

# Lexical and Indexical Conversational Components that Mediate Professional Noticing during Lesson Study

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•Received 22 January 2015•Revised 2 May 2015 •Accepted 25 May 2015

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Previous research indicates that lesson study can support preservice teachers' abilities to professionally notice. This qualitative case study examined specific lexical and indexical conversational components of lesson study analysis meetings that afford or constrain elementary preservice teachers' incidences of professionally noticing students' mathematical thinking. Results indicate that the facilitator supported preservice teachers to identify and provide evidence of student thinking through direct questioning and probing, allowing free discussion, modeling connections of student thinking to mathematics learning theory, and gesturing to explain mathematical concepts. Professional noticing was constrained by discussion of pedagogical procedures and longer talk segments by the facilitator or classroom teacher. Findings suggest that lexical and indexical inclusions in lesson study analysis meetings can support varied levels of preservice teachers' professional noticing. As demonstrated by the facilitator in our study, we recommend facilitators pay close attention to the prompts they pose and how they guide and model analysis of student thinking.

*Keywords:* discourse, lesson study, mathematics education, preservice teacher education, professional noticing, social development theory

## INTRODUCTION

Reform documents in education have suggested the importance of preparing preservice teachers to develop an understanding of students' reasoning and to modify their instruction based on this reasoning (e.g., NCTM, 2000). Many educational researchers have advocated for clinical experiences in teacher preparation programs to engage preservice teachers in innovative research-based practices that allow them to elicit student thinking (Darling-Hammond, 2010; Grossman, Hammerness, & McDonald, 2009). Through field-based clinical models, preservice teachers are given realistic teaching experiences and provided opportunities to improve their practice by teaching lessons and then reflecting on

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doi: 10.12973/eurasia.2015.1392a

these lessons while being supervised by expert educators. These research-based practices, considered key elements of teaching that can result in highly effective instruction, have been called “core practices,” (Grossman et al., 2009) “high-leverage practices,” (Ball, Sleep, Boerst, & Bass, 2009), and “generative practices” (Franke & Kazemi, 2001). Common to these three terms are notions of improvement of the learning and achievement of students, contribution to the integrity of the teaching profession, consistent implementation, and application across content and contexts.

One way to develop high-leverage practices across content and context is through Japanese lesson study (Lewis, 2002), which can provide opportunities for discussions that lead to deep understandings of student thinking. Lesson study is a forum for collaboration in which teachers collectively plan, teach, revise, and reteach lessons in order to modify instruction based on students’ needs and learning. Typically, one team member teaches the lesson, and then the lesson study team meets in a collaborative setting to reflect on and discuss the lesson they just observed, suggesting revisions to the lesson plan for future teaching. We refer to these joint discussions as *lesson study analysis meetings*.

Originating in Japan, lesson study in the United States has been practiced with both inservice and preservice teachers, mostly within the fields of mathematics and science education (Amador & Weiland, 2015; Fernandez, 2010; Hart & Carriere, 2011; Lewis, 2002; Marble, 2006; Sims & Walsh, 2009). Research about lesson study with preservice teachers has demonstrated varied levels of effectiveness, suggesting preservice teachers benefit from guided collaboration with their peers, yet providing unique challenges because preservice teachers do not yet teach in their own classrooms. Therefore, modified versions of traditional lesson study are typically implemented within the preservice population. These modifications have caused some constraints to the purposes of the lesson study model, such as limited observational data due to the lessons being video-taped (rather than viewed in-person), limited collaboration time, and lack of constructive feedback related to teaching and learning (Sims & Walsh, 2009). Regardless of these challenges, however, prior research has shown that through lesson study preservice teachers can learn how to analyze lesson goals, engage in detailed discussions about instructional strategies, and learn to critique the lesson rather than the teacher (Sims & Walsh, 2009). Furthermore, Marble (2007) found that during lesson study preservice teachers were able to reflect on their instruction and came to view teaching as an ever-evolving practice. Our work builds on this literature base by exploring how components of conversations during the lesson study analysis meeting with preservice teachers can mediate deep analysis, or *professional noticing*, of students’ mathematical thinking, and examines what constraints exist during these post lesson meetings that can perhaps hinder to

### **State of the literature**

- Previous research indicates that the abilities of preservice teachers to professionally notice is less comprehensive than those of inservice teachers.
- Research has found that preservice teachers are able to improve their abilities to professionally notice when supported in teacher preparation programs (e.g., video observation of classrooms during methods courses).
- Lesson study is one mechanism that can support preservice teachers in the processes of lesson planning, teaching, and reflection.

### **Contribution of this paper to the literature**

- Our research indicates that engagement in an authentic lesson study context, which includes conversations during lesson study analysis meetings, can support preservice teachers’ abilities to engage in varied levels of professional noticing.
- Direct prompting can afford preservice teachers the opportunity to cite specific evidence of students’ thinking; free discussion, facilitator modeling of classroom connections, and facilitator gestures can generate mixed or focused levels of noticing.
- Focusing on classroom procedure and longer talk segments during lesson study analysis meetings may provide a context for reflection on teaching, but can constrain preservice teachers’ abilities to professionally notice students’ mathematical thinking.

preservice teacher development of professional noticing (Amador & Weiland, 2015; Jacobs, Lamb, & Philipp, 2010).

Professional noticing as it relates to teaching is a metacognitive process during which teachers focus their attention on classroom events and their perceptions of these events (Mason, 2011). In the classroom, teachers notice a variety of elements, including environment, classroom management, tasks, content, and communication (Star & Strickland, 2008). Jacobs et al. (2010) distinguish professional noticing of students' mathematical thinking from these other types of noticing that teachers may engage in while teaching. We therefore focus our work specifically on teachers' noticing of student thinking, and how teachers decide on the factors that are most pertinent for improving instruction. To Jacobs et al. (2010), noticing includes attending to students' thinking, interpreting this thinking, and deciding how to respond on the basis of this noticing. van Es and Sherin (2002; 2008) incorporate within this definition connecting students' thinking to broader theories of learning and using the context to reason about the situation. These processes allow teachers to seek different approaches to various levels of understanding and are imperative to designing and implementing instruction based on the thinking and reasoning of students.

We therefore blend the purposes of lesson study with professional noticing and posit that the deep level of lesson analysis that occurs during lesson study can serve to support teachers' abilities to professionally notice. Previous research has demonstrated that preservice teachers can professionally notice in an authentic field placement context while engaging in lesson study that includes a facilitator (e.g., doctoral student in mathematics education, curriculum expert) and the classroom teacher (Amador & Weiland, 2015; Corcoran, 2011). However, further research is needed to understand *how* this noticing occurs within the lesson study context. We contend that conversational exchanges (verbal, or *lexical*, and non-verbal, or *indexical*) that occur during lesson study analysis meetings can influence the professional noticing practices of preservice teachers. We consider lexical exchanges to be spoken word and indexical exchanges to include gestures, movements, or other physical contributions to the conversation. Specially, we sought to understand: *how do lexical (verbal) and indexical (non-verbal) conversational components of lesson study analysis meetings afford or constrain preservice teachers' incidences of professionally noticing students' mathematical thinking?*

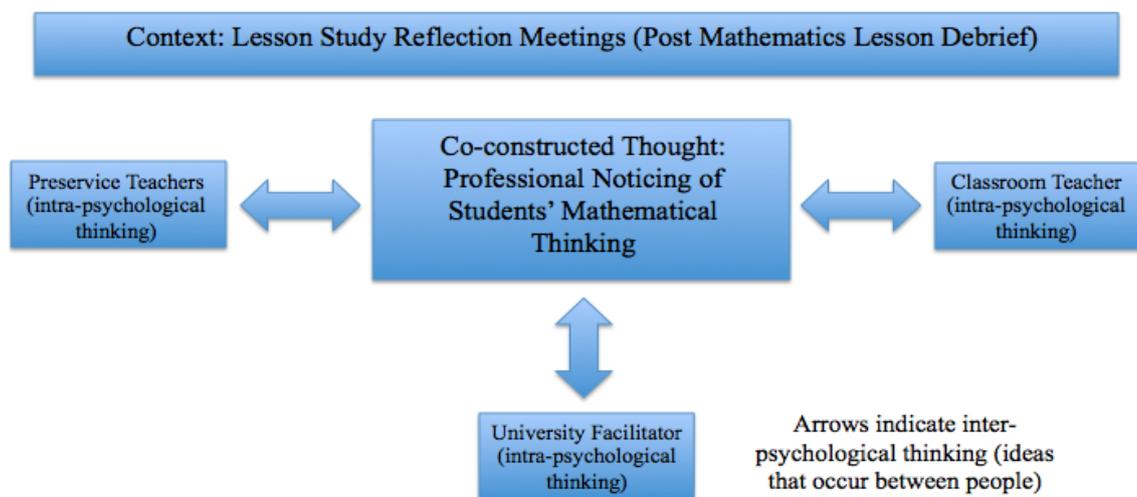
## THEORETICAL FRAMEWORK

This study was conducted through the lens of Vygotsky's social development theory (Vygotsky, 1978), which assumes that learning involves social contexts, thoughts are developed through shared experiences, and learning must occur within one's zone of proximal development. Vygotsky refers to the social plane, in which communication is accomplished through talk, gesture, writing, visual images, and action. It is through this social interaction that individuals formulate thoughts and engage in their own thinking. Vygotsky's (1987) notions of intra-psychological (within oneself) and inter-psychological (between people) thinking and speech recognize that thought processes involve both individual conceptions as well as those that occur between people through talk and gesture. This is a dynamic process by which each space is affected by the other. Discourse analysts have also recognized how conversation develops through the interactions of individuals, creating a flow of communication and thought that would not be otherwise accomplished by an individual, which is termed "co-constructed thought" or "interdiscursivity" (Fairclough, 1992; Rogers, 2004). Further, Gumperz (2003) discusses interactional sociolinguistics, stating that conversation is composed of a sequence of talk turns and that this communication is not only grounded in the

literal spoken word, but also in indexical inferences that are made, such as gesture. Thus, speaking is a reflexive process—either directly experienced or indirectly transmitted—by which speech is a direct reaction to preceding talk or a response to past events. Both verbal (*lexical*) and non-verbal (*indexical*) communication is influenced by cultural assumptions. Thus, in order to understand the flow of communication, it is critical to analyze the indexical cues that may demonstrate the intent of the speaker. Heller (2001) notes that what is interpretable is limited, however the meaning of common indexical cues can be inferred (e.g., yawning meaning tired or bored).

Sociocultural theory and theories of talk therefore provide grounding for collaborative reflection on teaching, allowing individuals to think about and analyze their practice in a reflexive process with other professionals in the field. Through the act of lesson study with preservice teachers and the classroom teacher, facilitators can encourage this collaborative learning and reflection on teaching practice. The communication that occurs during lesson study from different professional perspectives (in this case novice teachers, a classroom teacher, and a doctoral student) can result in varied but distinct sequences of interaction that lead to professional noticing (Amador & Weiland, 2015; Amador, Weiland, & Hudson, in press). Moreover, the lexical and indexical interactions that occur between reflection participants can support or hinder individual reflection on teaching, as well as the contributions made by others. Thus, theories of sociocultural learning were critical to this study, which focused on the conversational inclusions in lesson study analysis meetings (see Figure 1).

Our lesson study approach took place in an authentic elementary classroom and included preservice teachers as well as two knowledgeable others (Fernandez, 2010)—a university facilitator who was a former teacher and current doctoral student in mathematics education and the host classroom teacher. We therefore examined how preservice teachers interact with these experts—the facilitator (university personnel, experienced teacher, doctoral student, and instructor of the field experience course) and the classroom teacher (who was the primary educator of the group of kindergarten students with whom the participants worked, and had 21 years of teaching experience). While the intra-psychological aspects cannot be identified as they occurred within the individual, we examined the lexical and indexical conversational components that led to varied levels of professional



**Figure 1.** Framework for professional noticing during lesson study based on Vygotsky's (1978) Social Development Theory

noticing.

## LITERATURE REVIEW

In the following literature review, we discuss research on professional noticing with preservice teachers, as well as how lesson study has been used with preservice teachers to demonstrate how the current study builds on prior research in the field.

### Professional noticing

Professional noticing in educational research is a “way to understand how teachers make sense of complex classrooms” (Jacobs, Lamb, Philipp, & Schappelle, 2011, p. 98). The construct of professional noticing has developed in part from Dirkin’s (1983) work on cognitive tunneling and Endsley’s (1995) examination of situation awareness. These works involve analysis of teachers’ perceptions of what occurs in the classroom and how they negotiate the importance of various situations (Miller, 2011). Professional noticing is therefore the act of recognizing events or student actions and words, interpreting these occurrences, and then responding based on these interpretations (Jacobs et al., 2010). van Es and Sherin (2002; 2008) consider professional noticing to involve three related aspects: (a) identifying what is important about classroom interactions; (b) connecting classroom occurrences to broader theories of teaching and learning; and (c) using the context to reason about the situation.

van Es (2011) proposed a framework that provided educators and researchers with a means for analyzing various levels of noticing which include: Baseline, Mixed, Focused, or Extended. A Baseline level of noticing includes the teacher providing general descriptions of classroom occurrences, Mixed involves evaluation of the occurrences, Focused includes interpretations of classroom occurrences, and Extended noticing provides connections between events and theory or principals of teaching and learning. Not surprisingly, research has shown that the ability to notice is more prevalent among emerging teacher leaders compared to novices (Huang & Li, 2012; Scherrer & Stein, 2013; van Es & Sherin, 2008). Through a direct comparison between preservice and inservice teachers, Jacobs et al. (2010) found that more experience with students’ thinking resulted in higher levels of professional noticing. Novice teachers tend to focus on general descriptions of classroom occurrences and provide basic evaluation of these occurrences (e.g., stating that a particular students’ understanding was ‘good’ without providing supporting details), while more experienced teachers are more likely to interpret classroom interactions and can sometimes relate those interactions to broader education theory. Star, Lynch, and Perova (2011), however, found that teacher preparation programs can impact preservice teachers’ abilities to interpret students’ understandings. Researchers also suggest that since preservice teachers may not have extensive experience in examining students’ thinking, they need explicit opportunities to learn how to professionally notice, and teacher education programs can provide these opportunities (Sherin, Jacobs, & Philipp, 2011; Sims & Walsh, 2009; van Es, 2011).

Star and Strickland (2008) found that viewing video of classroom interactions improved preservice teachers’ noticing, although preservice teachers need support to make detailed observations in order to attend to and make pedagogical decisions based on students’ thinking. Sherin and van Es (2005) also noted that preservice teachers predominately focus on the sequence of events or on specific instances in the lesson as opposed to interactions between the teacher and the student. Despite preservice teachers’ novice status and perhaps lack of extensive experience the

classroom, Star et al. (2011) found that video observation supported the development of preservice teacher noticing in just one semester.

Many of these studies have incorporated video for lesson viewing; however, preservice teachers' abilities to professional notice may differ when they are placed in a more authentic context. The current study sought to extend the knowledge base on professional noticing to include this authentic context provided by participation in field-based lesson study.

### **Lesson study with preservice teachers**

Lesson study originated as a Japanese practice termed *Jugyokenkyu* (meaning lesson and study/research [Fernandez, 2010]) and has served as a model for the examination of teaching and learning within various contexts. As mentioned previously, the Japanese model of lesson study incorporates a meeting of educators who set a goal for the lesson study process, then work together over an extended time period to plan, implement, and reflect upon a research-based lesson (Lewis, 2006). The lesson study team studies research materials and curriculum guides to determine the best instructional methods for teaching the lesson. One teacher from the team then teaches the lesson while the other team members observe the lesson, focusing on evidence of student thinking. Following the lesson, the entire team meets to reflect on the lesson with regard to student learning and instructional methods, and then discusses revisions to the lesson for another team member to teach to their students—these are the meetings we refer to as lesson study analysis meetings. This student-focused process repeats until the team believes they have a well-developed lesson that meets the needs of their students.

Research with preservice teachers has found that the lesson study process can provide a context to promote connections across its various components, which include planning, teaching, and reflection (Murata & Pothen, 2011). Contemporary researchers in the United States have examined the use of lesson study in teacher education programs, yet the teaching portion of lesson study is often replaced with either peer teaching (during which university students teach lessons to other university students) or with teaching to small groups of K-12 students (Carrier, 2011; Fernandez & Zilliox, 2011; Potari, 2011; Sims & Walsh, 2009). One example of a modified approach is termed Microteaching Lesson Study in which preservice teachers instruct a reduced class size (approximately 5-10) of either students or peers (Cavin, 2008; Fernandez, 2010).

Fernandez (2010) investigated how and what preservice teachers learn through microteaching of peers, and found that the reflective and collaborative components of lesson study were critical for developing preservice teachers' abilities to examine student thinking. Marble (2006) provided preservice teachers a lesson study opportunity in authentic classroom settings (their field placement), yet the experience was limited to one cycle of lesson study. Despite the limited time frame, Marble (2006) noted that preservice teachers were able to reflect on their teaching with regard to lesson objectives, yet the lesson study process was constrained by the fact that preservice teachers were not able to observe one another nor discuss revisions to further develop the lesson concepts. Thus, previous work on lesson study with preservice teachers has demonstrated the value of engaging them in this process, however the lesson study model was not completely enacted due to the lack of an authentic whole-class K-12 teaching experience and peer observation. These limited contexts may hinder the opportunity to reflect on a lesson whereby varying observers professionally notice different aspects of the lesson (Murata, 2011). As a result, we intentionally focus on one small component of an authentic lesson study process used with preservice teachers to provide an in-depth understanding of what

occurs during the process and how this affords and constrains the incidence of professional noticing during the lesson study analysis meetings.

## **METHOD**

The current study was conducted using a qualitative case study approach. Case studies are used when the researcher wants to understand a real-life phenomenon in depth within a bounded system (Yin, 2009), and include rich descriptions of the case. In this study, the bounded case consisted of seven preservice teachers, the classroom teacher (kindergarten), and the facilitator. Data included video and transcripts of lesson study analysis meetings. In the next two sections, we describe in detail the study context, as well as data sources and analysis.

### **Context**

This case study focused on one lesson study team, including the aforementioned seven preservice teachers, a classroom teacher, and a facilitator. The preservice teachers were all students in a teacher education program at a large Midwestern university. Most were in their second year of the teacher education program and had taken three prerequisite mathematics content courses. As a component of the teacher education experience, the preservice teachers were enrolled in a field experience course focused specifically on students' thinking in mathematics and science. During the first two sessions of the field experience, the preservice teachers participated in two three-hour workshops that focused on how to elicit and analyze student thinking. Workshop topics included formative assessment interviews, building models of student thinking, and lesson study. The field experience course met for three hours weekly at a local elementary school, the site of the lesson study, and was designed so that the preservice teachers worked in clusters of six or seven and were placed together in one classroom. The decision to place six or seven in each classroom was made in order to provide an opportunity for preservice teachers to collaborate in planning, teaching, and reflection as they worked with the same group of children throughout the semester. Further, we felt that placing more than seven in one classroom would overwhelm the students and the teacher. In our larger research project, twenty-five preservice teachers were enrolled in the mathematics and science field experience course, whom were placed in four host classrooms. Of these four clusters, this cluster of seven was intentionally selected for further study because of their aptitude for professional noticing, as demonstrated by data analysis for the larger research project. The data for this current study come from the first seven weeks of the field experience course, which focused solely on mathematics.

As a component of the field experience course, the seven preservice teachers in this study were divided into three different groups of two or three each (Group A—two preservice teachers, Group B—two preservice teachers, Group C—three preservice teachers). Each week a different group (A, B, or C) was responsible for co-teaching a mathematics lesson to the kindergarten class. One preservice teacher from the group led the lesson while the other group member(s) supported implementation of the lesson. The pairs of preservice teachers each taught two lessons, thus each leading one lesson. The remaining group of three taught two lessons. In this case, all three preservice teachers shared the responsibility to lead the lesson (see Table 1).

To begin, each group (A, B, or C) wrote the initial lesson plan they were to teach in the classroom. They then taught the lesson while being observed by the other two groups of preservice teachers, the classroom teacher, and the facilitator who all took detailed field notes of students' actions and words using a lesson observation form

(designed by the research team for the larger project) while they observed the lesson in action. Following the lesson, the entire team met together for a lesson

**Table 1.** Lessons taught by preservice teachers

Lesson	Taught By ( <i>lead preservice teacher(s) in italics</i> )
0	Taught by classroom teacher
1	Group A ( <i>preservice teacher 1</i> , preservice teacher 2)
2	Group B ( <i>preservice teacher 3</i> , preservice teacher 4)
3	Group C ( <i>preservice teacher 5</i> , <i>preservice teacher 6</i> , <i>preservice teacher 7</i> )
4	Group A ( <i>preservice teacher 2</i> , preservice teacher 1)
5	Group B ( <i>preservice teacher 4</i> , preservice teacher 3)
6	Group C ( <i>preservice teacher 5</i> , <i>preservice teacher 6</i> , <i>preservice teacher 7</i> )

study analysis meeting. During these meetings, the team followed a predetermined protocol for discussing student thinking. The protocol was as follows:

1. Members of the group that taught the lesson provided input on what went well with the lesson
2. The other lesson study team members referenced their field notes and provided similar input
3. The preservice teachers who taught reflected by discussing components of the lesson that could have been improved
4. Other lesson study team members engaged in similar discourse
5. The team collectively discussed revisions that should be made to the lesson plan that guided the day's lesson
6. The team discussed the lesson that would be taught the following week

This protocol was designed to support preservice teachers' professional noticing (as defined by van Es, 2011) by reflecting upon what they observed during the lesson (Baseline), evaluating the lesson (Mixed), and proposing revisions (Extended). Furthermore, professional noticing was supported through written field notes and interpretations of those field notes (Focused) using a lesson observation form and subsequent discussion of the lesson to identify what was important about classroom interactions. Discussion of observed students' actions and words, as well as revisions to the lesson and implications for the proceeding lesson occurred during the lesson study analysis meeting in order to connect classroom occurrences to broader theories of teaching and learning (Extended), and to use the context to reason about the situation.

It should be noted that the lesson taught the following week was the next lesson in an instructional sequence and not a revised version of the previously taught lesson. This component of the lesson study process was modified from traditional versions of lesson study, similar to other versions of lesson study in the United States, based on the constraints of the school setting and the need for students to learn new material the following week (Hart & Carriere, 2011). Therefore, the following week a different preservice teacher group from the lesson study team taught the new lesson and the same process repeated, with the expectation that insights that occurred as the lesson study team engaged in professional noticing through lessons study analysis meetings about students' thinking and reasoning were incorporated into the proceeding lesson. This cycle initiated with the classroom teacher teaching the first lesson (Lesson Study 0), followed by Group A (Lesson Study 1), Group B (Lesson Study 2), Group C (Lesson Study 3), Group A (Lesson Study 4), Group B (Lesson Study 5), and finally Group C (Lesson Study 6). Each group had the opportunity to teach two mathematics lessons and the lesson study cycle went through seven iterations over the span of seven weeks.

## Data sources and analysis

Data sources for this study included videos and transcripts of seven mathematics lesson study analysis meetings. The first lesson study cycle involved the classroom teacher as the lead instructor (referred to as lesson study analysis meeting zero), while the other six were taught by a group of preservice teachers (labeled as lesson study analysis meetings one through six).

Initially all lesson study analysis meetings were transcribed verbatim, allowing for simultaneous transcript reading and video viewing during analysis. The entire data set included lesson study analysis meetings from four cadres of six preservice teachers, with each cadre working in a different classroom. All data were then analyzed for instances of noticing using a framework developed by van Es (2011). For this analysis, we both independently coded each talk turn (i.e., each instance of a new person speaking) based on the professional noticing framework adapted from van Es (2011) in Figure 2.

To determine the classification of professional noticing as Level 1: Baseline, Level 2: Mixed, Level 3: Focused, or Level 4: Extended; each of the levels were further broken down into two or three categories, such as 1AA to provide additional detail about the data. Approximately 1281 individual talk moves across 24 videos were coded. After coding, we met to determine inter-rater reliability (89%) and discuss discrepancies. Discrepancies were reconciled through joint discussion. The following provides an example of the coding process:

Preservice Teacher 6: I would say the launch went really well, but I would say, I would say the investigation needed a little bit of work.  
CODE: 1AA

This example was coded as 1AA because the preservice teacher provided a general description of what occurred (the launch went well, the investigation needed work) but did not provide detail or evidence to support the comment. An in-depth description of this analysis and results are described in Amador, Weiland, and Hudson (in press); Table 2 provides a summary of coding of preservice teachers' noticing across the seven lesson study analysis meetings.

The current study was inspired by this analysis, as we noted that one case was of particular interest. The case was notable as it appeared that the social context and shared interactions had an influence on the patterns of noticing, more so than in the other three cadres. Thus, we endeavored to explore through a deeper qualitative analysis the nuances of this social interaction, using the lenses of Vygotsky's (1978) social development theory and Gomperz's (2003) interactional sociolinguistics to determine if and how professional noticing was being afforded or constrained.

For the current study, we both re-watched the seven videos to ensure that the transcription was accurate, and added indexical detail in brackets related to

Level 1: Baseline		Level 2: Mixed		Level 3: Focused			Level 4: Extended	
1AA. Form general descriptive impressions of what occurred	1BB. Provide little or no evidence to support analysis	2CC. Provide Primarily Evaluative Comments	2DD. Provide evaluative comments that are supported by reference to specific events and interactions as evidence	3EE. Provide Primarily Interpretive Comments	3FF. Provide interpretive comments that are supported by reference to specific events and interactions as evidence	3GG. Elaborate on events and interactions interpreting the events	4HH. Make connections between events and principles of teaching and learning	4II. On the basis of interpretations, propose alternative pedagogical solutions

Figure 2. Framework for how to notice (Amador, Weiland, & Hudson, in press)

**Table 2.** Distribution of levels of noticing by preservice teachers during lesson analysis meetings (Amador, Weiland, & Hudson, in press)

Lesson Study Meeting	1AA	1BB	2CC	2DD	3EE	3FF	3GG	4HH	4II
1	57.20%	19.84%	7.78%	11.28%	0.39%	1.95%	0.00%	0.00%	1.56%
2	41.92%	26.80%	11.00%	15.12%	1.37%	3.09%	0.69%	0.00%	0.00%
3	55.12%	20.98%	9.27%	11.22%	0.98%	2.44%	0.00%	0.00%	0.00%
4	59.18%	6.63%	12.76%	13.78%	1.02%	6.63%	0.00%	0.00%	0.00%
5	61.24%	14.83%	11.96%	10.05%	0.48%	1.44%	0.00%	0.00%	0.00%
6	44.19%	17.05%	13.95%	16.28%	0.00%	6.20%	0.78%	0.00%	1.55%
<b>Average</b>	53.14%	17.69%	11.12%	12.95%	0.71%	3.62%	0.24%	0.00%	0.52%

gestures, entry and exit of participants, and hedges. Using the theoretical underpinnings of social development theory and the importance of social interaction to learning and reflection (Vygotsky, 1978), as well as Gomerpz's (2003) interactional sociolinguistics, we examined the sequences of talk moves with regard to the verbal (lexical) and non-verbal (indexical) communication that occurred. The lesson study analysis meeting videos and transcripts were analyzed using open coding (Patton, 2002) to gain a broader sense of various lexical and indexical conversational components that occurred throughout the reflection meeting, during which we noted the type of noticing that occurred based on the previous analysis that used the van Es (2011) framework (Amador & Weiland, 2015). Talk moves from all participant types were coded.

Data analysis focused on the types of conversational components, lexical and indexical, that led to varied types of noticing as defined by van Es (2011). Each talk move (defined as a segment of a single speaker) was coded, as well as the indexical cues (i.e., gestures, entry and exit of participants, and hedges). We both independently coded all data and met through an interactive process to reconcile codes and decide on the most prevalent themes. This occurred until codes were exhausted, and then condensed and grouped into similar themes. After identifying the main trends in the research, we coded the data once again with these themes (axial coding, see Patton, 2002). Please see Table 3 for final themes and examples from the data set. Finally, we examined the data to analyze patterns of lexical and indexical conversational components that led up to high levels of noticing per prior analyses. In the next section, results of these analyses are presented by themes that were generated during open coding. Representative quotes are followed by the a priori noticing codes assigned during analysis using the van Es (2011) framework that was done prior to open coding for conversation components that afforded or constrained noticing.

## RESULTS

Results indicate that both lexical and indexical conversation components served to either afford or constrain various types of professional noticing. Specifically, the tendency to connect evidence to suggestions while professionally noticing was largely dependent on the facilitator. The facilitator was able to support preservice teachers and the classroom teacher to identify and provide evidence of student thinking through direct questioning and probing, allowing free discussion, modeling interpretations of student thinking by connecting student actions to broader mathematical education learning theory, and gesturing to support explanation of mathematical concepts. In some instances, however, noticing was constrained

**Table 3.** Themes and Examples from the Data

Theme	Data Example	(Type of Preservice Teacher Noticing that Followed) and Quote
<b>Direct prompting</b>	Facilitator: What evidence of student thinking did you see?	<i>(Attending to student thinking)</i> Preservice Teacher 6: I brought out the tracing sheet and the whole time she was writing fours on her sheet, she does it backwards. And today after she traced three, I went to the page, she did it correctly. And so that was like evidence that you know those tracing sheets do help, especially when you know, it's repetition thing.
<b>Allowing free discussion</b>	[Preservice teachers talking freely, not going around in circle as dictated by protocol]	<i>(Connecting suggestion to evidence of student thinking)</i> Preservice Teacher 2: One thing I think, well we can see this with Gwendolyn, before her twelve, we'd say can you write the number twenty? She'll write twelve, but now she's writing twenty [says excitedly]. But she starts off, she writes the one but then she'll write a two over it. She knows it's not twelve, it's twenty so...I put in my notes, she knows that twenty starts with a two and it's not twelve. So I thought the tracing helped and that these lessons are just helping them figure it out.
<b>Modeling Interpretations</b>	Facilitator: One thing that I noticed is that they don't understand how the decades come together yet. They can count up. It's almost like they are starting to get it when they're counting rhythms, but they don't understand when we were looking at, I flipped to students, nineteen. And she didn't know that that number was nineteen. I started saying, "well what..." I said "now, what number does that sound like?" She doesn't connect nineteen and nine as being similar numbers yet.	<i>(Attending to student thinking)</i> Preservice Teacher 3: I noticed that too, Janice was writing twelve. She got the ones down. Even though there was a twelve right there for her to look at... She still was confused about where to put the two. I was like, there's a number two? I was like just try it, just how that is there. And then she, she did it. She just took her a minute figure out how to write the number.
<b>Gesturing</b>	Preservice Teacher 5: The kids I was working with, I was with Aaron and Phil and they got done real fast. Like they did everything they were supposed to. They guessed and they counted and then they drew and stuff. But they got done like really, really quick. [Classroom Teacher nods vigorously]	<i>(Deciding how to respond)</i> Preservice Teacher 5: But like Aaron, he still has problems with big numbers. So I think maybe if there was like more in the bag? Like if one of the numbers was like bigger, then he would have had time to like practice with big numbers too.
<b>Focusing on procedure</b>	Facilitator: [talking to classroom teacher] I definitely told [the preservice teachers] because they're not sure how to physically arrange the students, I said, 'Yeah,' I said 'You are a better resource than me' because I haven't worked in the room and I don't, you know how to troubleshoot the problem.	<i>(Suggestions not based on evidence)</i> Preservice Teacher 4: I think estimation would be fun. Preservice Teacher 5: Fun, but I think that counting... [this is said in very slow pattern] Preservice Teacher 4: They mastered that one.
<b>Longer talk segments by facilitator or classroom teacher</b>	[Long monologue by classroom teacher]	<i>(Focusing on pedagogy, not based on evidence)</i> Preservice Teacher 7: Yeah, going off of the timing I, I don't know if, I don't know [tentative] if the lesson just... I felt like it was going to flow a little bit better judging from how I, we wrote it on paper [laughing coyly]. But then actually like being in the moment it was little bit different. I think it was great because they were really engaged and it showed [moving hands]. I don't know if I was mentally like prepared [laughs], [giggling] prepared, for that. And so I think it was a learning experience in a good way. I think maybe preparing for some more 'what-ifs' would be helpful in the future.

because the facilitator or classroom teacher focused on procedures or engaged in extended conversation. These themes are discussed in further depth below. Noticing codes generated from the a priori analysis (Amador, Weiland, & Hudson, in press) are included—quotes that do not contain a priori codes were not considered instances of noticing, but instead were considered talk moves that led up to noticing events.

### **Noticing afforded**

The occurrence of the following themes supported noticing during the lesson study analysis meetings: direct prompting, allowing free discussion, modeling interpretations, and gestures. Each of these is discussed in the following sections.

#### ***Direct prompting***

The facilitator provided direct prompts and comments about student thinking which led to similar types of professional noticing from the preservice teachers. Direct prompts were instances when one participant asked a non-rhetorical question or made a statement that signified an expected response. When asked directly for evidence, preservice teachers were able to attend to student thinking and identify what was noteworthy about classroom interactions. For example, in the second lesson study analysis meeting, which discussed a lesson during which students used a number line to count physical objects from a container, the facilitator noted, “Alright, now let’s move on to evidence of students’ thinking. So what were some things you saw to either show that some students are really getting the concepts or maybe some are still struggling?” This direct questioning led to two consecutive preservice teacher comments that included detailed evidence of student thinking. For example, the comment immediately following the facilitator’s probe involved the preservice teacher describing a student’s action and then analyzing the student’s thinking:

Preservice Teacher 1: [The student] would guess that there was four and then before she would write the number four, she would actually draw like four squares, then write the number four [using a pencil tapping against her hand to demonstrate]. So, I was trying to figure out if she heard the directions wrong [moves arms away from body] or if she just...this is the way she’s thinking [facilitator nods]. Does she visually have to draw it out before she’s able to come up with the number? I couldn’t tell [shrugs shoulders] which one she was doing? [Coded as Focused Noticing, 2DD]

In such instances of direct prompting, the preservice teachers usually provided detailed descriptions of students’ actions and words, and sometimes attempted to interpret these observations. Following a specific prompt, they were more likely to verbalize professional noticing and engage in a discussion about a specific student or students’ understanding. Across the seven lesson study analysis meetings, the facilitator was the only participant type to engage in this direct prompting, which was critical for affording opportunities for noticing.

#### ***Free discussion***

The lesson study analysis meeting protocol familiarized participants with a standardized template for reflection that focused on professional noticing. Resulting from this process, the lesson study team members began the meetings talking in a predetermined circular pattern. Based on the protocol developed by the larger research team to which the facilitator was to adhere, the facilitator established this standardization in the first lesson study analysis meeting, and consistently reinforced the protocol through prompting. She said:

Facilitator: [Today] we're actually going to kind of model a lesson study. [Classroom teacher: 'Good. Perfect. Good.' Vigorously nods her head in approval]. So...the person leading the lesson starts and says [classroom teacher nods head] you know...things that went well, things that could be improved and how you could see evidence of student learning based on your goal for the lesson. [no a priori code, not coded as noticing]

In this quote, the facilitator established one objective of the lesson study analysis meeting—to recall evidence of student thinking. In lesson study analysis meetings zero through two, the set order of discussion (i.e., state what went well in the lesson, note what could have been improved, and discuss the following week's lesson) also allowed each participant the opportunity to reflect on what they noticed during the lesson. In fact, participants consistently responded in an orderly fashion, taking turns around the circle to share observations of the students' actions or words with whom they had worked. This allowed each preservice teacher an opportunity to share her thoughts, and each preservice teacher contributed equally.

During the third and fourth lesson study analysis meetings the preservice teachers still adhered to this protocol, but focused less on student thinking. It appeared that the structure of the meetings began to inhibit the participants' comments once they became comfortable with the protocol, perhaps providing too much structure as to stifle natural conversation and contribution. This is evidenced in the following segment from the fourth lesson study analysis meeting, after a lesson that entailed students moving from one counting station to the next with different activities in each location:

[Facilitator asks what preservice teachers could do better next time—part two of the protocol].

Preservice Teacher 4: It's really difficult to think of something that just was really, really bad because [laughing] I didn't think anything really went really bad. [Coded as Baseline, 1AA]

Preservice Teacher 3: Well like she said, I can't really... The only thing is um, you... well this is out of your hands but time maybe? [preservice teacher who taught is writing notes]. I know some people finished the tracing worksheets like this [snaps] and others were still trying to trace the line but that varied between students so it was really out of your control. Other than that...[Coded as Baseline, 1AA]

Preservice Teacher 2: [Speaking quietly] I agree, I really can't think of anything off the top of my head. The only thing which I really don't know how to control is, a lot of kids at times just started [waving hands back and forth to indicate energetic activity, preservice teachers laughing], like so one suggestion [all laugh], because it's hard to do with so many kids and so little of us and you're actually teaching. Just keep an eye on that because the students were a little wild [preservice teachers laughing, one preservice teacher who taught is writing notes]. [Coded as Baseline, 1AA]

In this segment, the preservice teachers appeared to feel it was their "turn" to speak as they sat in a circle but communicated that they did not have anything to share. This implied that the preceding comment might not have been something they felt they needed to respond to within the conversation.

Interestingly, once the lesson study analysis meeting participants broke out of the protocol structure in later meetings, meaning they discussed the contents of the protocol without a predetermined order, more noticing about student thinking occurred. Again, perhaps once the preservice teachers became more comfortable with the format of the lesson study analysis meeting and with the group dynamics, they began to discuss the lesson more freely and did not follow the circular turn-

taking pattern. In lesson study analysis meetings five and six, all participants were participating freely, without following the previous protocol pattern of speaking in turn around the circle. Furthermore, the preservice teachers began speaking in longer segments, which led to conversations that involved not only attending to student thinking, but initial interpretations of that thinking. Breaking out of the specified protocol order also allowed the preservice teachers an opportunity to dialogue about the lesson, sharing ideas back and forth. For example, in lesson study analysis meeting three, which entailed discussion about a lesson on counting fruit, completing a worksheet, and students taking part in a counting game, three preservice teachers engaged in discussion on revisions to the lesson, citing specific events to support their suggestions:

Preservice Teacher 6: I think the only thing that I could think of was making some of the numbers higher like just overall. Because some of the kids, I don't know but I was working with Adam and Matt like they blazed through some of the stuff pretty easily and then during the game Adam started crying! But he wanted there to be numbers higher than ten because those were the ones he felt like he needed to practice. [Coded as Mixed, 2DD]

Preservice Teacher 4: And so I think maybe like some of the numbers, some of the kids still need like the lower numbers so like just a mix of all of them I think would be pretty good [Coded as Focused, 3BB].

Preservice Teacher 1: So yeah I noticed one student having trouble trying when they were pointing and counting, getting kind of mixed up with where they were and needing their fingers to count. [Coded as Mixed, 1AA]

These examples indicate that when the preservice teachers spoke freely rather than in a turn-taking pattern, they began attending to student thinking and, at times, trying to interpret that thinking, building off of one another's comments. Further, they were often able to sustain the same this type of noticing in subsequent talk moves. As a result, the lesson study protocol provided an initial structure for the meetings, but findings indicate that divergence from the protocol to include increased opportunities for the free flow of conversation resulted in increased incidences of professional noticing.

### ***Modeling connections***

In order to professionally notice in an extended manner, van Es (2011) states that one must connect student thinking to broader educational theory. In our study, the facilitator modeled interpretations of student thinking to bridge connections to educational theory for the preservice teachers. For example, after lesson two, which entailed students counting objects from a container using a number line, the facilitator noted a student taking a different approach by drawing figures to count and stated, "Well it could be that she uses her art as way to think and process things." The facilitator was thus modeling an interpretation that connects to theory that students understand content through different learning modalities because the student drew out figures instead of using the number line to count. Immediately following this comment, a preservice teacher stated:

Preservice Teacher 1: I was working with Zach and, um, he first guessed... He guessed that there was three of a particular object and then when we counted there was actually four. And so I said, would you say that that's more than, less than or the same and he goes like it's just a little bit bigger. And I thought that that was so cool because he really understood that they were next-door neighbors on the number line, you know. [Coded as Focused, 3EE]

While this statement is not related to the facilitator's connection to art as a way to process information, nor does it continue the high level of noticing that connects student thinking to broader education theory, the preservice teacher did provide evidence of student thinking and provided some initial interpretations of this evidence, thus continuing analysis of student thinking. As evidenced in Table 2, the level of noticing in this example is quite high in comparison to the majority of talk moves coded, as the preservice teacher connected the actions of the student, Zach, with his knowledge about number lines and how students think about one more and one less.

It was clear that the facilitator also intended to push the preservice teachers and the classroom teacher by demonstrating how pedagogical strategies connect to broader theory. For example, after lesson three during which students counted fruit on a preservice teacher-created game board, she stated, "You used the idea of number of objects with the representative numeral throughout the whole thing, you did that when you had them put the number five up." Although the facilitator modeled these connections, the preservice teachers and classroom teacher made very few comments that connected theory to practice, and only did so on a general level, for example when the classroom teacher said after lesson three, "I liked the game board...they were having to think more spatially." Consequently, these modeling attempts afforded the opportunity for preservice teachers to understand what this type of analysis may include, and to make their own interpretations of student thinking, but did not result in frequent instances of connections to broader principles of mathematics teaching and learning.

### ***Gestures***

Gestures served to support noticing throughout the seven lesson study analysis meeting videos and corresponding transcripts. This occurred through general conversational gestures, such as nodding to indicate agreement and/or attentiveness, as well as through direct prompting of discussion (i.e., facilitator pointing to a preservice teacher to indicate a talk turn) or through gesturing to explain interpretations of student thinking.

Of particular interest were gestures that supported interpretation of student thinking. The following excerpt from the second lesson study analysis meeting provides an example (recall that the second lesson involved students counting using a number line):

Facilitator: I, I'm going to mention it again. I really like how you slowed them in the counting [moving hand up and down in a one-to-one correspondence pattern] because that goes back to what we were talking about during model building, that they know the sequence [moves index fingers in both hands in a circular way; one preservice teacher takes notes] but they... some of them are still struggling with the one-to-one correspondence [moves hand vertically to indicate one-to-one correspondence]. And I think some of you noticed when they were counting on their number lines [uses right index finger to show counting on an imaginary number line—points, moves finger to the right, points, moves finger to the right, points, moves finger to the right, points], when their fingers did not always match the number [pointing goes off of the table and she brings it back] they were on so that's really demonstrating that the one-to-one correspondence [moves hand on table back and forth rapidly] isn't quite there. By slowing them down, [moves hand away from body and brings it back repeatedly] you're really forcing them to think about it.

In this segment, the facilitator used her hand gestures to indicate and emphasize her interpretation of the mathematical thinking. Furthermore, she gestured a solution to

this issue, namely to slow students down to ensure an understanding of one-to-one correspondence. The facilitator's gesture to explicate one-to-one correspondence on a number line visually communicated with preservice teachers her interpretation of student thinking, and likely supported preservice teachers' understanding of the interpretation if they were unfamiliar with the concept of one-to-one correspondence. This comment with gestures was then followed by a response by a preservice teacher, who included a similar focus on students' thinking:

Preservice Teacher 2: Um, I have a suggestion [says assertively]. For the worksheet like we, the guessing and the actual...that was really confusing for them because they can't read and so they needed assistance with saying [she touches her paper one word at a time for how many] how many triangles are there in the bag, you know? [preservice teachers nod] Like they can't read so I had to physically [pointing to paper as if she was pointing word by word to a student who could not read] be there, work with Courtney and go through it with her step by step. They couldn't do it by themselves. [Coded as Mixed, 2DD]

We infer that the use of gestures supports discussion related to student thinking, mathematical reasoning, and suggestions based on student thinking, as it allowed students to visually see what the facilitator meant by one-to-one correspondence. However, it is interesting to note that this proceeding comment was not related to the comment made by the facilitator. The preservice teacher did not connect her comment to the concept of one-to-one correspondence; however, she did build on the idea of pointing out something students were struggling with and used her knowledge to make interpretations on this basis.

### **Noticing Constrained**

Two themes emerged that related to conversational components that constrained professional noticing during the lessons study reflection meetings: focusing on pedagogical procedures and long talk segments by the facilitator or classroom teacher.

#### ***Focusing on pedagogical procedures***

The type of prompt the facilitator provided was a crucial component of preservice teachers' noticing. As noted previously, direct prompts to discuss student thinking resulted in subsequent comments by preservice teachers that included evidence of student thinking, and sometimes interpretation of that thinking—both are types of professional noticing. However, when prompts were vague, the preservice teachers provided general feedback that often focused on classroom procedures or management. For example, in the fifth lesson study analysis meeting, after the following broad prompt from the facilitator: "Alright, people who taught it, let's uh... how did it go?" preservice teachers provided very general reflections (e.g., "I thought the launch went well"). Moreover, sometimes the facilitator's comments changed the preservice teachers' pattern of noticing by shifting the conversation from evidence of student thinking to more general pedagogical discussion. For example, in the fifth lesson study analysis meeting preservice teachers were discussing students' actions and words when the facilitator focused on classroom procedural aspects of the lesson. The fifth lesson involved students working in groups and partaking in various stations focused on counting. They rotated around the room to engage in the different activities:

Preservice Teacher 4: In my gear up, the kids they actually started to write the numbers [Coded as Baseline, 1AA].

Preservice Teacher 2: The only thing I can really say that would make it better is during bingo, if there was maybe different boards [many people agreeing by nodding. 'Umm,' 'Yep.'] [Coded as Baseline, 1AA]

Facilitator: Well and then, I mean kindergartners not so much but if you adjust it to like an older group some of them might start to, to figure out which differentiated group they're in, [preservice teachers nodding their heads] if you do it by groups. And so if everybody has different numbers then you know, subtle things like that helps everybody feel the same...[long pause and nodding head]. Well and, and they start catching onto that, there's always different ways you can do that without putting their names on necessarily. You know, you can have the red group, the blue group or the triangle group, the square group and the circle group. [no a priori code, not coded as noticing]

In this example, the preservice teacher (Preservice Teacher 2) made the suggestion that the lesson could have been further differentiated with the inclusion of bingo boards for different mathematical abilities. Following this, the facilitator shifted the focus from students' thinking to discussing procedures to prepare materials to mask ability levels (as opposed to discussing differentiation as related to student thinking). While this is indeed an important consideration related to protecting anonymity of mathematical ability levels, it shifted the focus of the conversation away from students' mathematical thinking and therefore away from professional noticing. Thus, the type of prompt, and promoting discussions that focus on classroom procedures as they specifically relate to student thinking, contribute to the level of noticing that can occur. This highlights the importance of fostering a context conducive to sustained professional noticing.

### ***Long talk segments***

In some instances, the conversation included longer periods of talking by the facilitator or the classroom teacher, which resulted in a lack of opportunity for preservice teacher input. In these cases, the speakers commonly focused on general pedagogy or connecting the day's lesson to their own experiences as teachers, likely to provide context to the conversation. However, when this occurred, preservice teachers did not speak freely and sometimes exhibited signs of lack of attention (e.g., playing with hair or fidgeting). The following example demonstrates this theme:

Facilitator: Something really simple that you think doesn't matter? Like for example, when I was a teacher, if they got an A on a quiz or a test, I just wrote a smiley face [all preservice teachers are looking at facilitator]. And that was for me, the fastest way to count the number of As. So when they win something or do something, drawing a smiley face, then they have something but they don't really have something [preservice teachers: 'Mmm hmmm']. But that's a way of reinforcing 'Hey you did a good job!' [one preservice teacher smiles], without having them expecting rewards for their work. Yeah, I mean because that's what I would do, I would just do checkmarks at the top of pages for something that just had to be checked off and wasn't graded [preservice teachers are starting to fidget by looking in bags, moving notebooks; one preservice teacher playing with hair; others are looking at facilitator]. And that was something for me as much as it was for them. They know that I saw it and I know that I saw it...so, yeah and gosh, kids they're like 'His checkmark is bigger than mine,' [says in loud voice like a kid complaining], 'Can you give me a big checkmark?' Or sometimes they get sophisticated, 'Can you put it in this box?' [Draws a box with fingers on the table]. You can have fun with them, over something as simple as a checkmark. But then you're making them feel special, wanted and appreciated as, as members of the community. So think about that rather than something physically that would be money out of your own pocket as well so... [no a priori code, not coded as noticing]

While this type of discussion certainly involves a critical aspect of teaching that many face—providing feedback efficiently and effectively—it does not highlight aspects of professional noticing with regard to mathematics teaching and learning. Indeed, the classroom teacher also engaged in extended talk segments, usually to discuss kindergarteners in general and provide background information related to how students learn. While also undoubtedly important, the length of these talk moves resulted in a shift in the conversation from this particular set of kindergarteners' mathematical thinking and learning to more general pedagogical discussion, and resulted in indexical cues that preservice teachers' attention was waning. This was exhibited in lesson study analysis meeting zero, about a lesson on same and different, when the classroom teacher spoke for almost five minutes (from the timestamp interval of 3:35-8:34) and preservice teachers began to fidget. The following is a short excerpt from this long monologue to demonstrate the general pedagogical nature of her discussion:

Classroom Teacher: We've been talking about the shapes but they had a hard time with the...the people. Part of that was a tactical error on my part because some of the examples of the shoes were pretty good, but the example of the shirts wasn't that clear. And so...you know...when you're doing things on the fly that happens. Um...so you kind of have to go with it. When somebody comes close you go, 'Yea, that's great!' You kind of make it work. Um...but that's a little bit hard. [no a priori code, not coded as noticing]

In this excerpt from the extended five-minute monologue, the classroom teacher focused on the spontaneity of teaching, and how flexibility is a critical part of instruction. Again, while this is an important part of teaching, these longer segments of discussion by the facilitator or classroom teacher stifled opportunities for preservice teachers to provide their own interpretations or comments on the lesson. There were also instances throughout the seven lesson study analysis meetings in which the facilitator and the classroom teacher engaged in back-and-forth conversation, without interjection by the preservice teachers. We posit that these longer segments could have constrained the preservice teachers' abilities to verbalize their professional noticing.

## **DISCUSSION**

This research contributes to a body of knowledge that examines the development of preservice teachers' high-leverage practices (Ball et al., 2009), in this case professional noticing of students' mathematical thinking. We support the notion that university-facilitated clinical preparation of preservice teachers is critical to developing effective teachers, and claim that participating in experiences such as lesson study can provide opportunities for shared reflection that support the development of preservice teachers' abilities to professionally notice.

Our approach follows the assertion of Vygotsky (1978; 1987) that social interaction is critical to formulate thoughts and engage in reflective thinking, and that these interactions can encompass both lexical and indexical components of communication (Gomperz, 2003). With regard to Vygotsky's (1978) social plane that distinguishes communication as talk, gesture, writing, visual images, and action, these lexical and indexical communication components contributed to the affordances and constraints of preservice teachers' professional noticing during lesson study analysis meetings. Our research suggests that various inter-psychological (interactions between people) conversational components can foster and sustain a focus on identifying instances of students' mathematical thinking, interpreting student thinking, and examining suggestions for future instruction. Thus, lesson study can support the integrity of the profession by fostering deep

levels of analysis of student thinking and reasoning, which can lead to targeted instruction for diverse student needs. These deep levels of analysis stemming from lesson study align with teacher education reform that calls for engaging preservice teachers in research-based high-leverage practices (Ball et al., 2009).

### **Noticing afforded**

Similar to van Es and Sherin (2002; 2008), we found that preservice teachers were afforded opportunities to professionally notice when asked to cite evidence of student thinking. Results of this study indicate that the facilitator's direct prompts provided preservice teachers with a clear focus to the conversation, as evidenced by their comments that detailed student actions and words related to their thinking, thus demonstrating about the influence of knowledgeable experts' facilitation (Hart & Carriere, 2011). While this finding is not surprising, it does provide clear evidence for the importance of the role of the facilitator in providing explicit attention and direction to deeply discuss students' thinking. In addition, we found that free discussion and equitable contribution were also imperative to sustained conversation about students' mathematical thinking. Indeed, when prompts were followed by free discussion amongst the participants, preservice teachers provided natural contributions that sometimes related to previous comments. Conversely, preservice teachers demonstrated hesitation when asked to talk in turn, which resulted in general comments such as, "The launch went well," and thus a lower level of professional noticing. Therefore, one may infer that the preservice teachers were more constrained in noticing when they felt it was their turn to speak and thus needed to comment, rather than adding to the discussion when they felt they had something to contribute. We therefore suggest a gradual release of the lesson study analysis meeting protocol, and, as did the facilitator in our study, we recommend encouraging natural contributions from preservice teachers once they become familiar with the format of the meetings. In this case, natural contribution to the discussion was imperative to fostering meaningful (and unforced) statements of students' noticing. Furthermore, when preservice teachers contributed in this manner, all seven tended to participate equally.

The findings of this study also suggest that lexical and indexical conversational comments that encourage noticing include modeling of deep thinking and connecting to broader education theory. The facilitator provided clear examples of connecting observations of students' actions and words to interpretations of student thinking through the lens of mathematics education theory, thus supporting a critical lens for reflecting on mathematics (Hart & Carriere, 2011). Research that has examined instructional supports for students suggests that modeling of thinking and viewing learning through specific lenses can scaffold mathematical thinking (Baker, Gersten, & Lee, 2002; Hart & Carriere, 2011). The preservice teachers in our study did not commonly connect their interpretations of students' thinking to broader mathematical education theory (perhaps because, as novice teachers, this was not within their knowledge base), however the facilitator's modeling resulted in subsequent comments by the preservice teachers' that focused on specific evidence of student thinking with some interpretation of this thinking. This case applies Baker et al.'s (2002) notion of "modeling of thinking" beyond teachers modeling for K-12 students to the value of modeling for preservice teachers recognition and analysis of students' mathematical thinking. Thus, if we expect teachers to model their thinking to students, we as teacher educators must model our analysis of students' thinking to our preservice teachers. This indicates that professional noticing by the facilitator and classroom teacher provided a crucial context for the preservice teachers to begin to professionally notice as well, even if it was a different type of noticing. Indeed, it appears there is room to support preservice teachers

even further with regard to this aspect of professional noticing and, perhaps, this can be accomplished by encouraging those in roles such as the classroom teacher and facilitator to include even more frequent verbal instances of professional noticing of students' mathematical thinking in their interactions with preservice teachers (Jacobs et al., 2010). Further conversational components such as gestures fostered the sustainability of in-depth noticing, as well. Although some indexical cues (such as the facilitator nodding) were prevalent throughout the lesson study analysis sessions, the gestures that supported an explanation of mathematical thinking (e.g., using a finger to denote counting on a number line) coincided most clearly with professional noticing. We infer that these gestures facilitated an understanding of how students' were thinking, providing an opportunity for visual analysis of students' mathematical strategies.

### **Noticing constrained**

As lesson study analysis meeting conversations developed through the interactions of the individuals (inter-psychological), instances of co-constructed thought were constrained when the facilitator or classroom teacher engaged in longer talk segments or in conversations with each other (Fairclough, 1992; Rogers, 2004). Based on the work of Gumperz (2003), who sites all communication as intentional, we wonder if the facilitator and classroom teacher viewed the lesson study context in part as a venue for sharing their extensive teaching knowledge, expertise, and experiences with the preservice teachers. While these extended talk segments by the facilitator and classroom teacher provided important general pedagogical suggestions and contextual information, they sometimes resulted in preservice teachers' decreased engagement. We therefore suggest that discussion about general pedagogy and classroom context during lesson study reflection meetings, while important, should be limited and should focus on providing background information directly related to better understanding students' thinking. This—as well as prompts, modeling, and gesturing—are paramount in providing opportunities for preservice teachers to professionally notice.

### **CONCLUSION**

These findings show promise for the affordances provided by lesson study for professional noticing with preservice teachers. The lexical and indexical inclusions in the lesson study analysis meetings encouraged discussion and analysis of students' thinking. As evidenced by this case, preservice teachers were able to attend to students' mathematical thinking, interpret their thinking, and begin to make connections to broader principles of teaching and learning while considering how to respond pedagogically (Jacobs et al., 2010; van Es, 2011). We examined how these interactions occurred, and provided insight into the importance of the facilitator allowing for open discussion and gesturing and modelling connections for preservice teachers so that they can fully partake in a collaborative process of professional noticing. While these results are not entirely surprising, they do suggest key implications for focusing lesson study analysis meetings, which are often constrained by time. We suggest that the role of the facilitator is critical, and therefore, as did the facilitator in our study, they must pay close attention to the prompts they pose and how they guide and model analysis of student thinking. Furthermore, our case study approach (Yin, 2009) permitted the inclusion of deep analysis of one case, which exposed the influence of various roles on the process. As such, further research investigating the roles of the different participant types in the lesson study process would provide a more in-depth understanding of the reasoning behind extended talk segments and may shed further insight about the affordances and constraints on professional noticing.

## ACKNOWLEDGEMENTS

Support for this project was funded by the National Science Foundation Project #0732143. The ideas in this manuscript are solely generated by the authors and do not necessarily reflect those of the National Science Foundation. We would like to thank the National Science Foundation, as well as the principal investigators of the grant, Enrique Galindo, Meredith Park Rogers, and Valarie Akerson of Indiana University, Bloomington.

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