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Teacher Leaders as Professional Development Facilitators: Capturing the Practice of Supporting Practicing Teachers

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Abstract

In this qualitative case study, we examined the following two research questions: 1) Given teachers' productive talk about students' mathematical thinking, what was the substantive content of facilitators' contributions around such talk during lesson study teacher professional development (PD)? 2) What is the relationship between facilitators' contributions around teachers' productive talk and disposition toward lesson study PD and its facilitation? We found that, despite common substantive foci on teachers, students, and mathematical content, two teacher leaders differed in their dispositions toward the lesson study PD and its facilitation, leading to varying degrees of nuance with which they addressed each of the three foci during the lesson study planning meetings. The implications of our findings for PD facilitation practice and future research directions are discussed.

Teacher Leaders as Professional Development Facilitators: Capturing the Diversity of Practice of Educating Practicing Teachers

Practice-based collaborative professional development (PD) opportunities focused on students' mathematical thinking are acknowledged as an important factor in improving teaching practice (Ball & Cohen, 1999; van Es & Sherin, 2010) and potentially increasing student achievement (Bergan, Sladeczek, Schwartz, & Smith, 1991; Black & Wiliam, 1998; Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Desimone, 2009). While there is a growing body of literature on the structure and content (Lewis & Hurd, 2011; Lewis, Perry, & Murata, 2006; Wilson & Berne, 1999) as well as the outcomes (Perry & Lewis, 2008; van Es & Sherin, 2010) of effective PD programs in mathematics education, there is still a limited amount of research on the work of facilitators engaged in implementing such PDs (Borko, Koellner, & Jacobs, 2014; Even, 2008). In particular, practicing mathematics teachers, who are knowledgeable and committed to student learning and professional improvement, have a great potential for leading practice-based collaborative PD (Borko, Koellner, & Jacobs, 2014; Elliott et al., 2009; Koellner, Jacobs, & Borko, 2011). However, little is known about how these teacher leaders facilitate teachers' learning about students' mathematical thinking (Even, 2008; Neumerski, 2013; York-Barr & Duke, 2004).

The current case study aimed to contribute to this research literature by examining the nature of practice of two experienced teacher leaders engaged in facilitating lesson study PD focused on elementary school mathematics. In particular, we addressed the following two research questions:

- Given teachers' productive talk about students' mathematical thinking (i.e., when teachers discussed student learning as a sense-making process and engaged in nuanced unpacking of student reasoning and understanding) , what was the substantive content of facilitators' contributions around such talk during lesson study teacher PD?

- What is the relationship between facilitators' contributions around teachers' productive talk and facilitators' disposition (i.e., facilitators' manners of acting and thinking) toward lesson study PD and its facilitation?

Literature Review

Lesson Study

Lesson study (LS) is a form of practice-based collaborative PD, characterized by a strong connection to teaching practice, focus on student learning and teacher collaboration, and responsiveness to school improvement goals – the characteristics closely aligned with the qualities of effective PD (Desimone, 2009; Lewis & Hurd, 2011; Wilson & Berne, 1999). During LS, which is typically implemented in cycles consisting of four steps, a team of teachers engages in study of curriculum materials, instructional approaches and students' thinking in order to plan and implement a research lesson (Armstrong, 2011; Fernandez & Yoshida, 2004; Hart, Alston, & Murata, 2011; Lewis & Hurd, 2011). While LS models may vary across contexts, in the particular model this study follows, for the first step, a LS team reviews curriculum and other resources to identify topic of interest. Next, teachers formulate goals for student learning and write an instructional plan for a research lesson. During the third step, a team member teaches the research lesson while other teachers observe and collect data. Finally, in the fourth step, teachers reflect on the research lesson. During the whole LS process, the role of the facilitator carries a number of responsibilities, including leading and preparing for each session, maintaining the schedule and calendar, sending reminders, making arrangements for release time, organizing the teachings and post-lesson discussions, and cultivating support from administrators (Gorman, Mark, & Nikula, 2010). In particular, practicing mathematics teachers, who have expertise and commitment to student learning and teacher professional improvement, have a great potential for leading LS PD (Saito, 2012). However, little is known about how these teacher leaders facilitate teachers' learning about students' mathematical thinking (Even, 2008; Neumerski, 2013; York-Barr & Duke, 2004).

Teacher leadership

In the United States, calls for increasing teacher leadership as an essential part of educational reform had been made in most national reports since *A Nation at Risk* in 1983 (Barth, 2001). Although the definition of what teacher leadership entails has changed in the three decades since then, most of the literature has traditionally focused on leadership at the individual level rather than as a collective endeavor (Muijs & Harris, 2003). Teacher leadership in this view is seen as a formal activity, usually equated with status and authority, with an emphasis on "leading" and "changing" others, and it is often placed in opposition to the role of principal (Greenlee, 2007).

More recently, however, experts have shifted their focus away from this form of leadership and towards a view where school leadership is seen as *distributed* among members of a group, working in collaboration to achieve shared goals. In this view, teacher leadership is separate from a person or persons, understood instead as a *process* of "empowerment" and "enculturation," where teachers exercise expertise and actively create and re-create school culture both within and outside their classrooms (York-Barr & Duke, 2004; Muijs & Harris, 2003). Greater involvement, as well as the ability to apply their expertise and influence the conditions of teaching and learning, have also been cited as positive effects of distributed teacher leadership (York-Barr & Duke, 2004; Greenlee, 2007), which in turn have been linked to greater student achievement and learning (Day & Harris, 2002). From the distributed leadership perspective, a teacher leader might empower teachers to take initiative in promoting their own professional development and learning. However, little is known about how teacher leaders apply their expertise to facilitate teacher learning in a professional development setting (Neumerski, 2013).

Profession development facilitators

While there is a limited amount of empirical information about the work of “teachers of teachers” (Even, 2008, p. 59), researchers have begun investigating how experienced facilitators support PD participants’ productive engagement and idea progression in discourse (Zhang, Lundeberg, & Eberhardt, 2011) as well as high-quality conversations about student thinking (van Es, Tunney, Goldsmith, & Seago, 2014). Specifically, van Es and colleagues (2014) identified four categories of practices for the facilitation of teachers’ analysis of video in a collaborative setting, specifying distinct discourse moves associated with each practice (e.g., pressing, connecting ideas). With a similar focus on facilitators’ discursive moves, Zhang and colleagues (2011) identified 21 strategies (e.g., questioning, revoicing, etc.) aligned with the goals of a problem-based learning PD program. Focusing on the work of experienced facilitators supporting productive discourse, these researchers suggested a set of practices for an effective leader of PD. However, in addition to defining the knowledge and practices needed to be an effective PD facilitator, there is a need to also examine the learning trajectory and capture the diversity of practice of emergent facilitators (Wiggins & McTighe, 2005). For instance, while novice facilitators are relatively successful at using questions to launch a discussion about student thinking, they are less effective in sustaining a deep level of analysis of student reasoning (Borko, et al., 2014). Furthermore, while questioning is an important strategy for promoting productive discourse (Zhang et al., 2010), facilitator questioning is ineffective when it is not built on teachers' ideas and when it frequently shifts the focus of the discussion (Zhang et al., 2011).

In this study, we examined the discourse practices of two experienced teacher leaders engaged in facilitating teachers' discussions about students' mathematical thinking. However, unlike previous research, we focused on the substantive content of what the facilitators said while initiating and responding to teachers' talk about students' thinking. Furthermore, we aimed to understand the relationship between facilitators' contributions around teachers' productive talk and facilitators' disposition, or their manners of acting and thinking that show an approach toward LS PD and its facilitation.

Conceptual Framework

Over the past decades, many national-level initiatives proposed the shift in classroom practices toward supporting student engagement and conceptual understanding in mathematics. (Common Core State Standards, 2010; National Council of Teachers of Mathematics [NCTM], 2000; National Research Council [NRC], 2000, 2005). In order to implement reform-based mathematics instruction, student learning and content must come together through teacher facilitation (Cohen & Ball, 1999). Specifically, "effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well" (NCTM, 2000, p. 16).

Given the importance of interaction of instruction, student learning, and mathematical content in teaching, it is valuable to examine what aspects of teaching, students, and content PD facilitators invoke while supporting teachers' learning *about teaching*. Thus, in order to conceptualize and operationalize the substantive content of what the facilitators said around teachers' utterances about students' mathematical thinking, we relied on the teaching-students-content triangle (Cohen & Ball, 1999; Murata, Bofferding, Pothen, Taylor, & Wischnia, 2012) – a framework that captures the important interaction between teaching, students, and mathematical content. In particular, we were interested in capturing what aspects of the teaching-students-content triangle facilitators invoked when initiating and responding to teachers' talk about students' thinking. Moreover, we aim to understand the relationship between facilitators' contributions around teachers' productive talk and facilitators' disposition toward LS PD and its facilitation. While we were interested in examining facilitators' practice in relation to the LS goals (see Zhang, Lundeberg, & Eberhardt, 2011), we recognized that the facilitators might not necessarily be guided by a singular vision of LS (Lefstein & Snell, 2011). In order to capture the facilitators' purpose for LS, we used the construct of dispositions, defined as facilitators' manners of acting and thinking that show an approach toward the goals, process, and outcomes of the LS PD and its facilitation process (Philipp, 2007).

Context and Participants

The case study was conducted at two elementary schools, Trailways and Riverside[1], in Coast County School District in the state of Florida (see Table 1).

Table 1
School and District Characteristics

	Trailways	Riverside	District	State
School Characteristics				
School Size	721	741	64,058	2.6 mil
% FRL	42.6%	48.7%	39.3%	45.4%
% Minority	23.2%	30.5%	38.9%	58.4%
% ESE	15.6%	15.6%		

[1] All the school, participant, and district names in this proposal are pseudonyms to conceal their identities.

At Trailways, 43% of students receive free and reduced lunch, and 23% of students are ethnic minorities. At Riverside, 49% of students receive free and reduced lunch, and 31% of them are ethnic minorities. Fifteen elementary school teachers, who were members of two LS teams (Trailways and Riverside), participated in the study (see Table 2). Two teacher leaders, Betty and Sonja, served as facilitators at each school (see Table 3). Betty, who was the facilitator of LS at Trailways Elementary School, has 26 years of teaching experience in grades 3-5. She has been teaching at Trailways Elementary since 2014. Betty has an elementary education certification, with a gifted endorsement. Sonja facilitated the Riverside LS team. She has 28 years of teaching experience in grades K-5, with certification in elementary and physical education, with an ESOL endorsement.

Table 2
LS Team Background Characteristics

	Trailways	**Riverside**
Team Characteristics		
Number of teachers	8	7
Number of teachers new to LS	3	0
Range of LS experience (# of LS cyles)	0-10	1-5
Range of teaching experience	11-25 yrs	9-34 yrs
Mean of teaching experience	18.0 yrs	19.6 yrs

Note. LS=lesson study

Table 3
LS Team Facilitator Characteristics

Name	School	Teaching experience (years)	Current grade level	Prior levels taught	Certifications	Years participating in lesson study

Betty	Trailways	26	3 - 5	3 - 5	Elementary 1- 6 / Gifted Endorsement	12
Sonja	Riverside	29	4	K--5	P.E. K 8 / P.E. 6-12 / Elementary Education / Adapted P.E. / ESOL endorsed	9

Between January and March of 2015, both LS teams spent over 20 hours for researching and planning a research lesson, focused on the 5th-grade content of fractions. While most meetings were held after school hours, and lasted about 90 minutes, planning meeting 2 was an all-day meeting, lasting about 6 hours. Table 4 presents an overview of activities and discussion foci during each meeting.

Table 4

Lesson Study Meeting Agenda

Trailways LS team		Riverside LS team	
	Agenda and main activities		Agenda and main activities
1	Examining resources and mathematics • Discussed resources available for the lesson study process (e.g., Edmodo website, NCTM articles, etc.) • Assigned research articles for teachers to read and report on • Examined three different representations of multiplying fractions, as well as student misconceptions	1	Discussing potential topics for the research lesson. • Brainstormed fraction-related topics that students struggle with • Teachers agreed to review the results of a pending pre-assessment before making the final decision
2	Discussing research and curriculum materials • Each teacher shared the assigned research articles • Examined the standards across K-5 grade levels to identify knowledge and skills related to multiplying fractions • Reviewed the notes from the Knowledge Others • Brainstormed problem situations for the RL	2	Examining student data, curriculum materials, and research; initial research lesson planning • Shared the results of the pre-assessment, identifying student learning gaps in modeling fractions greater than 1 • Examined the standards across K-5 grade levels to identify knowledge and skills related to modeling fractions greater than 1 • Shared the research on fractions • Brainstormed real-world contexts for the RL task
3	Identifying the goal of the research lesson	3	Planning the research lesson

	• Exploring the linear model of multiplying fractions • Discussing the conceptual building blocks of multiplying fractions • Brainstormed real-world contexts for the RL task		• Re-examined the standards to clarify the grade level for the research lesson • Outlined the sequence of the RL activities • Discussed teacher prompts in the lesson and student responses
4	Planning the research lesson • Discussed an introductory lesson task • Discussed problem situations for the RL • Skyped with the Knowledgeable Other to clarify the problem situation for the RL	4	Planning the research lesson • Reviewed the notes from the Knowledgeable Other • Continued writing and making adjustments to the RL plan, focusing on the sequence of activities • Discussed the logistics of the lesson (e.g., buying needed materials)
5	Planning the research lesson • Discussed teacher prompts in the lesson and student responses • Made adjustments to the lesson tasks • Addressed student misconceptions and discussed how to address them	5	Planning the research lesson • Anticipated student answers and discussed how to address them • Refined the teaching script • Discussed the logistics of the lesson day
6	Finalizing the research lesson plan • Discussed logistics of the lesson day • Anticipated students responses while working with the manipulatives • Fine-tuned the lesson script	6	No recording of the meeting
7	Debriefing of research lesson	7	Finalizing the research lesson plan • Rehearsed the RL plan, anticipating student responses and making adjustments to the teaching script
		8	Debriefing of research lesson

Data Collection and Analysis

Data for this study was collected in spring 2015 and include the LS planning meetings, teacher and facilitator background survey, and teacher and facilitator interviews. All LS planning meetings and interviews were transcribed. Meeting 6 at Riverside elementary school was not observed because there was no recording of the meeting due to the researchers' oversight.

To begin the analysis of the planning meeting transcripts, we narrowed our focus to what we defined as teacher productive utterances about students' mathematical thinking. These utterances were conceptualized as having a potential to construct high-quality conversations, or serve as a springboard for a sustained, in depth, collaborative discussion of students' mathematical thinking (vas Es et al., 2014).

However, without assuming that these utterance were, in fact, a part of a high-quality conversation, we wanted to examine the ways in which the facilitators motivated and responded to these teacher utterances. For all planning meetings, we identified utterances where non-facilitating teachers discussed student mathematical thinking as a sense-making process and engaged in nuanced unpacking of student reasoning and understanding. The following quote is an example of a productive teacher utterances about students' thinking:

> And I wonder if there's a disconnect, say with an addition problem, we're saying that two and three is the same as five, and even though it is, that's visually not the same. Is there some kind of disconnect with looking at that and saying, "these have to be the exactly the same to be equal, whereas over here these don't have to be exactly the same to be equal. I don't know. Is there a disconnect somehow there?

Across the 6 Trailways planning meetings, non-facilitating teachers made 1658 utterances (or speaking turns), 140 of which were coded as productive. Across the 6 Riverside planning meetings, non-facilitating teachers made 2735 utterances, 125 of which were considered productive.

Once teachers' productive utterances were identified, we examined facilitators' talk prior to and following these utterances in order to understand how the facilitator might have initiated and responded to teachers' productive talk about students' mathematical thinking, where non-facilitating teachers discussed student learning as a sense-making process and engaged in nuanced unpacking of student reasoning and understanding. The unit of analysis was the facilitators' speaking turns. In our data analysis, we were informed by grounded theory (Strauss

& Corbin, 1998) and qualitative data analysis (Miles & Huberman, 1994) approaches. First, we open-coded the data using Nvivo software and used these initial codes to identify categories. We then classified the facilitators' turns according to two dimensions – the substantive content of what the facilitators said and discursive strategies used. In this paper, we systematically report the substantive content of what the facilitators said. Informed by the teaching-students-content triangle, we identified three corresponding substantive categories (see Table 5 for details).

Table 5

Coding Scheme for Analyzing the Substantive Content of Facilitators' Utterances

Substantive category	Types of references	Description	Examples
Teaching	Teacher-focused	Facilitator's talk about instruction is focused on what the teacher does. For example, teacher might be demonstrating content, responding to students, reviewing, summarizing what was learned during the lesson. Facilitator might also talk about language use and logistical issues of time, materials, etc.	And then for our demonstration, you know how we had a round one before we can make that a bar, a line, we can make that linear instead. What happens if they put ¾ and ½ or fill it all up with weird ones, what are we going to say?
	Student-focused	Facilitator's talk about instruction is focused on students. References under this category must specifically relate teaching to student thinking/practices during the lesson. For example, teacher builds on students' prior knowledge (as opposed to simply assumes that students SHOULD have certain knowledge prior to the lesson), uses questioning, and allows students to wrestle with the content without teacher telling. The facilitator might also consider specific student responses and ways to make student thinking visible during the lesson.	And you're right, I think when we connect somehow back to all that work that they've done with arrays, in third grade especially [pointing to M.], with whole numbers – it will help them understand the fractions. And then you say 'Well, what if we ran a half of our track, how far would you run?', and then lead it to 'Is it still multiplication?'
	Instructional medium	Facilitator's talk about instruction is focused on the instructional medium within which teacher/students work. For example, when discussing instructional tasks, the facilitator might consider various contexts and details of the problem situations, as well as instructional strategies (e.g., manipulatives, graphical representations, strategic use of language)	Unless you did butter, measured butter [context] I think that's the direction that we were going, when we were saying that the lap was a half a mile. And we ran two times around the ½ mile; and 3 times around the ½ mile track, and then what if we only ran ½ of that 1/2–mile track [problem situation] Well, does that mean that when we're doing this, do we still do the paper folding? Does it still connect?

			[strategy]
Students	Nuanced with respect to students' thinking	References in this category are centered on students' in-depth thinking about conceptual mathematics, as well as students' sense-making. Facilitators are referring to student misconceptions, prior knowledge, as well as reasoning.	There's research behind that that's really huge, and this goes back to your area model that you were talking about earlier. They discovered that a lot of kids thought fractions were actually two numbers
	Superficial with respect to students' thinking	References in this category are peripheral to students' in-depth thinking about conceptual mathematics. For example, facilitators are referring to student behaviors, answers, or procedural work with mathematics. References to students' individual characteristics, test performance, motivation, as well as vague statements about what students get and don't get also fit under this category. Lastly, this category also includes references to prerequisite knowledge students SHOULD have without a clear discussion of how this knowledge will be built on during the lesson.	I've had kids get this and understand this [a whole times a fraction]; I've never had kids who understood that [a fraction times a whole], because we've never taught it. Well, we did, but it was the end of the book.
Content	Specific	Detailed discussion of conceptual mathematics	Yeah, although you're connecting…well, one of the key ideas is we want them to be able to connect to multiplication idea that they already know, which you [P.] were talking about earlier – how do you connect this to repeated addition when you're not adding a whole, you're not adding the whole group, just a part of it.
	Broad	Cursory discussion of non-conceptual mathematical content, including references to standards, progression of topics, grade levels, procedural skills.	So we have already done decomposing, most of us now, so we would have to do it in a third grade class if we chose that. So are we saying we want to stay with a fraction times a fraction?

Identification of the discursive strategies was informed by the literature (Hmelo-Silver & Barrows, 2008; van Es et al., 2014; Zhang, Lundeberg, & Eberhardt, 2011) as well as derived inductively based on our data. While we do not report systematic results for the discursive strategies used in order to focus on our research questions, Table 6 lists the definitions of the discursive strategies identified.

Table 6

Coding Scheme for Analyzing Facilitators' Discursive Strategies

Discursive strategy	Description	Examples
Confirming	Seeking confirmation on a decision. the questions are convergent and closed-ended. Facilitator can confirm/clarify with the group or with the individual. Includes yes/no and "decide between two alternatives" questions (Hmelo-Silver_2008)	Hang on, let me see if I can/so you're saying this is split into 1/3 So are we saying we want to stay with a fraction times a fraction?
Request /Directive	Requesting participants to act; assigning tasks to the participants.	And I've got to go, but ya'll spend the next few minutes trying to think of a scenario. OK, can you read it one more time? Liz, this is where we need you to get our words/you –first and kindergarten teachers/we are just wordy, wordy, wordy and you guys help us to make it=
Soliciting ideas	Open-ended questions used to get new information.	Where do you think children are going to get stuck? What misconceptions might they form, or what might be difficult for them to understand? What happens if they put ¾ and ½ or fill it all up with weird ones, what are we going to say?
Countering	Disagreeing and/or presenting an alternative idea.	To be devil's advocate, you can share the 1 between two people or between four people, but now we're trying to build a connection to multiplication – are we building the connection to division?
Elaboration	Elaborate on the idea raised by a participant in prior talk turn. A facilitator might restate AND elaborate on the idea. With elaboration, the facilitator builds on what a participant is saying.	Yeah, it's our problem – it is very easy to multiply. The steps are the easiest math you'll ever do, because the numbers are small and it's just multiplication. But it's the understanding, which is what the standard says – "use previous understanding".
Presenting new information	Presenting new info that is disconnected from other participants' prior talk. The facilitator initiates a discussion by presenting an idea not previously introduced. NOTE: If new idea involves personal experience or KO input, don't code under this node, just the other two.	OK, there is one other representation that I've seen that I'll just admit, I went "holy". Let me think if I can remember how to do it. So he had the whole mile – that's the whole mile.
Restating	Restatement of what a participant said to achieve a common understanding, or to summarize what has been discussed and agreed upon.	So Stephanie is saying that these float better for her than doing it on a number line, which I kind of agree with that.
Sharing Knowledgeable Other input	Presenting new info or elaboration that involves input of the knowledgeable other.	[Looking at the comments provided by the knowledgeable others] I think this is Alice, and she said agree that proportion and scaling are not the way to go because all you're doing, you're taking that complete part and you're either making it smaller or you're making it bigger, if you're just doing proportion and scaling.
Sharing personal experience	Presenting new info or elaboration that involves personal experience.	My kids this year, with these new standards, we're doing a lot of things like this [pointing at the area model]. And we're finding equivalent fractions by drawing on top of other fractions.

Results

In this section, we report results for each research question. First, drawing on facilitator interviews, we characterize facilitators' disposition toward LS PD and its implementation. We then describe LS facilitators' initiation of and follow up to teachers' productive utterances about students' thinking across the three dimensions of teaching, students, and content. In the discussion section that follows the results, we relate facilitators' dispositions to their facilitation practice.

Facilitators' dispositions toward LS PD and its facilitation

Overall, while facilitator Betty of the Trailways LS team stressed the importance of teacher learning as a result of developing the research lesson plan and observing student thinking, facilitator Sonja of the Riverside LS team emphasized the identification of student achievement gaps, as well as planning and conducting of the research lesson to address these gaps. For Betty, teacher learning was the primary goal of LS, and she communicated this during the interview as well as the first planning meeting: "The goal [of LS] is to improve your teaching in general, in ways that you think it should be improved" (Betty, PM 1).

Although Sonja referred to personal learning – "And what I've learned a lot from lesson study, that's really so important, [is] to listen to kids" (Sonja, Facilitator interview) – she did not seem to emphasize the learning of other team members as an important outcome of LS. What seemed essential to Sonja is validation of teacher ideas – "it's really important to listen and respect each person's ideas" (Sonja, Facilitator interview). Moreover, teachers' satisfaction with the research lesson was an important outcome of LS for Sonja. Specifically, when asked what she hoped the group would learn from the current LS cycle, Sonja stated "I hope we'll learn if this was an effective way to teach fractions greater than one", elaborating that "it is important to us to come away with a good feeling like, 'Huh! That was a good lesson'".

Emphasizing teacher learning as the goal of LS, Betty frequently contrasted it to producing a lesson plan. On multiple occasions during the interview and the first planning meeting, Betty explicitly negated the lesson plan as the primary focus of LS:

> Sometimes lesson study seems like we're spending all these hours on one lesson, but that's really not the goal of lesson study. The goal is to enrich your whole math—teaching—vocabulary, some part of your teaching itself, so even though the product is one lesson, the knowledge gained should include all of your teaching. (Betty, PM 1)

Moreover, when commenting on the efficiency of LS process, Betty validated the time spent with the overall goal of teacher learning and growth:

> If your goal was to develop a lesson, then you are going to feel like the meeting are back down and can we move, let' s get it done, but if your goal is what can I learn about teaching and what can I learn about the content, then the slowness and the amount of time spent discussing what is the meaning of this content and how will children perceive this content then we're spot on, we're right where that is. (Betty, Facilitator interview)

Sonja, on the other hand, expressed some tension between spending the time to explore the lesson background and writing of the actual lesson plan. In fact, one of the key aspects of LS process for Sonja was the importance of organization:

> Also is the organization of things… So keeping a good timeline it's really important,...and it's just to have everybody on a time commitment and to stay organize, and to keep the material all together, and what we need—those things are really important. (Sonja, Facilitator interview)

As a facilitator, Sonja is a leader who “takes charge”—an observation made by her teammates—and guides her LS team through the identification of student needs, planning a lesson to address these needs, and evaluation of the lesson success in terms of student outcomes. Thus, Sonja seemed to perceive LS as a means to an end. When commenting on her facilitator role, Sonja emphasized the importance of organization, suggesting that her strength is in keeping the team members on track with the lesson study process:

> I know this probably sounds bad, but I really don’t have…if we get off task, I try to get us back on task. And we try to make the goals for our meetings, and then for me, as a facilitator, it’s the basic organization of ‘OK, I need to do this, get in touch with [the researchers]’…And so for me, I just consider myself a big secretary. I’m kind of just a behind the scenes secretary that way, and we just all try to keep our eye on our goal. (Sonja, Facilitator interview)

Betty, on the other hand, is first and foremost a teacher educator who perceived LS as a mechanism for developing participants’ learning about teaching practice. Being a facilitator for her is “like being a teacher in that your mind is constantly crafting the next question…that would cause people in the group to think and discuss” (Betty, Facilitator interview).

Next, we report the results for LS facilitators’ initiation of and follow up to teachers’ productive utterances about students’ thinking across the three dimensions of teaching, students, and content.

Facilitators’ initiation of productive utterances

Across the 6 Trailways planning meetings, we identified 102 initiation utterances made by the facilitator Betty around teachers’ productive comments about students’ mathematical thinking. Thus, about 78% of 140 productive utterances in the Trailways team were clearly initiated by the facilitator. In particular, Betty's initiation utterances were primarily nuanced with respect to students' thinking, specific in relation to conceptual mathematics, and addressed instruction from a students' perspective. Across the 6 planning meetings, Sonja made 76 initiating utterances, which is about 61% of 125 productive utterances made teachers in the Riverside team. Sonja's initiations were primarily superficial with respect to students' thinking, focused on non-conceptual mathematics, and addressed instruction from a teachers' perspective. We present a detailed report of these patterns below.

Table 5

Frequency and Percentages of Facilitators' Initiation of Teachers' Productive Utterances

	Teaching-students-content coding categories						
	Teaching			Students		Content	
	Student-focused	Teacher-focused	Instructional medium	Nuanced	Superficial	Specific	Broad
Betty's initiation frequency (%)	26 (25.5)	4 (3.9)	11 (10.8)	23 (22.5)	5 (4.9)	27 (26.5)	6 (5.9)
Sonja's initiation frequency (%)	14 (18.4)	18 (23.7)	6 (7.9)	12 (15.8)	16 (21.1)	3 (4.0)	7 (9.2)

Betty's initiations focused on teaching. Forty-one (40.2%) initiations were focused on teaching, 26 of which were student-focused (see Table 5). Thus, while these initiations were focused on instruction, the majority of them were closely linked to student learning. Betty elaborated on how the research lesson could connect to and build on students' prior knowledge, suggested and elicited teachers' ideas about instructional strategies that can be used to make students' thinking visible during the lesson, asked teachers to anticipate students' responses, as well as shared personal experience about the nuances and challenges of teaching for student understanding (see Table 6).

Table 6

Betty's Teaching Category Initiations of Teachers' Productive Utterances

Teaching category	Example quotes
Student-focused	"Because when we start multiplying fractions, I take them back to, "well, what does two times three mean?" Two groups of three. So then what would two times one half mean? Two groups of one half. I think that's a key." (Betty, PM 2)
	"So it wasn't a teacher reveal 'here's what you did'…I think the purpose was to get them to look at the expression and think about those numbers and operation. So that's how it starts." (Betty, PM 4)
Teacher-focused	"And that's kind of what I was saying right here, and picking up on what Melody was saying was 'students discover kindergarten and then just fill in the next grade without focusing on the content' of the hill, so is there something that we can do *to help focus on the content of the hill*?" (Betty, PM 5)
	"And so what is the [teacher] response [*to student response*]?"
	"OK, so is there any kind of summary that you visualize saying?"
Instructional medium	"*We want them* to get that it's multiplication without us saying that it's multiplication, so I think that's why we need to do the whole numbers and then with the same scenario move down to the fraction times a fraction"
	"I guess the question is do we want them to do a representation here, so that they are more comfortable or would they be more comfortable doing a representation when they get to the ½ times ¾." (Betty, PM

Note. Segments implying student involvement are italicized. Italics are added.

For instance, Betty extended a teacher's comment by saying "And you're right, I think when we connect somehow back to all that work that they've done with arrays, in third grade, especially with whole numbers – it will help them understand the fractions". This, in turn, initiated the teacher's productive utterance about making instruction relevant to students. Betty's questions such as "When they look at that paper, can you visualize any other reactions of the students? What do you think they'll say and do?" also served to initiate teachers' productive talk about students' thinking. In addition to the 26 student-focused initiations, Betty also posed four instructional questions focused on what the teacher might do during the research lesson (see Table 6). While these questions were oriented toward teachers' actions, student involvement was implied (see italics in Table 6).

Within the teaching category, 11 initiating talking turns were not distinctly teacher-focused or student-focused, but were about the instructional medium for teaching and learning to occur. Specifically, Betty made substantive contributions about the mathematical details of instructional tasks, solicited and confirmed teachers' ideas about the real-work scenarios to use as a context for instructional tasks, as well as instructional strategies to use during the lesson (e.g., folding paper strips, graphical representations, shading, vocabulary). Importantly, while these initiating utterances were focused on the instructional medium, Betty frequently considered students (see italics in Table 6).

Sonja's initiations focused on teaching. Most of Sonja's initiations within the teaching category considered instruction from a teacher's perspective. In particular, Sonja made 38 (50%) initiations, 18 of which focused on what the teacher does during instruction (see Table 5). For instance, Sonja shared personal experience about instructional approaches used to deliver mathematical content to students, elaborated on the research lesson teaching script, at times rehearsing verbatim what they teacher will say during the lesson, as well as solicited teachers' ideas about how the teacher might address students' responses during the research lesson (see Table 7).

Table 7

Sonja's Teaching Category Initiations of Teachers' Productive Utterances

Teaching category	Example quotes
Student-focused	"Someone will say, "well, she filled up one whole cup and another whole cup and

	she has a third extra", is that what we want them to say? What do we want them to say?" (Sonja, PM 2)
	"And if they have four one-fourth and two one-thirds, then you can say, "can you prove why this works to me?". And so Amber would go around and say, "Well, that is an interesting way, why did you choose that?" Then if it's wa::y off, she could say what?" (Sonja, PM 5)
	"So then it says, "We need five one-third cups for this recipe, I can use one whole cup and two-thirds extra". And in that spot, we need to say, "These are the same fraction" somehow. "Do these represent the same amount? This and this - remember, I dumped three one-thirds into this one whole", or something." (Sonja, PM 7)
Teacher-focused	"So now after that successfully, hopefully, we could then go into the teaching section and say "When you have a numerator larger than the denominator that is called a fraction greater than one. As you saw when we had 7/3 we filled two full cups plus 1/3. So two wholes, three thirds in each one, and an extra third". Something like those words." (Sonja, PM 2)
	"*What happens if they put ¾ and ½ or fill it all up with weird ones*, what are we going to say?" (Sonja, PM 3)
	"But I am telling you, I don't know about all the other fourth grade teachers, but this fourth grade teacher ((pointing at herself)), was pretty good about modelling what things would look like. *So I think that my students who had me last year, would get five one-third cups*." (Sonja, PM 5)
Instructional medium	"Alright. Thirds are easy, do you want thirds, eighths, fifths, or what?" (Sonja, PM 2)
	"OK, and then will we want *them to put it into the cup*?" (Sonja, PM 2)
	"Yeah, and then we'll model all of the other ones and *have them justify*. We should use that word 'justify'. Because I bet you that's going to be on that new FSA. Justify your response." (Sonja, PM 5)

Note. Segments implying student involvement are italicized. Italics are added.

Moreover, Sonja frequently asked teachers to confirm instructional decisions about the lesson plan using questions requiring a simple decision between two alternatives: "Right, and then when do we go back to what Lucinda said about discovery – are we going to give them the cup and let them do it or are we just gonna do it there ((pointing to the white board))?"

In addition, Sonja had 14 student-focused initiations, most of which elaborated on specific questions a teacher could ask, as well as potential student responses during the research lesson. Interestingly, rather than asking teachers to anticipate potential students' responses, Sonja offered these herself (e.g., "What happens if they put ¾ and ½ or fill it all up with weird ones, what are we going to say?"), asking teachers to consider instructional implications instead. Furthermore, Sonja asked teachers to confirm desirable student responses (e.g., "They have to prove that three thirds is a whole. So they can pour it back into the whole it has to be a cup, right? Don't we want that?"). Thus, instead of asking teachers to consider the question of 'what will students say', Sonja emphasized the question of 'what do we want students to say' (see Table 7).

Within the teaching category, 6 initiating talking turns were focused on the instructional medium. Specifically, Sonja confirmed the team's decisions about mathematical details of instructional tasks, the use of manipulatives, and the strategic use of language (see Table 7).

Betty's initiations focused on students. Twenty-eight (27.5%) initiations were focused on students, 23 of which were nuanced with respect to student thinking. The overall characteristic of these nuanced utterances was their emphasis of students' mathematical sense-making (see Table 8). In particular, Betty shared research and personal experience, as well as elicited teachers' ideas about student misconceptions, stressed the importance of students' prior knowledge, and considered the details of students' reasoning. However, five initiating statements were superficial with respect to student thinking, focusing on students' correct answers or behaviors without delving deeply into students' reasoning (see Table 8).

Table 8

Betty's Students Category Initiations of Teachers' Productive Utterances

Students category	Example quotes
Nuanced with respect to students' thinking	"So as you look at this, as you think about this idea – 2/3 times ¾ is equal to ½ - what misconceptions, or what challenges do you think we have to think about. Where do you think children are going to get stuck? What misconceptions might they form, or what might be difficult for them to understand?" (Betty, PM 1)
	"I think somewhere we need to highlight. This is where they gain the understanding of the meaning of multiplication. That is means equal groups." (Betty, PM 2)
	"There's research behind that that's really huge, and this goes back to your area model that you were talking about earlier. They discovered that a lot of kids thought fractions were actually two numbers." (Betty, PM 2)
Superficial with respect to students' thinking	"I've had kids get this and understand this [a whole times a fraction]; I've never had kids who understood that [a fraction times a whole], because we've never taught it. Well, we did, but it was the end of the book [laughing]" (Betty, PM 3)
	"Do you visualize them writing anything else? I can see them doing ½ times ½ and stopping, not getting the answer, not putting an answer at all. That's a possibility that they'll recognize it was that [multiplication] and not come up with an answer." (Betty, PM 5)

Sonja's initiations focused on students. Twenty-eight (36.8%) initiations were focused on students, 16 of which were superficial with respect to students' thinking. Most of Sonja's superficial utterances occurred during planning meeting two, when the Riverside team examined the results of student pre-assessments. In particular, Sonja prompted teachers to determine the number of right and wrong responses on the pre-assessment, without asking teachers to analyze student reasoning. Rather, Sonja invoked superficial categories (e.g., lowest math students, gifted, smart) to understand the results. Moreover, Sonja emphasized procedural and behavioral aspects of student learning in her own classroom and during the research lesson (see Table 9). Nevertheless, Sonja's students-category initiations did include 12 utterances that were nuanced with respect to students' thinking, most of which also occurred during planning meeting two. In particular, Sonja shared research and personal experience about student reasoning (see Table 9). She did not, however, directly elicit teachers' ideas about student misconceptions.

Table 9

Sonja's Students Category Initiations of Teachers' Productive Utterances

Students category	Example quotes
Nuanced with respect to students' thinking	"Because my kids came and said, "Oh, yeah, we know what that means". Well, some of my came." (Sonja, PM 1)
	"Let us look 13 and 14 just for a second. How many of your guys children drew an extra part? Some of my children thought that they could just divide this into whole. And really this is a whole, so you had to do an extra part." (Sonja, PM 2)
	"Well, we know the misconceptions – they don't know how to make it and whole and into parts. Is that what you were saying?" (Sonja, PM 2)
	"I don't think that they understand what that means, they can do the pattern." (Sonja, PM 2)
Superficial with respect to students' thinking	"Now in fourth grade, I want to show you what we did today. We did 4 1/2 plus 6 1/2 plus 3 3/4th, and they had to add this first and then add to that and then convert the improper fraction into a mixed number." (Sonja, PM 1)
	"This will be a good lesson then for them. We know that there is a range of abilities…[talking to J] Oh you know that boy's smart – he'll be one of the first to figure out that that's 2 and 1/3 cup." (Sonja, PM 2)
	"OK, so we've got some wrongs" ((Teachers are calling out "right" "wrong" as they are reviewing students' responses to questions 14 and 16)) (Sonja, PM 2)

Betty's initiations focused on content. Thirty-three (32.4%) initiations were focused on content, 27 of which were specific in relation to conceptual mathematics. In particular, Betty presented new information about various representations of multiplying two fractions, solicited teachers' ideas about core concepts in relation to multiplying fractions, and elaborated on teachers' utterances to emphasize conceptual meanings (see Table 10). These types of initiating utterances were representative of Betty's overall focus on conceptual mathematics throughout the LS process. In fact, at least one initiation specific in relation to conceptual mathematics occurred during each planning meeting. Furthermore, planning meeting one was solely dedicated to unpacking the conceptual underpinnings of the multiplying fractions standard – Betty began this planning meeting by stating the following goal: "What I thought we'd do today is just look at if we're multiplying fractions, what does that mean".

In addition to the nuanced utterances, six initiations in the content category were not conceptually specific, referring to standards, topical progression of the unit, and procedures, but without any unpacking.

Table 10

Betty's Content Category Initiations of Teachers' Productive Utterances

Content category	Example quotes
Specific content	"So we know that the problem was 2/3 of ¾. Another representation I've seen with a story problem is OK, so our kids run around in the parking lot as a track; so if we think of a mile – 1 mile is our whole – that track is ¾ of a mile, so the track itself is ¾ of a mile. [drawing] Here is a full mile and a track is three quarters of that mile. So does that make sense, so we're actually starting with a part – and I think that's where it gets hard…" (Betty, PM 1)
	"So the question what transferred from one situation to another? What transferred from area to the multiplication of fractions?" (Betty, PM 2)
	"When you said kids could think of a recipe rather than just a fraction, I think that's what I was trying to ask Tad and Alice is there a way to approach this with just thinking about the action rather than having to think 'OK, I have to split this, and fold this'" (Betty, PM 3)
Broad content	"The beauty of having a multi-grade lesson study team is that you can have a real conversation about how is this concept seeded in lower grades and they progress on through." (Betty, PM 2)

	"Well, this is 5th grade now [a fraction of a whole], so we could go in that direction, or we could stay here, and frankly as a 5th grade teacher I can do either one." (Betty, PM 3)
	"Well, that's a good point, and they might, so do we want…must it be multiplication?" (Betty, PM 5)

Sonja's initiations focused on content. Ten (13.2%) initiations were focused on content, 7 of which were not conceptually specific, referring to broad topics and grade levels. Most of these utterances occurred during planning meeting two when the team engaged in creating a developmental story for fractions. Sonja prompted teachers to recite the standards pertaining to fractions at K-5 grade levels, but without detailed unpacking of the concepts involved.

Table 11

Sonja's Content Category Initiations of Teachers' Productive Utterances

Content category	Example quotes
Specific content	"Then it was talking fractions as sets. We never say that; no, we never do." (Sonja, PM 2)
	"Well most kids=most teachers don't know why that works, so they just do the circle method because someone taught them to do that, and so you only have two numbers to worry about." (Sonja, PM 2)
Broad content	"Fractions was a big hang-up? OK, so do we all agree that we want to do something with fractions?" (Sonja, PM 1)
	"We need to figure out what the developmental story is for modelling and see where fractions even begin." (Sonja, PM 2)
	"Let's see, third grade." (Sonja, PM 2)

Summary of Initiations

In summary, the majority of total initiations made by Betty and Sonja were focused on teaching. However, within the teaching category, most of Betty's initiations addressed teaching from a students' perspective, while most of Sonja's initiations were teacher-focused. Furthermore, while Betty frequently asked open-ended questions that solicited information from teachers, Sonja posed closed-ended disjunctive questions asking teachers to confirm instructional decisions regarding the research lesson.

Facilitators' follow up to productive utterances

Across the 6 Trailways planning meetings, we identified 102 follow up utterances made by the facilitator Betty around teachers' productive comments about students' mathematical thinking. Thus, about 78% of 140 productive utterances in the Trailways team were followed up by the facilitator's comment. In particular, Betty's follow-up utterances were primarily nuanced with respect to students' thinking, specific in relation to conceptual mathematics, and focused on the instruction medium. Across the 6 planning meetings, Sonja made 109 follow up utterances, which is about 87% of 125 productive utterances made teachers in the Riverside team. Sonja's follow-ups were primarily superficial with respect to students' thinking, focused on non-conceptual mathematics, and addressed instruction from a teachers' perspective. We present a detailed report of these patterns below.

Table 12

Frequency and Percentages of Facilitators' Follow up to Teachers' Productive Utterances

	Teaching-students-content coding categories						
	Teaching			Students		Content	
	Student-focused	Teacher-focused	Instructional medium	Nuanced	Superficial	Specific	Broad
Betty's follow up frequency (%)	19 (18.6)	4 (3.9)	23 (22.5)	20 (19.6)	13 (12.7)	20 (19.6)	3 (2.9)
Sonja's follow up frequency (%)	16 (14.7)	34 (31.2)	14 (12.8)	11 (10.1)	25 (22.9)	0 (0)	9 (8.3)

Betty's follow-ups focused on teaching. Forty-six (45.1%) follow-ups were focused on teaching, 23 of which were focused on the instructional medium (see Table 12). Specifically, Betty followed up teachers' productive utterances by elaborating on, soliciting and confirming teachers' ideas about the use of instructional tools and strategies (e.g., the number line, mathematical language, folding paper strips, drawing), as well as making substantive contributions about the mathematical details of instructional tasks (see Table 13). Importantly, while these follow up utterances were focused on the instructional medium, Betty frequently considered students (see italics in Table 13). Moreover, 19 follow-ups were directly focused on students (see Table 12). During planning meeting two, Betty restated and elaborated on teachers' comments, as well as shared personal experience about the importance and challenges of teaching for student understanding. During the remaining planning meetings, Betty's student-focused follow up comments solicited teachers' ideas about teacher questioning and potential student responses (see Table 13). Lastly, Betty also followed up with four teacher-focused statements, elaborating on 'doing teaching' in her classroom and during the research lesson (see Table 13).

Table 13

Betty's Teaching Category Follow-ups to Teachers' Productive Utterances

Teaching category	Example quotes
Student-focused	I don't want to get way in to this. But I think your point about not teaching tricks is really good. And talking about it, because multiplying with fractions has been taught as all tricks in the past [gets up to set up a poster]. (Betty, PM 2)
	Well, and part of the wrestling with it, and I'm still wrestling with this, kids spend so much energy trying to solve a discovery problem, and they work so hard at it, and they're so excited when they discover, that if you're still in the same lesson and you try to take it—okay, so this is the math learning that I want you to walk away with, they've already shut down. (Betty, PM 2)

	"So what kind of answer do we expect students to say when we ask the question of 'why do we write this as multiplication?'" (Betty, PM 5)
Teacher-focused	"No, because I haven't even done this [1/4 of a group of 3] with my students; we've only stayed here [3 groups of 1/4]." (Betty, PM 3) "They could do that, but I think when we're discussing with the whole class, we are showing [pointing at each quarter]." (Betty, PM 6)
Instructional medium	"On the other hand, *if they fully understood the number line, they fully understood this idea of intervals*, the number line can become a great tool." (Betty, PM 2) "Is there language? The way that you all teach some of these ideas, is there specific strategies or language, representations that you use that you feel really work well?" (Betty, PM 2) "And see you intuitively went back to the half a group, a half of a set, because it can be easily divided, and nicely illustrated with kids." (Betty, PM 3)

Note. Segments implying student involvement are italicized. Italics are added.

Sonja's follow-ups focused on teaching. The majority of Sonja's follow-ups within the teaching category considered instruction from a teacher's perspective. In particular, Sonja made 64 (58.7%) follow-ups, 34 of which focused on what the teacher does during instruction (see Table 12). As with her teacher-focused initiations, to follow up teachers' productive utterances about students' thinking Sonja shared personal experience about instructional approaches used to deliver mathematical content to students, elaborated on the research lesson teaching script, and solicited teachers' ideas about how to respond to students' ideas during the research lesson (see Table 14). Furthermore, by reframing teachers' comments about students' thinking in terms of instruction, Sonja seemed to treat students' developing understanding as something that can be fixed instructionally. For instance, in response to a teacher comment about students' sense-making – "With that 7, if you show them that 7 I'm thinking they are going go "Yeah that is greater than one, 1, 2, 3, 4, 5…yes it is greater than one because 2 is greater than one". Even through is not greater than one because 2 over 3 is less than 1" – Sonja replied with a description of how to address it instructionally: "Right, so that is why you have to say three thirds, three thirds, and then show the whole cup. We are doing both". Thus, rather than sustaining the focus and deepening teachers' thinking about student reasoning, Sonja refocused on instruction.

In addition, Sonja had 16 student-focused instructional follow ups, most of which occurred during planning meeting two when the team began working on the research lesson plan. In particular, Sonja elaborated on potential student responses during the research lesson, as well as teacher questioning (see Table 14). Within the teaching category, 14 follow-up talking turns were focused on the instructional medium such as instructional strategies, use of the manipulatives and language (see Table 14). Interestingly, in response to teachers' talk about students' thinking, on multiple occasions Sonja shared personal experiences about instructional strategies used in her classroom, as if offering the teachers instructional tools to fix student misconceptions.

Table 14

Sonja's Teaching Category Follow-ups to Teachers' Productive Utterances

Teaching category	Example quotes
Student-focused	"That is a good idea. If we just gave them the sets without the cups first, then we could say "How could you prove it?" And then they might say, "Can we have a whole cup?". ((speaking to Lucy)) Oooh, you are on fire girl!" (Sonja, PM 2)
	"So can you prove how these fractions are greater than one? Someone will say, "well, she filled up one whole cup and another whole cup and she has a third extra", is that what we want them to say? What do we want them to say?" (Sonja, PM 2)
Teacher-focused	"I do. I make them draw it. I make them say that is one whole, let's make it 8/8, then OK, how many more eighths do I need, 3/8...I did those, those, those [pointing at the examples on the white board] I had to do a lot." (Sonja, PM 2)
	"Maybe after you do it on the Elmo you could say, this is one-third plus one-third plus one-third…do we have five one-thirds?" (Sonja, PM 4)

	"I don't think we want to do that. If somebody does that, are you going to bring it up - is what I am saying? So we are going to accept four one-half's and two one-thirds?" (Sonja, PM 5)
Instructional medium	"I got it from Engage New York, they tape the adding tape and we did it like an adding tape. You get little brackets and you can pick anything that you want like 3/12th plus 4/12th plus 8/12th..." (Sonja, PM 1)
	"OK, can you read it one more time? Liz, this is where we need you to get our words/you –first and kindergarten teachers/we are just wordy, wordy, wordy and you guys help us to make it=" (Sonja, PM 3)

Note. Segments implying student involvement are italicized. Italics are added.

Betty's follow-ups focused on students. Thirty-three (32.4%) follow-ups were focused on students, 20 of which were nuanced with respect to student thinking. In every planning meeting, Betty followed up at least one teachers' productive contribution with a nuanced utterance about students' thinking by sharing her personal experience, restating, or elaborating on teachers' productive talk. However, during every planning meeting, Betty also followed up with 13 total utterances that were superficial with respect to student thinking. Specifically, she shared personal experience and elaborated teachers' comments, focusing on students' behaviors, characteristics, and broad performance (see Table 15).

Table 15

Betty's Students Category Follow-ups to Teachers' Productive Utterances

Students category	Example quotes
Nuanced with respect to students' thinking	"I did do a lesson like this with kids a couple of years ago. And I had a child say to me 'oh, well you really have two wholes, you have two wholes. Here is one mile – that's a whole, and ¾ - that's a whole. So there is two wholes'." (Betty, PM 1)
	"Yeah, yeah. So understanding the importance of the whole, and knowing what the whole is. And I think what Paula is saying - it is huge." (Betty, PM 1)
	"Well, but one of the things that students learn in 5th grade is that fraction is

	division, so when you see 1/2, they do think of 1 divided by 2; they've learned that; that's part of what we do, so they do see fraction as division." (Betty, PM 6)
Superficial with respect to students' thinking	"Well, we have been practicing folding thirds. My third grade can fold thirds pretty darn well." (Betty, PM 2)
	"I think they're OK, and again this is knowing the group of kids, they are a very talkative group, and I have a harder time keeping them focused as a whole class [TM OK], but if I give them things to talk about at their table, they'll focus." (Betty, PM 4)
	"After all the fraction work we've done, and I bet Melody would say the same, I bet, about her 5th graders, after all the fraction we've done with Engage NY, I implore [unclear] fractions. They do them better than decimals, that's for sure." (Betty, PM 6)

Sonja's follow-ups focused on students. Thirty-six (33%) follow-ups were focused on students, 25 of which were superficial with respect to students' thinking. Specifically, Sonja responded to teachers' productive comments about students' thinking by invoking broad statements about student learning (see Table 16). Moreover, some of Sonja's superficial follow-ups served to close off any further discussion about students' thinking. For example, during planning meeting five on multiple occasions when teachers anticipated students' responses during the lesson (e.g., "And then if it overflows then they really will need to go back in and get some more because they'll say that is not right. We have lost some."), Sonja followed-up by rejecting the possibility of such a response, in effect suppressing the discussion (e.g., "Oh, dear. That's a complicated situation. ((Laughter)) I wouldn't even think that somebody would do that, but they might. I don't know…"; "Oh go::lly::, we hope they don't do that."; "Do you think anybody will get it wrong after all that?"). Nevertheless, Sonja's students-category initiations did include 12 utterances that were nuanced with respect to students' thinking, most of which also occurred during planning meeting two. In particular, Sonja elaborated and confirmed teachers' talk about student reasoning (see Table 16).

Table 16

Sonja's Students Category Follow-ups to Teachers' Productive Utterances

Students category	Example quotes
Nuanced with respect to students' thinking	"So the misconception, pretty much, that the idea that we are trying to get to is that they don't understand how to even conceptualize that 1 3/8 is one whole part divided into eight and three extra eighths." (Sonja, PM 2)
	"=So you think that they will worry about the other half, is that what you are talking about?" (Sonja, PM 2)
Superficial with respect to students' thinking	"That is why they cannot get it – it is not their world." (Sonja, PM 2)
	"You are 100% right and this is what we are going to get the whole time. Hopefully somebody will do it differently. I mean you have hope with Anniston." (Sonja, PM 2)
	"Well, they better know it by then. For fifth grade, I meant. For fourth grade, you're right." (Sonja, PM 4)

Betty's follow-ups focused on content. Twenty-three (22.5%) follow-ups were focused on content, 20 of which were specific in relation to conceptual mathematics. In particular, Betty restated and elaborated on teachers' productive comments, highlighting the conceptual aspects of mathematics discussed. In addition to the nuanced utterances, three follow-ups in the content category were not conceptually specific, referring to standards and topical progression of the unit, but without any unpacking (see Table 17).

Table 17

Betty's Content Category Follow-ups to Teachers' Productive Utterances

Content category	Example quotes
Specific content	"Well, I think part of the challenge in drawing representations is what Melody said

	is that extra part. You've got to draw a one." (Betty, PM 1)
	"So knowing that my numerator is the number of pieces that we're talking about, I can say I have two groups of those three pieces." (Betty, PM 2)
	"And that gets fraction of a set, like I have a set of 8 and I'm taking a third of a set of 8, but then the candy bar is 1 whole. It is not a set, so that one would be 1/3 of the whole and you see that you're only getting a part of it." (Betty, PM 3)
Broad content	"Then what I think I'm hearing, I think, is…because I'm trying to answer this question – where in the progression will our unit focus. It's sounds like you're talking about let's focus on multiplying a whole number by a fraction." (Betty, PM 3)
	"Well, this is 5th grade now [a fraction of a whole], so we could go in that direction, or we could stay here, and frankly as a 5th grade teacher I can do either one." (Betty, PM 3)

Sonja's follow-ups focused on content. Nine (8.3%) follow-ups were focused on content, all of which were not conceptually specific, referring to broad topics and grade levels. Most of these utterances occurred during planning meeting two when Sonja was aiming to confirm the topic for the research lesson (see Table 18).

Table 18

Sonja's Content Category Initiations of Teachers' Productive Utterances

Content category	Example quotes
Broad content	"So are we all in agreement that we need to go back to/so really this would not be a fourth grade lesson because it would be a third grade lesson because third grade introduces improper fractions. Third grade." (Sonja, PM 2)
	"Now we have our idea about what kind of lesson we are going to do, something with modelling ((talking to Lucinda)) Do you want modeling or subtraction?" (Sonja, PM 2)

Summary of follow up

In summary, the majority of total follow-ups made by both Betty and Sonja were focused on teaching. However, within the teaching category, most of Betty's follow-ups addressed teaching from a perspective of the instructional medium, while most of Sonja's initiations were teacher-focused. Accordingly, while Betty frequently elaborated on teachers' productive comments as a follow up, Sonja tended to reframe or repurpose teachers' talk about students' thinking in terms of instruction.

Discussion

So how do Betty's and Sonja's dispositions toward LS PD and its facilitation relate to the nature of their talk around teachers' productive utterances about students' thinking? For Betty, teacher learning was the primary goal of LS. Thus, Betty used the LS process to actively promote teacher learning. For instance, in order to initiate teachers' productive comments about students' thinking, she used open-ended questioning to solicit teachers' ideas about students' nuanced thinking about conceptual mathematics. Furthermore, to follow up teachers' productive comments, Betty frequently elaborated, focusing the discussion on the conceptual mathematics or instructional tasks. Sonja, on the hand, emphasized the LS as a means to an end, used to identify student achievement gaps, and then to design and conduct a research lesson to address these gaps. Thus, Sonja frequently used discursive strategies (e.g., closed-ended confirmatory questions) that pushed the team to come to an instructional decision about how to address students' learning needs. Furthermore, teachers' productive comments about students' mathematical thinking, were frequently reframed by Sonja in terms of instruction.

In characterizing the facilitation practice of the two teacher leaders, we do not want to claim that one approach is better than the other. Rather, our findings highlight the complexity of LS as a PD process. While lesson planning typically takes up the most time in a single LS cycle (e.g., Murata et al., 2012), researchers and teacher educators agree that the creation of a lesson plan is not the main goal of LS. Conversely, the process of lesson planning is seen as a way for teachers to deepen their knowledge and improve practice through inquiry, with teacher learning being the primary purpose of LS (Lewis & Hurd, 2011; Lewis, Perry, & Murata, 2006). However, some teachers engaged in LS PD still tend to focus on the lesson per se instead of the inquiry process (Fernandez, Cannon, & Chokshi, 2003). This potential inconsistency between the goal of LS and its implementation might be due to a discrepancy embedded in the process of lesson planning when it is used for teacher learning – “an endemic tension between ‘figuring things out’ and ‘getting things done’ (Horn & Little, 2010, p. 208). Whereas teacher learning involves ‘figuring things out’ through inquiry (Goldsmith, Doerr, & Lewis, 2014), typical lesson planning is about converging on instructional decisions in order to ‘get things done’ (Borko & Shavelson, 1990; Horn & Little, 2010). Sonja echoed this tension during her interview:

> I feel like we get so stuck on what grade the lesson is going to be on, and we spent so much time trying to think about the developmental story of it, that we—I just feel rushed and behind actual words of the lesson, and the actual lesson. But that developmental story is so important, so I just feel rushed a little bit. (Facilitator interview)

We believe that teacher learning about students’ mathematical thinking and the creation of a research lesson plan designed to improve student outcomes are two important aspects of LS. However, these two aspects might be competing for time and resources during the LS process, and the LS facilitator must tread a fine line to try to accomplish both aims.

Conclusion

Scholars argue that there is a need to define and systemically examine the Mathematical Knowledge for Professional Development (MKPD) – “an area of professional knowledge pertaining to leaders of effective PD”, which may include knowledge of content and students as well as knowledge of content and teaching, both from a perspective PD facilitation (Borko, Koellner, & Jacobs, 2014, p. 165). In our work, we found that teacher leader facilitators' *disposition* toward PD and its facilitation might be an important aspect of this knowledge base warranting further exploration. Analogous to the influence of teachers' disposition toward teaching on their practice (Philipp, 2007), we hypothesize that PD facilitators' disposition toward PD and its facilitation will influence their facilitation practice and PD participants' learning. In this study, we began to unpack the 'facilitator's dispositions' construct by capturing the teacher leaders' perceptions of the goals, process, and outcomes of LS PD, as well as the relationship of disposition to facilitation practice of initiating and responding to PD participants' productive comments about students' thinking.

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