Lesson Study: Investigating How Facilitators Support Teacher Noticing

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In many Western countries, there has been an emphasis on ways in which to support teachers to shift practice from traditional mathematics instruction to inquiry-based classrooms. As a form of professional learning and development, lesson study offers the potential for teachers to develop their ability to respond to students' thinking through participation in a professional learning community. Drawing on sociocultural learning theory, in this paper, we investigate how teachers in New Zealand learned to notice students' mathematical thinking. We analysed transcripts from teachers' post-lesson discussions. Our findings draw on analysis of teachers' post lesson discussions. They illustrate the ways in which teachers interacted with each other and highlight the important role of facilitators in supporting teachers to notice student thinking.

Ambitious teaching is beneficial for all learners' mathematical development. Facilitating meaningful whole-class discussions and inquiry-based tasks is an ambitious endeavour because of the complex nature of responding to students' thinking in the moment (van Es, 2011). Establishing a community of learners where students feel safe expressing their mathematical ideas takes time to develop (Hufferd-Ackles, Fuson, & Sherin, 2004). Discussing understandings as a whole class requires risk-taking on the students' behalf, especially for those whose cultural identities have traditionally been excluded from mathematics tasks or normative ways of being in the classroom such as Maori and Pasifika students in New Zealand (Hunter & Anthony, 2011). Ambitious teaching also requires reflection from the teachers as they develop their knowledge of students' mathematical ideas.

Lesson study, also known as research lessons, is one method of professional development that directly informs teachers' practice for the benefit of student achievement (Fernandez, 2005). During lesson study, teachers share their expertise with each other while helping colleagues notice students' mathematical understandings (Stigler & Hiebert, 2016). Teachers support each other in recognizing student thinking when they are open to inquiring about their practice (Chamberlin, 2005). However, teachers outside of Japan, where lesson study originated, can struggle with implementing lesson study with the same fidelity as Japanese teachers because the cultural perspectives of community and hierarchy are misaligned (Ebaeguin & Stephens, 2014). In this paper, we explore the potential of lesson study discussions as professional development by asking the following research questions: *In what ways do teachers contribute to post lesson discussions about student thinking? How do facilitators support teachers in noticing student thinking?* To achieve this, we examine the ways primary and intermediate teachers in New Zealand communicated with each other about students' mathematical ideas.

Relevant Literature and Theoretical Framework

We subscribe to a sociocultural learning theory for professional communities. DuFour, Eaker and DuFour (2005) found that teachers develop their practice most effectively when

they are able to reflect and revise their teaching in collaboration with other colleagues. The purpose of lesson study is for teachers to reflect on the mathematical understandings that students demonstrated in inquiry-based lessons. Japanese teachers regularly collaborate with each other, teach inquiry-based lessons, and reflect and revise the lessons based on student thinking (Hiebert, Stigler, & Manaster, 1999). The advantage of conducting lesson study is that teachers develop their practice via learning from reflection and each other's expertise rather than the top-down transmission-of-information structure commonly found in professional development programs (Stigler & Hiebert, 2009). The facilitator of the post lesson discussions is positioned as the "more knowledgeable other" (Takahashi, 2014). Although there are many benefits to learning from peers, it also requires teachers to be open and transparent about their practice for the benefit of the group (Chamberlin, 2005). Ebaeguin and Stephens (2014) found that western countries that are focused more on individualism tend not to critique each other's practice as much during the post lesson study discussions compared to those who are more orientated towards benefiting the community with the purpose of understanding student learning, as in Japan.

It is difficult for Japanese teachers to explicitly describe the process of lesson study because the practise is so intuitive. Generally, lesson study can be described as such: 1) teachers choose a broad goal or question to address; 2) they collaboratively design a lesson around a specific topic; 3) one teacher implements the lesson in his/her classroom; 4) the teachers reflect and revise the lesson based on students' mathematical understandings; 5) another teacher implements the lesson in his/her classroom; and 6) the group reflects on students' thinking (Burghes & Robinson, 2010). After implementation of lesson study in the U.K., Warwick and colleagues (2016) found that the teachers in their study created a targeted use of resources, learned to be flexible with time, helped students develop mathematical language, presented problem-solving tasks, and discussed pedagogical strategies based on discussions around student thinking. Although there are a variety of ways to implement lesson study (Hunter & Back, 2011), the overall goal of learning to notice student thinking remains the same, worldwide.

Differences between each country are becoming more evident as lesson study gains popularity outside of Japan. For instance, a recent study conducted by Fujii (2014) found that the teachers in U.S., Uganda, and Malawi did not plan lessons around an overall goal or question like Japanese teachers did. Additionally, the post lesson discussions differed from the Japanese facilitators who carefully planned the last segment of the post-lesson discussion to connect the teachers' observations with their overarching learning goal. Fujii (2014) found that the post-lesson discussions are most effective when the discussion is focused on the teaching not the teacher.

There is even a range of preparation styles and perspectives among Japanese facilitators. Takahashi (2014) examined post lesson discussions among three different primary teachers in Japan. Takahashi found that one of the "more knowledgeable others" connected a first grade topic to the ministry-recommended textbook and referred to the importance of concrete understanding for later grade levels. The knowledgeable other also referred back to the teachers' overarching goal they had for the students (e.g. to be able to explain and justify their thinking).

Additionally, Lewis (2016) recently explored facilitators' constraints and affordances of interacting with teachers. The facilitators in Lewis' study reported the challenge of promoting teacher autonomy while simultaneously supporting the teachers to notice students' mathematical ideas. These researchers began exploring ways facilitators learn to guide post-lesson discussions. Our study deepens the knowledge of how facilitators support teachers in the important task of learning how to notice student thinking.

Methods

Context

Our study is part of an ongoing larger professional learning and development (PLD) program called Developing Mathematical Inquiry Communities (DMIC). In this PLD, teachers learn to facilitate classrooms that promote equitable, inquiry-based lessons where students have opportunities to discuss and explore their mathematical ideas while engaging in mathematical practice. For teachers participating in the professional learning, the development of new pedagogical practices are supported through PLD meetings and workshops as well as dynamic mentoring during mathematics lessons (see Hunter, Hunter, Bills, & Thompson, 2016). In the DMIC project, lesson study is introduced after two years of PLD as a way of sustaining critical reflection on pedagogical practices being used during mathematics lessons. Initially, this was also a new form of professional learning for the mentors who were facilitating the lesson study process. In this paper, we draw on post lesson discussions from 15 primary and intermediate schools over a three-year period.

The lesson study process within DMIC involves a group of four teachers working with a mentor to collaboratively plan a lesson focused on a mathematical concept. The study lesson is then taught in a classroom by one of the teachers while the other teachers and mentor observe and take detailed notes based on a set of discussion questions. Following the lesson observation, a reflective discussion is undertaken using the set of discussion questions. This discussion is facilitated by the mentor. The lesson is then collaboratively re-planned by the group of teachers and taught in a different classroom in the following term. Over the school year, the lesson will be taught four times.

Data Collection and Analysis

All of the planning meetings, research lessons, and post lesson discussions were video-recorded and wholly transcribed. In this paper, we draw on analysis of the post lesson discussions. Transcripts from the post lesson discussions were iteratively coded using a grounded theory approach (Corbin & Strauss, 1990). First, the entire text of each transcript was coded as either *facilitator* or *teacher* talk. We used a qualitative coding system called, NVivo, to calculate the percentage of teacher talk compared to facilitator talk written in the transcript. Second, the responses to each discussion question were analysed and a set of codes for each question was developed. This included parent nodes (e.g., teacher noticing, mentor talk, lesson study process) and child nodes (e.g., mathematical practices, organisational structure, pedagogical decisions). In this paper, we focus on responses to three discussion questions: *Did the planned lesson activity support the children in reaching the lesson objectives and mathematical goals? What mathematical practices were being used? How did (teacher's and peers') questions and guidance enhance and facilitate students' learning?* Two members of the research team coded the transcripts individually and then met to discuss any differences in the coding until agreement was established.

Findings

The findings present three key themes which emerged from the analysis: 1) focus of post lesson discussions, 2) what teachers noticed about students' thinking, and 3) the communication norms during post lesson discussions. We also evaluated the quality of these types of talk based on the teachers' descriptions of evidence. Below, we use these three themes to provide examples illustrating the ways teachers noticed student thinking.

Focus Topics Discussed During Post Lesson Discussions

Teachers. Our data analysis showed that the topics teachers discussed in the post lesson discussions varied from organisational and management issues to detailed descriptions of students' thought processes. For example, in some cases teachers reflected on surface level features of a lesson such as the timing of activities or grouping arrangements. One teacher commented by saying, "I think time for me was an issue. I even set the alarm to go off and then do this. Never mind, it's all part of learning!" These comments reflect general teaching practice but did not reflect students' mathematical understandings.

Other topics teachers commented on were the pedagogical decisions they made during the lesson. For instance, one teacher made note of how he/she planned to listen to students more effectively. He/she said "I know I was prompting some children but I think next time I will just listen in and see where they are going and probably go up to them and say, 'how did you solve this problem?'" The teacher made note of how to shift his/her practice without mentioning what he/she noticed the students understood. Although it is useful to reflect upon how to open up the discussion to provide more opportunities for students to talk, the teachers were still focused on teacher moves not student thinking. The deepest level of teacher noticing occurred when teachers revised classroom actions based on students' understandings, which we describe in the next section.

The highest quality of excerpts were when teachers reflected on his/her own classroom practice based on the outcome of the observed lesson. For example, "Actually I was just thinking I do that with mine, if they have misconceptions they've actually solved it just while they're there…" Teachers made note of their own students and how to support them in their classrooms based on what they observed in the lesson.

Mentor. The mentors' comments prompted the teachers to notice the pedagogical decisions. Sometimes the mentors focused on the organisational structure of the lesson rather than student thinking. For instance, the mentor drew attention to timing by saying, "Just think about your timing; think about when the most learning happens and how to make sure that you've got enough time in your lessons for that learning to happen." Comments such as this encouraged the teachers to reflect on their teaching rather than on student learning.

In addition, the mentors sometimes evaluated the teachers' decisions by making comments about how effective their actions were. One facilitator stated, "Your setting of the norms, I thought was quite exceptional…" Evaluative comments did not prompt discussion among the teachers.

The most meaningful topics that mentors brought up were when they pressed teachers to reflect on students' opportunities to speak. Specifically, one mentor asked, "My question for your reflections is, how much teacher voice versus student voice, what do you think about that?" Through specifically prompting teachers to reflect on the amount of student voice, the mentor encouraged teacher discussion around the effectiveness of their inquiry-based lessons.

Noticing Students' Mathematical Understandings

Teachers. The ways teachers noticed students' mathematical thinking ranged between non-descriptive affirmations and detailed accounts of the lesson. In some cases, teachers made general statements regarding students' mathematical understandings, such as, "They got it," or "They did it." These comments lacked specific evidence from the observed lesson.

Some excerpts were more specific, stating the mathematical topics students seemed to understand, such as, "Well S1 knew what equal sharing meant and S2 knew what sharing meant." Although this teacher noticed particular students' understanding particular topics, the teacher did not provide evidence as to how he/she knew what the students understood.

The most meaningful excerpts were the ones where teachers explained the actions they noticed students engage in. One teacher described a group of students as such, "They saw the pattern but they did not articulate it. They saw the two sevens, fourteen six is twenty-one so the six is two lots of three." In this excerpt, the teacher stated specific numbers that he/she noticed the students wrote down. Details such as these provide evidence as to the mathematical understandings that students do or do not know.

Mentor. In the earlier transcripts, mentors made evaluative comments such as, "They were using their whole number knowledge." Evaluations such as these did not prompt the teachers to discuss what they noticed.

The mentors made some statements that supported the teachers' comments by providing their own evidence from the classroom observation. Specifically, one mentor stated, "I don't think they had such strong understanding because they were trying to treat it like whole numbers to prove it." Although the mentor used a particular example from class, he/she did not prompt the teachers for evidence to support their claim.

The most meaningful mentor comments about students' mathematical understandings were when they pressed the teachers for examples from the observed lesson. One mentor asked, "What did you see happen?" This question opened up the conversation for teachers to discuss specific examples of student thinking.

Productive Communication Norms

Teachers. Teachers changed the ways they interacted with each other over time. At first, teachers responded to the mentors' comments positioning the mentor as the authority of knowledge. Excerpts such as, "Can I say that?" or, "Is that okay?" reflect the affirmations of approval teachers were seeking from the mentors.

With practice, teachers learned to ask each other questions. One teacher questioned the group by asking if anyone noticed students' thinking, "Did anyone see? I couldn't find anyone who had any particular difficulty with the first one. They all seemed to go through that quite fast." The teachers' questions prompted others to state their observations from the lesson.

The most meaningful talk moves that teachers enacted during post lesson discussions occurred when they asked the group to reflect on pedagogical changes that would support students' learning, demonstrated in this excerpt, "So if you were walking around, would you say, 'Hey S3, looks like you want to say something,' would you do that, would you intervene?" Asking colleagues to share their advice prompted teachers to share their ideas and collaboratively determine effective classroom strategies.

Mentor. In the early implementation of lesson study as part of the DMIC PLD, the mentor talked for the majority of the conversation. We used the NVivo analysis to examine the progression of one mentor over three months. The mentor started the year (in March 2015) by talking during 55% of the post lesson discussion. Two months later (in May 2015), the mentor's excerpts took up 48% and 24% of the post lesson transcripts. After three months of implementing lesson study (June 2015), the mentor's comments took up 41%, 29% and 26% of the overall post lesson discussions. After six sessions, the mentor reduced their comments from 55% to 26% of the conversation. See *Figure 1* below.
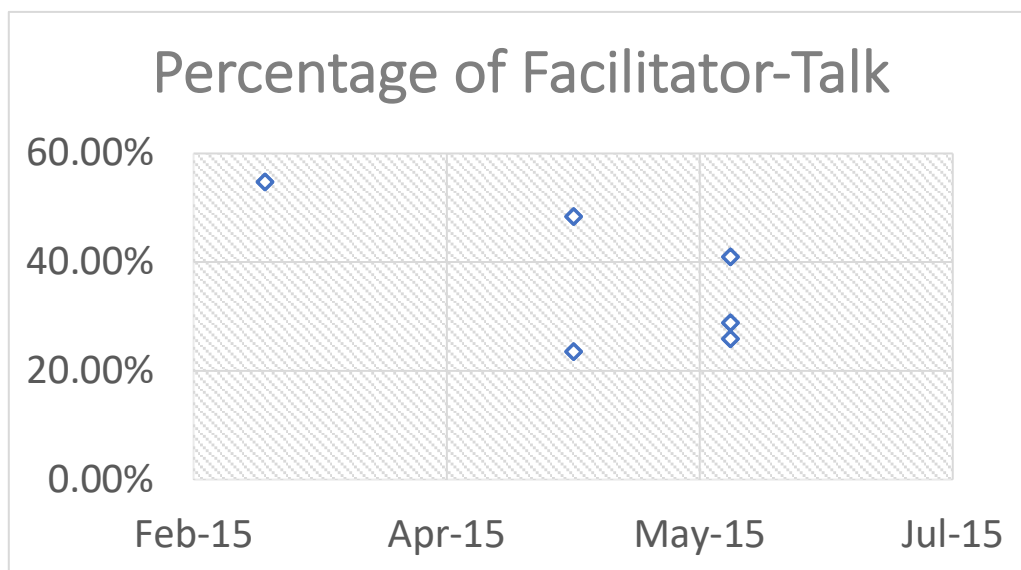
Figure 1. Percentage of facilitator talk during six post lesson discussions.

Additionally, the type of comments made by mentors evolved over the three years of use of lesson study. In the beginning, mentors tended to use the lesson study as an opportunity to share their own expertise with the teachers. This may be associated with the novelty of lesson study for the mentors or alternatively the shift in role from dynamic mentoring within the classroom to facilitating a collaborative reflective discussion. Many of the initial comments were suggestive or evaluative. This excerpt illustrates this, "If you can, pose it as a question or mention that a student did it this way and share it." Directives such as this offer helpful advice, but do not allow teachers to share their expertise with each other.

Over time, analysis indicates that mentors learned to ask teachers more questions, either prompting or clarifying. Specifically, "What do you mean, they started off with it? What is some of the learning that's come out do you think there?" In this example, the mentor prompted the teachers to provide specific details from the classroom observations. The mentor's questions encouraged teachers to think about students' mathematical understandings.

The most productive types of talk the mentors engaged in were when they paraphrased or opened up space for teachers to join in to the discussion. Sometimes mentors called on people by name to prompt them to share their ideas. This allowed multiple voices to be heard, including those who took longer to speak. The mentors also revoiced some of the teacher's ideas, which caused them to clarify their thinking. A case of this occurred in this excerpt, "So really noticing and responding to different mathematical practices and different strengths that kids are bringing, which raises everyone's status." In this excerpt, the mentor restated the topics that the teachers discussed. The mentor emphasised the most relevant aspects of the post lesson discussions.

Discussion

We noticed a shift in the three categories described above. First, as teachers and mentors grew more accustomed to the process of lesson study the comments shifted from structural issues to conceptual ideas about students' mathematical knowledge. Discussion of student thinking is more meaningful than the structural aspects of the lesson that occurred in earlier post lesson discussions (DuFour et al., 2005). Second, teachers' noticing of students'

mathematical understandings shifted from general statements to detailed accounts of the observed actions. Descriptions of students' ideas provide evidence as to how students made sense of the mathematics. This information assists teachers' pedagogical decisions in ways that build upon students' prior knowledge (Hufferd-Ackles et al., 2004). Third, we noticed that the authority of knowledge shifted over time. Teachers noticed more when they had opportunities to reflect and share their thinking. The mentor and the community of teachers prompted teachers to question and critique each other's practice. The quality of the discussion depended on the talk moves used by the mentor and the teacher.

Mentors played an important role in teachers' noticing. When DMIC initially started implementing lesson study with teachers, mentors made evaluative or directive comments about what they noticed in the lesson. Mentors learned to question and paraphrase more regularly after several years of lesson study being used. This resembles Lewis' (2016) findings, that facilitators develop their skills after at least eighteen months of practice. Additionally, Fuji (2014) found that many facilitators never experienced lesson study themselves and therefore lack a model. Although this was true for some of the mentors in our study, teachers and mentors grew accustomed to the process of lesson study. They also learned how to utilise the collaborative structure effectively.

There were several limitations to our study. One constraint was the willingness of teachers to open up one's practice. Similar to Chamberlin's (2005) findings, the teachers also expressed their concerns about being observed by their colleagues. This concern relates to a second limitation of our study which is teachers' perspectives of professional learning. Western perspectives and a focus on individualised results shape education and professionalism in New Zealand. This perspective contradicts the purpose of lesson study, which is that the observed lesson benefits the learning of all the participants in the community (Stigler & Hiebert, 2016). Finally, we analysed data as a collective group of transcripts. This caused us to examine the lesson study process evolving over three years. With the exception of the one mentor who reduced the amount of talk from 55% to 26% over six sessions, analysing the transcripts as a collective group of data eliminated potential findings that narrowed in on individual mentors or particular schools.

Conclusion

Lesson study is a method of professional development aimed at supporting teachers in facilitating inquiry-based lessons (Hiebert et al., 1999). In this study, teachers and mentors learned how to notice student thinking while also learning how to navigate the structure of lesson study. This is important for professional learning communities who seek to develop their practice in a collaborative way. It is also valuable for practitioners interested in ambitious teaching to learn how to support students' in sharing and developing their mathematical understandings.

There is a question as to the effectiveness of lesson study. We found examples of both ineffective comments, such as general statements by teachers ("they got it" or "they didn't get it") and the directive comments made by the mentor. We also found constructive excerpts of teachers' meaningful reflections based on the students' mathematical understandings. The teachers who observed the lesson reflected on their own practice by commenting on interactions with students that they hoped to have in their classrooms. This is important because lesson study is an ongoing process that shapes how teachers learn to interact with students during classroom discussions (Stigler & Hiebert, 2016). Lesson study can be a meaningful form of professional development or it can perpetuate status quo depending on the discussants' willingness to critique the lesson, not the teacher.

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