a form of teacher professional development that has gained increasing popularity in the United States (see Yoshida, 1999, and Stigler & Hiebert, 1999). In traditional lesson study, a team of teachers collaborates through four phases: (1) they formulate a goal for student learning; (2) they study their curriculum and plan a lesson that attempts to address the goal; (3) they investigate the implementation of the lesson by having one member of the team teach the lesson while the other members collect data through observation; and (4) they revise and

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reteach the lesson based upon careful reflection on the observations of the initial lesson implementation. Mentor-guided lesson study is a variation of lesson study in which the team includes a pair of PSTs and their mentor teacher. At our institution, PSTs complete a weekly 4-hour field experience as part of a secondary mathematics methods course required prior to student teaching or internship. The frequency with which PSTs visit their placements varies based on their schedules. Some students may visit schools just once a week, while others split their hours over multiple days. Mentor-guided lesson study (MGLS) is an assignment integrated with the field experience; it is PSTs' primary opportunity prior to student teaching to teach full lessons in the field.

Each cycle of the MGLS activity consists of four phases (goal setting, planning, teaching, and reflecting), and teams are required to complete two cycles during the semester (see Table 1). The role of teacher of the study research lesson is rotated among the team members to support collaboration. The mentor teacher assumes the role of teacher in Cycle 1, and the PSTs co-teach the research lesson in Cycle 2. Within a cycle, the PSTs complete five online Collaborative Learning Logs, which consist of reflection prompts designed to focus the team's discussions in particular ways during each phase. Sample questions from the Collaborative Learning Logs are provided as we discuss each phase of the MGLS activity below.

In the first phase of MGLS, Setting Goals, the team develops two mathematics learning goals for their students. For Cycle 1, mentor teachers guide the development of the learning goal, because they play the role of lead teacher and because their experience helps them anticipate difficulties for their students related to the mathematical concepts. After meeting with mentors to set the research lesson goals, PSTs collaborate to complete one Goals Development Log,[1] which is posted online as a private Google Form. The three log prompts are (1) "Write the content goal you have for this lesson," (2) "Write the process goal you have for this lesson," where a "process goal" is to address the specific Common Core Standards for Mathematical Practice (NGA & CCSSO, 2010) to be encouraged during the lesson, and (3) "Indicate any questions or concerns you have at this point about the goals you have developed for this lesson study." PSTs submit the Goals Development Log prior to the next phase so that the course instructor can review them and provide feedback to teams. Instructor feedback at this stage is warranted, since well-specified, researchable goals are important for a successful lesson study (Fernandez, 2002) and because writing lesson study goals is a practice that mentors may not need to engage in regularly. The only difference in the process of goal setting during Cycle 2 is that the PSTs set the lesson goals in consultation with the mentor.

Table 1

Breakdown of Assignments During Mentor-Guided Lesson Study Phases

	1. Setting goals*	2. Planning	3. Teaching	4. Post-lesson discussion	
Cycle 1	Goals Development Log	Topic Study Log Observation Guide Log Mathematical Context Chart Lesson Plan	Lead by MT	Post-Lesson Reflection Log Post-Lesson Debrief Log	Revised lesson plan End-of-Cycle Reflection Paper
	1. Setting goals*	**2. Planning**	**3. Teaching**	**4. Post-lesson discussion**	
Cycle 2	Goals Development Log	Topic Study Log Observation Guide Log Mathematical Context Chart Lesson Plan*	Lead by PST-Ms	Post-Lesson Reflection Log Post-Lesson Debrief Log	Revised lesson plan End-of-Cycle Reflection Paper

* Indicates places during the assignment phases where the course instructor provided feedback.

1 The prompts for the online logs were developed from materials in *Lesson Study in Practice: A Mathematics Staff Development Course* (Gorman, Mark, & Nikula, 2010).

In the Planning phase, the team designs a lesson plan to address their goal(s) and decides how team members will observe and document students' thinking during the lesson. As in the Setting Goals phase, a five-prompt online log (Topic Study Log) guides the PSTs in thinking about the mathematical content of their research lesson prior to meetings with their mentor teacher to plan the research lesson. Another four-prompt log (Observation Guide Log) structures teams' planning for data collection and observation. Prompts in these planning logs include—

"Discuss how you have addressed your concerns about your understanding of the topic. This may include working through related problems with your mentor teacher or placement partner or reading through textbook materials." (Topic Study)

"Which parts of the research lesson will allow your team to learn about students' progress toward the lesson study goals? What would you consider evidence of progress on the goals?" (Observation Guide)

In addition to these logs, each PST pair submits a completed lesson plan to the course instructor in advance of the lesson. For Cycle 1, the PSTs construct the lesson plan in a format used throughout our program. Because the mentor teacher assumes the role of teacher of the research lesson in Cycle 1, the course instructor does not provide feedback on the lesson plans to honor the mentor teacher's expertise and sense of efficacy in planning lessons. In Cycle 2, when the PSTs assumed the role of teacher, the course instructor provides written feedback about potential issues in lesson implementation, suggests student responses that may have been unanticipated, and supports PSTs' skills in lesson planning.

In phase three, Teaching, the PSTs observe their mentor teachers teach the research lesson in Cycle 1, whereas the PSTs take the lead and co-teach the lesson while the mentor teacher and, in some cases, other interns, observe in Cycle 2. Although not required, some of our teams were able to video record the research lesson enactment.

In the fourth and final phase of each cycle, the Post-Lesson Discussion, teams reflect upon the research lesson enactment and on possible modifications that would better achieve the desired learning goals. Within 24 hours of the lesson enactment, each PST completes an online, four-prompt Lesson Reflection Log. This log consists of prompts such as—

"List one or two observations you would like to share with the team. Be as specific as possible about the evidence of student thinking that you observed."

"In what ways did the lesson seem effective (or ineffective) in helping students understand the main mathematical ideas in the lesson?"

After the postlesson discussion, the PSTs complete a final, three-prompt online Post-Lesson Reflection Log. The intent of this log is not only for PSTs to report on any modifications their team decided to make to the research lesson, but also for participants to reflect upon their team's collaboration. Prompts on the Post-Lesson Reflection Log include—

"Discuss how your team came to make decisions about the revisions. You will want to discuss what seemed to be the most important pieces of evidence collected about what students learned."

"Discuss your impressions of how well your team collaborated during the debrief and revision process."

PSTs also submit a revised lesson plan and reflection paper at the end of the cycle. The process of completing this final phase is consistent across both cycles. Cycle 1 and Cycle 2 occurred approximately one month apart, based on the curriculum schedule of the mentor teacher's class. The teams were not required to reteach revised lessons within cycles because of typical scheduling issues involved with attending the placement on nonconsecutive days.

To assess PSTs' work in the lesson study cycles, the course instructor checked all of the log responses for completion and used a rubric to evaluate the initial lesson plan, the revised lesson plan, and the final reflection paper.

Mentor-Guided Lesson Study in the Context of Secondary Mathematics Methods Courses

We implemented MGLS in the second course (which we will call Methods II) of a four-course sequence of mathematics methods courses taken by prospective secondary mathematics teachers at a large university in the Midwestern United States, where students earn a bachelor's degree in mathematics while taking education credits required for certification. Teacher candidates typically take Methods I in fall semester, followed by Methods II in the spring prior to a year-long, full-time student teaching internship. Methods III and IV are taken during the student teaching internship year. At the time of this investigation, 17 students were enrolled in Methods II, and the first author was the instructor for both Methods I and II. During the Methods I course, 17 PSTs were grouped with eight mentors in four different schools, for a total of eight MGLS teams. Pairs (and one triad) were required to be in their placements for at least 4 hours per week throughout Methods I and II.

In addition to the field placement, Methods II included a seminar for 3 hours per week, where students explored practices supporting inquiry-oriented mathematics instruction, and a lab where students learned about practices related to teaching students with special learning needs. The MGLS was a focal assignment in the Methods II course and was designed to deepen PSTs' learning and capacity to collaborate with mentor teachers. The first MGLS cycle occurred after PSTs had been working in their mentor teacher's classroom for approximately two to three months in the fall semester, so that the PSTs were familiar with the students, curriculum, school context, and their mentor teachers.

Although all of the mentor teachers had taught for more than 5 years, mentors' experience with lesson study varied. Three of the mentor teachers were first-time mentors for PSTs in this program and had not previously participated in lesson study. Three other mentors had participated in MGLS once in the past, so they were familiar with the assignment. The two remaining mentors had participated in MGLS once and had completed three lesson study cycles with colleagues. Although these two mentors had lesson study experience, they had not used the Collaborative Learning Logs to guide each phase of the cycle.

Regardless of experience level with lesson study, all mentors participated in a half-day workshop designed and facilitated by the authors before PSTs worked in field placements at the beginning of Methods II. During this half-day workshop, mentors learned about phases of lesson study and the various assessments, such as the lesson plan requirements and Collaborative Learning Logs that the prospective teachers were to complete during MGLS. Mentors also watched videos of a secondary mathematics lesson study team during a postlesson discussion (from Gorman, Mark, & Nikula, 2010) and completed a simulation in which they wrote and revised lesson study goals for a given standard with guidance from the Methods II course instructor.

Investigating the Nature of PSTs' Learning through Mentor-Guided Lesson Study

Research on teacher learning during lesson study highlights how the process supports teachers' learning about mathematics for teaching (Fernandez, 2005) and promotes rich conversations about mathematics (Parks, 2008). Because these opportunities were some of PSTs' first to engage with students in an instructor role, we wondered which aspects of instruction PSTs would attend to as they completed each cycle of MGLS. To study the aspects of teaching and learning secondary mathematics foregrounded by PSTs during MGLS, we used techniques of grounded theory (Strauss & Corbin, 1990) to examine patterns and generate descriptions of themes present in the PSTs' reflections. The analytic process that we used to generate codes and themes in our data is specified in the following section.

Analytic Process

The primary source of data for this investigation was the Collaborative Learning Logs, which offered identical prompts for all PSTs, unlike the teams' lesson study conversations, which varied in content and form. Our analysis began with open coding, where we identified instances in the logs in which each of the PSTs reflected upon particular features of the research lesson related to his or her knowledge of mathematics, of students, and of teaching. After the initial open coding, we generated a complete set of subcodes for three emergent themes, which we named Analyzing Mathematics, Attending to Student Thinking, and Analyzing Teaching Moves. Using the constant comparative method (Strauss & Corbin, 1990), we further refined these categories and developed the coding scheme shown in Table 2.

The category Attending to Student Thinking differed from the other two categories, both of which have "analyzing" in their name, because these codes reflected observations, rather than evaluations or assessments, of student thinking. Reflections coded into Analyzing Teaching Moves were more evaluative in nature, such as discussing whether a teacher move was appropriate in relation to students' engagement or the class discourse about the tasks assigned. Likewise, reflections coded into Analyzing Mathematics evaluated aspects of the students' or teachers' mathematical work in terms of its validity or worth in supporting conceptual thinking.

It is worth noting that particular prompts in the logs may have encouraged reflections related to one of the categories more than others. For instance, this prompt from the Lesson Reflection Log—"List one or two observations you would like to share with the team. Be as specific as possible about the evidence of student thinking that you observed."—would likely result in responses coded as Attending to Students' Thinking. However, further analysis of subcodes (listed in Table 2) assigned to those responses yielded more information about the quality of such reflections and whether PSTs' stepping into the role of lead teacher in Cycle 2 had possible effects upon what PSTs noticed about teaching and learning during the lesson study. In the sections that follow, we describe the categories in more detail and provide examples from the data to illustrate particular subcodes.

Analyzing mathematics. Statements in this category include PSTs' focus on the mathematics of a particular

Table 2
Composition of Categories of Reflection in Collaborative Learning Logs

Analyzing mathematics	Attending to student thinking	Analyzing teaching moves
Analyzing mathematics related to— • students' thinking • teaching moves	Observations of— • students' difficulties or errors • student understanding • student use of mathematical procedures • students' prior knowledge • student engagement • student discourse • students' ability to apply new knowledge • questioning/wondering about student thinking	Analyzing teaching moves related to— • students' difficulties or errors • students' prior knowledge • students' thinking • students' mathematical procedures • students' discourse • students' engagement

research lesson, such as the mathematical features of students' statements or written responses or the mathematics of teaching moves. None of the statements coded to this category included pedagogical features of the lesson. The following are examples from the category Analyzing Mathematics Related to Students' Thinking:

"Students discussed all but one possible method to estimate the area."

"The teacher graphed both the function and inverse function on the same set of axes, but this is mathematically incorrect."

The first example specifically analyzes the mathematics content of student responses, not the students' interaction or instruction. In the second response, the focus is on the mathematical content of the instructional move, not its pedagogical aspects.

Attending to Student Thinking. This category includes observations PSTs made about students' thinking, procedures, or interactions, such as how students made sense of mathematical concepts presented during the research lesson as well as any errors. The subcategories of this code distinguish between a focus on students' understanding of concepts and students' ability to execute procedures. Examples of responses coded to some of these categories include—

"Students used a chart or graph to help them understand the properties of the equation." (Observations of Student Understanding)

"Students were having trouble determining the effect of the negative leading coefficient on the shape of the graph." (Observations of Student Difficulties or Errors)

We distinguish between Observations of Student Understanding and Student Difficulties or Errors by analyzing the semantics of the statements: If the statement about students' thinking was framed in terms of what students know or understand, it was coded as Observations of Student Understanding. In the second example, the comment was about something that students were struggling to understand. We coded these as Observations of Student Difficulties or Errors.

Analyzing teaching moves. This category captures PSTs' statements related to their own teaching moves or those of their partner PST or mentor teacher. This category included analysis of the reasoning for a particular teaching move. The subcategories group the PSTs' observations based on what they interpreted as the motivation of the teaching move. Some examples include—

"Since students were having problems plotting points, then the lesson before should have covered how to construct a graph." (Teaching Moves in Response to Student Difficulties)

"The exit slips helped us see exactly how the students were thinking and what they thought was the best approximation." (Teaching Moves Related to Student Thinking)

"My accommodations of group work and reading out loud had a positive effect with the student I included it for. For instance, he spoke up during class discussion and was talking openly during group work." (Teaching Moves Related to Student Engagement)

Data Collection and Analysis

The results in this paper are based on our analysis of PSTs' responses to the Lesson Reflection and Post-Lesson Discussion Collaborative Learning Logs. We focused on these logs because they represent PSTs' reflections on the research lessons. We examined similarities and differences in the coding (see Table 1) assigned to PST responses on logs across Cycle 1 and Cycle 2 to ascertain the potential influence of the shift in roles between the PSTs and the mentor teachers. We translated the Google Form spreadsheet entries from the two logs into de-identified text (.txt) files and coded them using the software HyperResearch (version 2.8.3, www.researchware.com).

Results

In the following section, we present results of our analyses indicating, importantly, that MGLS supports PSTs in attending to, and reflecting upon, students' thinking. We also discuss how the mentor's lesson study experience may directly influence the focus of PSTs' reflections in the Lesson Reflection and Post-Lesson Discussion Logs. We present these findings in two ways: (1) general quantitative results from our codes of the logs and (2) detailed descriptions of specific trends noted in the quantitative findings.

Part I: Overall Results

We coded 340 instances of the three categories of reflection (see Table 2) from the 17 participants' Lesson Reflection and Post-Lesson Discussion Logs from Cycle 1 and Cycle 2. Figure 1 summarizes the frequency of codes across the three general categories. One clear finding is that instances of Attending to Student Thinking occurred more frequently than other two categories, and that Cycle 2 included more codes overall than Cycle 1. Although the mean number of instances of Attending to Student Thinking was greater in Cycle 2 than in Cycle 1 (141 versus 91, respectively), a paired sample t-test showed this difference to be insignificant ($p = 0.162$).

The frequency of Attending to Student Thinking codes far outnumbered the frequency of codes for Analyzing Teaching Moves, which is interesting because the responses coded came from logs written after the lesson enactment. This finding suggests that MGLS focuses PSTs' observations on their students' thinking. The relatively low frequency for the code Analyzing Mathematics was due, in part, to the fact that we are reporting findings from analyses of selected log responses (see Data Collection and Analysis section) and is likely not indicative of the PSTs' lack of attention to the mathematics of the research lesson. Results from coding other logs, such as the Topic Study Log, would likely yield a different balance of categories emerging from the coding.

As for the increase in responses coded into one of the three general categories from Cycle 1 to Cycle 2, we propose several explanations. One such explanation is that the PSTs may have become more familiar with the prompts and the process of lesson study. Another possible explanation is the shift in the PSTs' role from Cycle 1 to Cycle 2. Becoming the lead teachers in Cycle 2 may have afforded PSTs opportunities to recognize important moments in the lesson related to student thinking less apparent to an observer. The design of our study, particularly that all participants completed the cycles using the

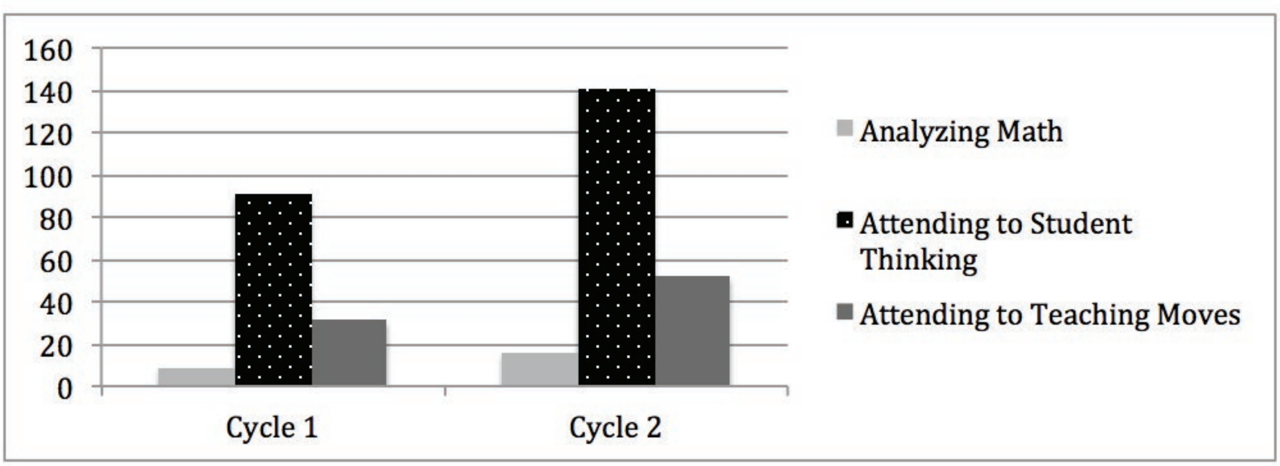

Figure 1. **Frequency of codes by cycle.**

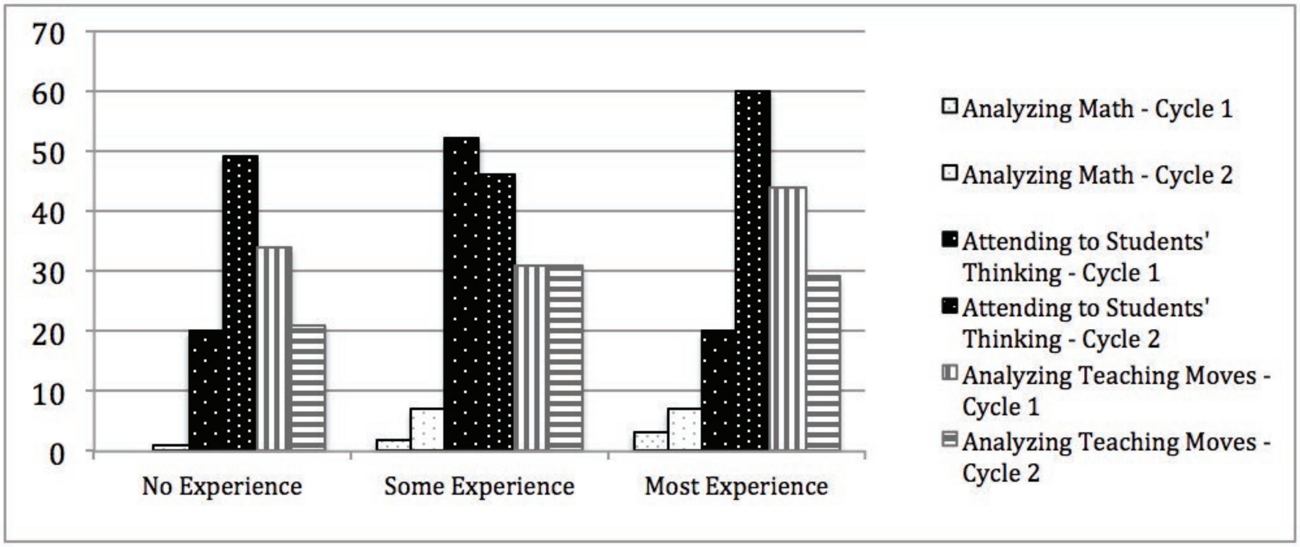

Figure 2. **Frequency of codes in each category disaggregated by mentors' lesson study experience.**

same protocol and shifted into the role of research lesson teacher in Cycle 2, does not allow for further investigation into these possibilities.

An initial focus of the work was to examine the mentor's influence on the nature of PSTs' reflections during the MGLS process. One initial hypothesis of the study was that the more prior experience a mentor had with the lesson study process, especially lesson study experience with other colleagues, the more likely his or her collaborations with PSTs would influence the sophistication of PSTs' noticing during the lesson study process. Figure 2 shows mentors' level of experience and frequency of codes across cycles, where mentors were assigned to one of three different experience levels. Mentors with no prior experience doing MGLS or any lesson study are categorized as "No Experience." Mentors who had some prior experience with MGLS, but no experience in lesson study with inservice teacher colleagues, were categorized as "Some Experience." Mentors who had prior experience both in MGLS and in lesson study with inservice teacher colleagues were categorized as "Most Experience." Results from a repeated measures ANOVA found level of experience to be a significant predictor of increased frequency in responses coded to one of the three categories of observation ($F(2,13) = 4.515$, $p = 0.032$).

In the following section, we examine these general findings on the nature of PSTs' reflections on student thinking and the influence of mentor teachers' prior experience with lesson study on those reflections so that we can better understand how PSTs' experience in doing MGLS supported reflections to develop MKT.

Part II: Zooming In on Reflections About Students' Thinking

One of the most frequently mentioned outcomes of lesson study is its ability to focus teachers' attention on student thinking (e.g., Lewis, Perry, & Murata, 2006), and our findings showing this to be the case with MGLS are especially important in teacher education because they suggest that PSTs may learn more in field placements when engaging in an activity such as MGLS. The formal nature of observation in lesson study may account for some of this, but the tradition of discussing observations of student thinking before discussing revisions to the research lesson may also serve to focus teachers' attention to student thinking. A closer look at the responses coded as Attending to Student Thinking revealed more about the salient aspects of students' thinking for PSTs during the MGLS process, particularly as they transitioned from role of team member in Cycle 1 to the role of research lesson teacher in Cycle 2.

As Figure 3 shows, with the exception of mathematical procedures, all of the subcategories of Attending to Student Thinking increased from Cycle 1 to Cycle 2. Perhaps more important, participants noted aspects of engagement and understanding more than the other categories. To better understand why participants noticed these aspects more than others in this category, we investigated a potential relationship between mentors' level of experience with lesson study and the frequency of particular categories assigned to responses related to Attending to Student Thinking. Figure 4 shows these results.

One noticeable finding is that responses coded as Attending to Student Engagement were predominantly from PSTs whose mentors had no prior MGLS experience. It is unlikely that this finding reflects particular differences in these PSTs' knowledge and skills compared to other members of their cohort, as pairs of PSTs were randomly placed with a mentor depending upon factors such as schedule availability. Further, we cannot assume that more reflection about student engagement means that student engagement is a problematic aspect of a mentor teacher's classroom. It is more likely that the differences in the teaching practice of mentors who have lesson study experience and those who do not contributed to the differences in PSTs' noticing, because prior lesson study experience likely contributes to the mentors' habits of reflection and noticing. Another relevant factor may be that the PSTs' role in discussions between themselves and their mentor teachers could account for PSTs' reflection upon certain aspects of the research lesson.

A deeper look into patterns among the reflections coded as Attending to Student Thinking revealed distinctions related to the specificity of the reflections. van Es and Sherin (2008) argue that specificity is one characteristic of increasingly more sophisticated teacher noticing. A high degree of specificity would help all team members understand what they observed, and contributed to a team's ability to modify the research lesson to address students' thinking.

The following examples illustrate differences between high and low degrees of specificity. These responses were all coded as Attending to Student Engagement:

"Without question, the most telling observation for this entire lesson came during 2nd hour, about 10 minutes into the group work time. At this time, I noted that 22/24 students in the room were either standing at the board writing/discussing with their group, or were at their desk actively calculating and crunching numbers." (Cycle 2, Lesson Reflection Log, mentor had most experience with lesson study)

"This was interesting because the teacher had gone over an example of what to look for and they seemed to not pay attention or see the correlation between the example they had done and the explore task." (Cycle 1, Lesson Reflection Log, mentor had no experience with lesson study)

In the first example, the PST-M provides exact counts of students doing particular actions, whereas the second example simply states "there were a lot more people off task." Highly specific reflections about student engagement provided precise counts for how many students were engaged or disengaged and specified actions that students were doing or saying as evidence of engagement. Given the context of MGLS, a high degree of specificity indicates either that individual PSTs carefully accounted for

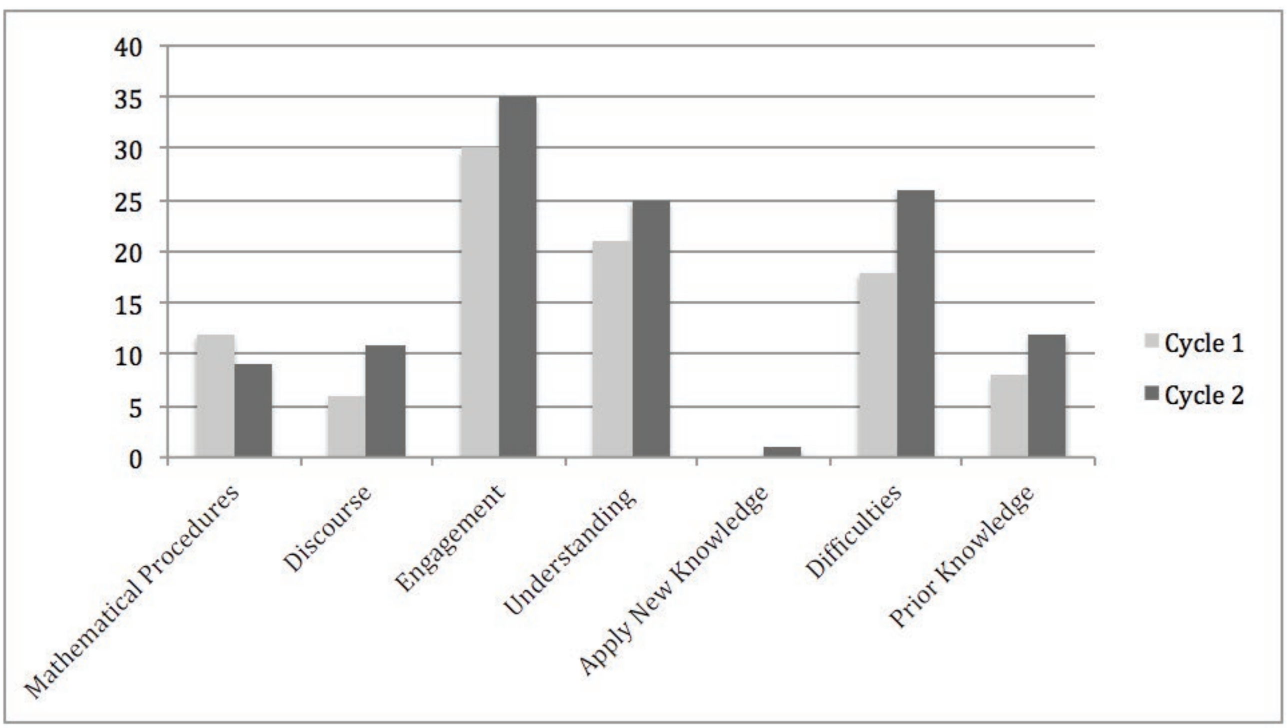

Figure 3. **Frequency of subcodes for Attending to Student Thinking across cycles.**

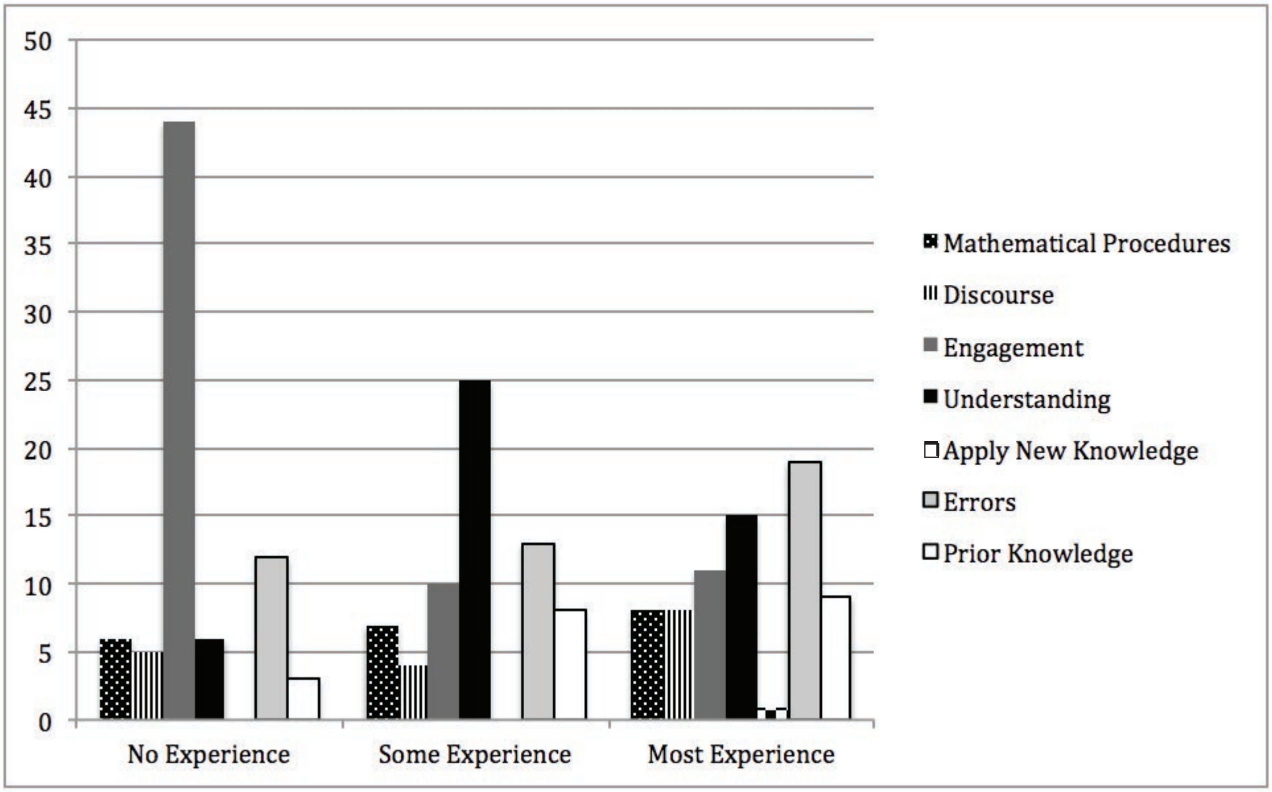

Figure 4. **Frequency of subcodes for Attending to Student Thinking for different levels of mentors' experience with lesson study across both cycles.**

episodes during the research lesson or that the conversations between the PSTs, or as a team with their mentor teacher, referenced detailed actions made by the students and/or teacher.

The majority of responses coded to the Attending to Student Engagement category had a low degree of specificity (see Figure 5). This finding is unsurprising given that the construct of Attending to Student Engagement involves noticing student behavior at a relatively large grain size. In contrast, the construct of Attending to Student Understanding involves noticing student cognition and defining what mathematical skills or ideas students understand. When analyzing level of specificity for responses coded as Attending to Student Understanding, our findings contrasted those from our analyses of Attending to Student Engagement. We found responses coded to Attending to Student Understanding were more likely to be highly specific, especially for teams whose mentors had at least some experience with MGLS (see Figure 6).

The following two examples illustrate the differences between responses with high and low specificity for reflections coded as Attention to Student Understanding:

"Students made some really good observations on the question 'How does a student make it to Box A? B? . . . G? How many heads or tails would they have to get? Does order matter?' Two students only listed one possibility for each and said that there are more possibilities in the middle. Another student noticed that order did not matter as long as you had a certain number of heads or tails you would end at a certain spot." (Cycle 2, Lesson Reflection Log, mentor had most experience with lesson study)

"What I mean is a lot of students individually were getting stuck on the questions and from each other's help in the group and some probing from the teacher, I think they got a lot more out of the word problems. The students strengthen their skills in pulling and gathering information." (Cycle 2, Lesson Reflection Log, mentor had no experience with lesson study)

Both responses describe students' understanding during the lesson, but they vary in terms of how specifically they identify students' mathematical thinking. The response from a PST working with a mentor who had the most experience with lesson study articulates specific student responses, whereas the PST-M working with a mentor who had no prior experience with lesson study only provided

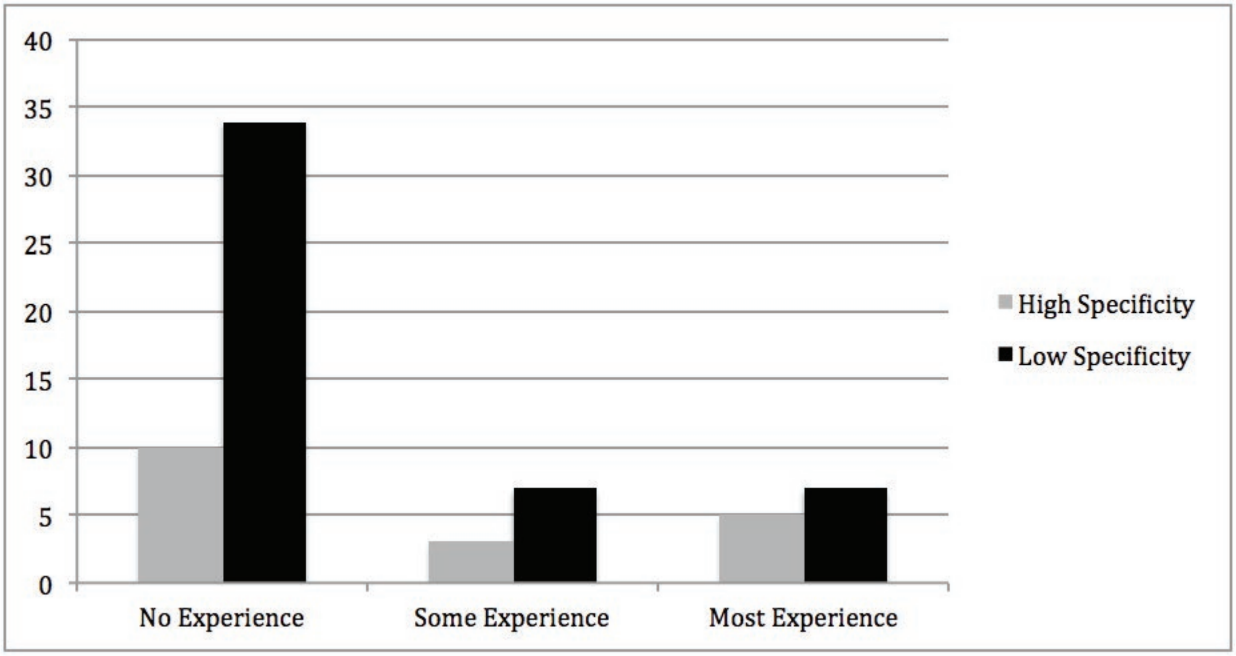

Figure 5. **Specificity of responses coded as attending to student engagement across both cycles for different levels of mentors' experience with lesson study.**

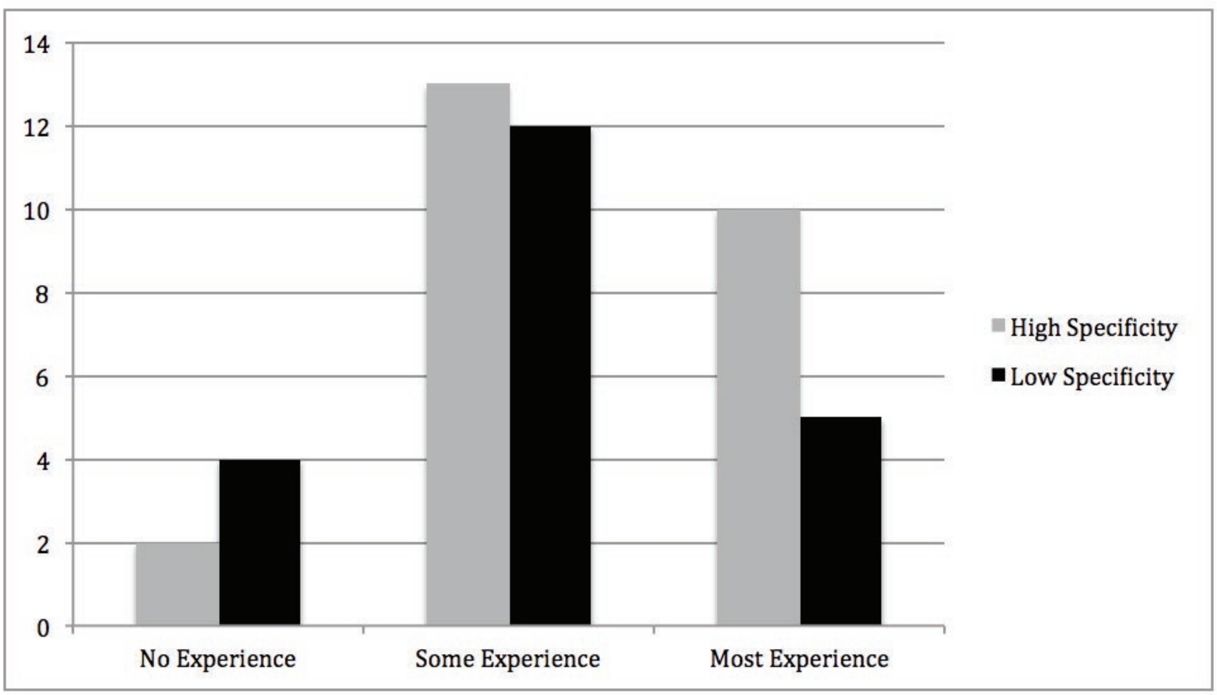

Figure 6. **Specificity of responses coded as attending to student understanding for different levels of mentors' experience with lesson study.**

"I think they got a lot more out of the word problems" instead of stating specific responses from students or mathematical ideas students appeared to be learning while solving the word problems. We acknowledge that mentors' level of lesson study experience only correlates with increases in specificity of PSTs' reflections during MGLS, but our findings raise the possibility that implementing MGLS is particularly successful when mentors have some prior experience with lesson study.

What We Have Learned

These results suggest that the MGLS experience focuses PSTs' attention upon student thinking during research lessons and addresses what Star and Strickland (2008), among others, acknowledge as a need to develop PSTs' skills in noticing key features of classroom instruction. In particular, what PSTs notice during MGLS may support the development of knowledge of content and students (Ball, Thames, & Phelps, 2008). The results also suggest that PSTs' capacity for noticing aspects of instruction related to students' thinking and key teaching moves increases in Cycle 2 with more experience in doing MGLS. Levin, Hammer, and Coffey (2009), arguing against stage-based notions of prospective teacher development, show that it is possible, and desirable, for prospective teachers to attend to student thinking. From our work, we have found that MGLS is a promising means for promoting prospective teachers' skill in attending to student thinking in ways that go beyond attending to students' engagement.

As we have discussed, a likely factor influencing what PSTs reflect upon during MGLS is the mentor's teaching practice. One explanation for why PSTs placed with mentors who have at least some experience with lesson study have a higher frequency of highly specific reflections coded to categories such as Attending to Student Understanding is that mentors' prior experience with lesson study has shaped their practice in ways that prioritize building upon students' thinking. In addition, it is plausible that the nature of the tasks in the research lessons and their cognitive demand is influenced by mentors' prior experience with lesson study (and all forms of PD). The nature of the tasks in the research lessons would certainly influence what teachers have access to notice about student thinking. Moreover, the mentor's ability to shift his or her practice in these ways is also likely correlated with MKT.

We caution against an interpretation of our findings that PSTs guided by mentors inexperienced with lesson study are not noticing important aspects of teaching mathematics or developing MKT through MGLS. It may also be the case that mentors do not have as much influence in the quality of PSTs' reflections. It may be the two-cycle structure of the assignment where PSTs take on the role of lead teaching in the second cycle that has the most influence on the quality of PSTs' reflections. Our study design can only provide limited information about which aspects of MGLS were more influential in shaping PSTs' reflections, as we did not systematically vary the conditions of the assignment.

Ideas for Supporting Successful Implementation of Mentor-Guided Lesson Study

The structure of lesson study, in any form, is not what promotes learning. Instead, it is the process of collaboratively discussing goals for student learning, mathematical tasks, evidence of student thinking, and teacher moves that enhances their professional knowledge. Our findings show that the MGLS helps PSTs' attend to critical aspects of instruction, and our implementation of MGLS suggests two strategies that promote successful implementation of MGLS. First, we have found that the adoption of MGLS is most successful in classrooms where mentors agree to work with multiple PSTs and in schools where multiple mentors are paired with PSTs for MGLS. This arrangement encourages a community of practice around lesson study. Given that the activity occurs as an early field experience, where PSTs are placed in mentors' classrooms for only 4 hours per week, it is feasible for experienced mentors to work with multiple PSTs.

Second, sharing materials such as the Collaborative Learning Logs is essential for supporting mentor teachers in facilitating discussions with PSTs about the lesson study throughout the cycle. Perry, Lewis, Friedkin, and Baker (2009) found evidence that toolkits containing suggested tasks and activities for teams of inservice teachers to complete during the lesson study process increased opportunities to learn MKT. The Collaborative Learning Logs we used were adapted from *Lesson Study in Practice: A Mathematics Staff Development Course* (Gorman, Mark, & Nikula, 2010), an excellent source for such materials. These resources support PSTs as they complete phases in the process, but they can also support the mentor teachers for when (or if) they decide to engage in lesson study with their colleagues.

Concluding Remarks

MGLS is grounded in the typical work of teaching, but it encourages participants to attend more deliberately to how the features of a lesson affect students' thinking. Although MGLS is time intensive, the payoffs are significant. In engaging in the mentor-guided lesson study process, the PSTs are not just observing or assisting, but are also supported to reflect upon the key aspects of instruction highlighted in exemplary support for learning to teach (Feiman-Nemser, 2001). Anecdotally, mentors participating in the experience over the past 2 years report that the MGLS structure nudges them to be explicit about aspects of their practice they were not even aware were necessary to share with PSTs. It may be that important pieces of the canon of excellent teaching practice are so tacit that they cannot be taught through a textbook or observed in a video. Mentor-

guided lesson study experiences have the potential to support mentor teachers in accessing, and sharing, these aspects of practice to enrich what PSTs learn in early field experiences.

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