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A Framework for the Facilitation of Teachers' Analysis of Video

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Abstract

Video is being used more widely in professional development to help teachers learn to notice and systematically analyze teaching practice. Video captures the authenticity and complexity of teaching and can promote the examination of classroom interactions in a deliberate and focused way. However, simply viewing video does not ensure teacher learning. An important question concerns *how* to facilitate substantive analysis of teaching practice with video so that it becomes a productive learning tool for teachers. In this study, we examine the in-the-moment moves facilitators make in two different video-based professional development programs to offer a framework for facilitation with video. We then examine patterns in facilitation across both contexts and identify practices that are unique to the goals of each setting. The findings from this study have implications for the design of video-based professional development and for developing a knowledge base for professional education.

Keywords

teacher learning, facilitation, video analysis, professional development

The use of artifacts to support teacher learning has increased significantly in the last decade or so. A number of professional development environments, particularly in mathematics education, have been designed to engage teachers in video-based analysis of classroom instruction or in the analysis of student work as a way to help teachers develop pedagogical content knowledge and content knowledge for teaching as well as the dispositions and skills to notice and analyze important elements of teaching and learning (e.g., Borko, Jacobs, Eiteljorg, & Pittman, 2008; Driscoll, Nikula, DiMatteo, & Eagan, 2008; Driscoll et al., 2001; Seago, Mumme, & Branca, 2004; Star & Strickland, 2008; van Es & Sherin, 2008). The ability to notice and respond to student thinking has been identified as a hallmark of expertise in teaching (Berliner, 1994; Mason, 2002). Moreover, research in mathematics education has identified the central role that both content knowledge for teaching and teacher noticing have for achieving the goals of ambitious mathematics instruction (Ball, Thames, & Phelps, 2008; Hill et al., 2008; Sherin, Jacobs, & Philipp, 2011). The bulk of the research investigating artifact-based professional development environments has focused on detailing the impact of such professional development opportunities on teachers' learning (e.g., Borko et al., 2008; Goldsmith, Doerr, & Lewis, 2014; Goldsmith & Seago, 2011, 2013; Seago, Jacobs, Heck, Nelson, & Malzahn, 2013; van Es & Sherin, 2008). Less is known about how professional development facilitators construct interactions and enact activities to create the conditions that promote such learning (Goldsmith & Seago, 2008). This article therefore shifts the focus from the question of "what did teachers learn?" to "how do facilitators support teacher learning during artifact-based professional development?" In particular, we draw on analysis of two video-based professional development programs to develop a framework articulating ways that facilitators shape, focus, and support teachers' use of video to inquire into mathematics learning and teaching: a group of middle and high school teachers working with the *Learning and Teaching Linear Functions* (LTLF) materials (Seago et al., 2004) and a group of elementary teachers participating in a mathematics-focused video club (Sherin, 2000). We use these different settings to transcend the particulars of one specific context, so as to produce a more generalizable framework for the facilitation of mathematics teachers' analysis of video.

We have reported on these two groups before, from the standpoint of the teachers' learning. We found that teachers who examined classroom video learned to focus on the mathematically important details of student thinking (Goldsmith & Seago, 2008, 2011; van Es & Sherin, 2008). Moreover, prior research found that teachers who learned to attend to

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student mathematical thinking in a video-based professional development setting shifted their teaching practice to attend more closely to student ideas while teaching, an important element for teaching mathematics for understanding (Sherin & van Es, 2009). This research, however, left us with questions about *how* the teachers learned to be more analytic as they inquired into student thinking and the facilitators' role in that process. Thus, the central research questions for this article are as follows: (a) What particular practices do facilitators of video-based professional development enact to support teachers in productive discussions of mathematics teaching and learning? and (b) How do these practices coordinate to support teacher learning? Based on analysis of video and transcript data from two different video-based professional development programs, LTLF for middle and secondary teachers and a video club for elementary mathematics teachers, we propose a framework for facilitating video-based discussions. We then include examples from both contexts to illustrate ways that the facilitators coordinate these practices to promote teachers' collaborative analysis of mathematics teaching and learning as represented in video.

Theoretical Framework

The use of video in professional development is premised on the idea that it can help promote teacher learning by providing concrete examples of classroom work with which teachers can investigate learning and teaching (Ball & Cohen, 1999; Hatch & Grossman, 2009). The idea of inquiring into artifacts of practice is embedded within learner-centered theoretical perspectives, including constructivist and situative theories on learning (Cobb, 1994; Lave & Wenger, 1991; Putnam & Borko, 2000; Vygotsky, 1978). These perspectives share the notion that engaging in challenging, practice-based, and socially shared activities is likely to promote an expanded knowledge base for participating teachers (Borko et al., 2005). Putnam and Borko (2000) argued that researchers can gain greater insight into how to productively support teacher learning by attending to teachers' collective inquiry with artifacts of practice that are situated within the work of teaching. Mathematics professional development has embraced the use of video as a tool that offers teachers opportunities to gain a better understanding of the relationship between the mathematical content of a lesson, students' mathematical work, and pedagogical decisions and practices (Castro, Clark, Jacobs, & Givvin, 2005; Hiebert & Stigler, 2004). Video offers teachers the opportunity to observe and study the complexity of classroom life and to consider instructional challenges from a variety of perspectives—for example, in terms of lesson content, student thinking, and pedagogical approaches (Hiebert, Gallimore, & Stigler, 2002). Teachers can also "break set" (Putnam & Borko, 2000, p. 6) from the constraints of their regular classroom routines to delve deeply into their practice without the pressure of needing to act in the moment.

While collective video-based inquiry of mathematics teaching and learning shows promise for improving teaching practice, important questions remain about how to facilitate such learning, and in particular, how facilitators create contexts where teachers work together to make sense of their practice and participate in the group work to engage and support teachers in their learning. We draw on two conceptual frames to explore the role of the facilitator in video-based professional development: (a) situative perspective and (b) teacher learning with video in collaborative contexts.

Using the Situative Perspective to Explore Facilitation of Mathematics Professional Development

The situative perspective conceptualizes learning as coming to participate more centrally in the organized activities of a social group (Lave & Wenger, 1991). As individuals move from periphery to the center of a community, they become more active members, taking on new roles and participating in the routine activities of that particular social group (Lave & Wenger, 1991; Rogoff, 1995). According to the situative perspective, learning largely occurs through interactions with others, mediated by tools and resources in the environment, and involves supporting newcomers in learning how to use the standard tools and language of a community (Goodwin, 1994; Rogoff, 1995). Through increased participation in a community, newcomers come to develop routine practices for participating in the community's activities. Conceiving of learning this way suggests that research attend to not only what teachers learn but also how they learn through interactions with others. Therefore, this perspective is consistent with a research agenda that includes how the facilitator of teacher learning promotes teachers' new ways of thinking about and engaging in their practice.

We concur with Elliott and colleagues (2009) that there is a limited research base addressing the role of the facilitator (or teacher leader) in supporting teacher learning in mathematics professional development. Yet, we also observe that there is increasing acknowledgment that, as the mediator between the professional development program and teachers' experiences of the program, the facilitator is central to orchestrating effective learning experiences and that the field must more clearly articulate and study the work of facilitation (Borko, 2004; Elliott et al., 2009; Givvin & Santagata, 2010; Koellner, Jacobs, & Borko, 2011; Nikula, Goldsmith, Blasi, & Seago, 2006; Remillard & Geist, 2002; Santagata, 2009).

Researchers have recently enlisted two frameworks to guide the study of facilitation in mathematics professional development—framing facilitation in terms of attention to sociomathematical norms (Elliott et al., 2009; Yackel & Cobb, 1996) and the orchestration of productive discussions

(Borko, Jacobs, Seago, & Mangram, in press; Elliott et al., 2009; Stein, Engle, Smith, & Hughes, 2008). Both these frameworks were initially developed in the context of mathematics classroom learning and teaching and both are grounded in a situative perspective. Moreover, these frameworks have provided a way for characterizing a core set of practices that guide the work of facilitation. In particular, they each draw attention to the important role the facilitator plays in establishing, monitoring, and maintaining norms for collective exploration of mathematical ideas and for orchestrating productive discussions of mathematics, mathematical thinking, and mathematics instruction. The introduction of these frameworks has provided a more systematic lens for the study of facilitation. For example, Elliott et al. (2009) proposed that Stein et al.'s (2008) five practices have important implications for the work of teacher educators and professional development leaders. They argued that by applying these practices in their professional development workshops, facilitators were able to lead more intentional and focused conversations around rich mathematical tasks. In a similar vein, Borko and colleagues (in press) suggested that there are specific practices facilitators can engage in to purposefully use classroom video during professional development, especially to engage teachers in productive conversations about mathematics learning and teaching captured by the video. Inspired by the analogy to improvisation and the five practices for successfully managing classroom mathematics discussions, Borko et al. (in press) posited a framework for facilitating video-based discussions during professional development workshops, which includes six practices for planning and orchestrating discussions. These practices are intended to promote high-quality conversations during which teachers deeply explore mathematical concepts, students' mathematical reasoning, and teachers' instructional behaviors. Our goal in this article is to further expand on these frameworks by articulating four categories of practices for engaging teachers in substantive discussion of video in a group setting, while also defining particular moves that are uniquely associated with each practice. This approach is consistent with Lampert (2010) and Grossman, Hammerness, and McDonald (2009) who advocate for the field to define a core set of practices for the work of teaching. Research in mathematics education has made progress toward this goal, defining high-leverage practices that show promise in developing a pedagogy for teacher education (Kazemi, Lampert, & Franke, 2009). In this study, we take a similar perspective and extend this conversation to the practice of facilitation by documenting routine ways that facilitators engage teachers in their learning with video.

Participating in Communities to Critically Analyze Teaching and Learning With Video

A common goal of professional development is to help teachers adopt a more inquiry-based stance toward artifacts—to shift from evaluating student work to identifying and interpreting it for evidence of students' mathematical reasoning and teachers' decision-making (e.g., Goldsmith & Seago, 2011; Schifter, Bastable, & Russell, 1999; van Es & Sherin, 2008). The idea is that teachers' careful analysis of the cognitive, mathematical, and pedagogical features of artifacts will help them develop the disposition to attend more closely to the mathematical thinking of their own students and to the skills needed to make instructional decisions that will advance their students' learning. However, it can be challenging for teachers to adopt this stance, because (for many) it is not the approach they typically take to analyzing teaching practice (Kagan & Tippins, 1991; Miller & Zhou, 2007). Instead, teachers tend to focus on their own behaviors—what they perceive they are doing well or poorly. They are less accustomed to using artifacts of practice to investigate students and their learning (Goldsmith & Seago, 2011).

Video offers many benefits for helping teachers develop an inquiry stance to their work, particularly when teachers learn to interrogate the video in a planful and intentional way (Nikula et al., 2006). It can capture much of the complexity of classroom interactions and allows teachers to re-view classroom episodes multiple times and from different perspectives. Also, when a group of teachers view video together, they bring their own experiences and points of view to the setting and can share different interpretations of the events that unfold. Finally, when collecting and selecting video for examination in professional development, it is possible to choose interactions that highlight aspects of classrooms that teachers may not always be able to see during instruction. For instance, teachers are not often able to work with a particular student or group of students for a sustained amount of time. Thus, they only have glimpses into how particular students experience a lesson or how different groups of students coordinate their work together. But with video, they can explore these issues further with sustained footage of student group work.

While there are many benefits to using video, it can be difficult for teachers to feel comfortable viewing and discussing what happens in their classrooms with their colleagues (Brophy, 2004). Teaching is an isolating activity. Teachers are rarely observed by their peers, and teachers may be self-conscious having their colleagues view a lesson from their classroom (Brophy, 2004; Rosenholtz, 1989). In addition, it is uncommon for teachers to take a critical stance when they work with colleagues to inquire into their practice (Ball, 1996; Grossman, Wineburg, & Woolworth, 2001; Horn & Little, 2010). It is not common for teachers to collectively focus on issues of teaching and student learning and critically examine classroom interactions to explore ways to improve teaching together, and to support each other to change their practice (Skerrett, 2010). Lord (1994) referred to this type of interaction as "critical colleagueship" (p. 184), with teachers posing questions related to each other's teaching, probing each other's thinking, and using evidence to

make claims about teaching and student learning. Research suggests that teacher learning is more likely to happen when groups of teachers engage in productive *disequilibrium* through self-reflection, collegial dialogue, and on-going analysis of teaching practice and student learning (Goldsmith & Schifter, 1997; Lord, 1994; Schifter & Simon, 1992; Skerrett, 2010). However, teachers do not have well-established norms for collaboratively working with colleagues to inquire into their work (Horn & Little, 2010). Thus, participation and discourse norms need to be created to help members become comfortable making their practice public and analyzing each other's teaching and the interactions that unfold in their classrooms (Lieberman & Pointer Mace, 2010; Skerrett, 2010).

Three recent studies articulate the kinds of strategies facilitators enact during discussions of classroom video to promote greater teacher participation in a learning community (Borko et al., in press; Coles, 2012; Zhang, Lundeberg, & Eberhardt, 2011). All three emphasize that facilitators encounter a range of decision points while using video in professional development (Remillard & Geist, 2002) and that facilitators use a variety of approaches to engage teachers in productive exploration of teaching and learning.

Drawing on Hmelo-Silver and Barrows' (2006) analysis of facilitation of medical students' participation in a problem-based learning (PBL) curriculum, Zhang and colleagues (2011) identified 21 strategies that professional development facilitators used to engage science teachers in discussion of classroom video. They categorized these strategies according to four main facilitation goals (promoting PBL discourse, establishing a learning community, maintaining the group process, and modeling the study group practice), although they observed that individual strategies could be used to serve multiple goals. Analysis indicated that facilitators' coordination of multiple strategies tended to promote productive discussions of PBL. Working from video of his own facilitation of teacher groups, Coles (2012) developed a framework for facilitating teachers' productive analysis of video that consists of five decision points: selecting clips for analysis, establishing norms for discussion, determining when and how often to re-view clips, shifting the discussion from describing to interpreting what is viewed, and helping teachers generalize from the particulars in the clips to important ideas in teaching and learning, what he referred to as "metacommenting" (p. 5). Similarly, Borko and colleagues (in press) identified three practices for orchestrating productive discussions with video—eliciting teachers' ideas, probing for evidence, and helping teachers make connections between what they observe and key mathematical ideas. These frameworks reveal the intentional nature of facilitation—that facilitators make deliberate choices before professional development and enact particular strategies during professional development to ensure that video is used in productive ways to support teacher learning.

Drawing on these lines of inquiry, this study contributes to research on facilitation in two important ways. First, we build on earlier work that articulates intentional use of classroom artifacts to promote teacher learning (Goldsmith & Seago, 2011; Nikula et al., 2006). Second, we increase the generalizability of the proposed framework by analyzing facilitation in two rather different video-based mathematics professional development programs. By examining facilitation practices across two programs that use video from mathematics classrooms as a central artifact for analysis, we can begin to construct a framework that articulates routine practices for engaging teachers in video analysis of classroom interactions.

Research Design

Study Context

Data for this study come from two video-based professional development programs. The first is a video club that consisted of a group of fourth- and fifth-grade teachers from an urban school who met once a month over the course of a school year. In a video club, a group of teachers come together on a regular basis to view video segments from each other's classrooms (Sherin, 2000). We refer to this group as the Mapleton Video Club. The research team, that also designed and facilitated the meetings, consisted of two graduate students and the lead researcher for the project. For each meeting, there was a primary and a secondary facilitator. The primary facilitator led the meetings, whereas the secondary facilitator videotaped the meetings and also participated in the discussions. The first author of this article was the primary facilitator for 7 of the 10 meetings. The team's lead researcher took on the role of facilitator for the other 3 meetings, with a third research team member participating as the secondary facilitator. All members of the team were experienced at using video for teacher education and research.

The video club was designed to help teachers learn to attend to and interpret the particulars of student mathematical thinking, based on research that emphasized the need for teachers to shift the focus from themselves to students, to attend closely to the ideas students raise, and to use those ideas to make instructional decisions (Ball & Cohen, 1999; Ball, Lubienski, & Mewborn, 2001; National Council of Teachers of Mathematics [NCTM], 2000). For this particular video club, the research team videotaped in the participating teachers' classrooms and selected clips for analysis at each meeting. The team made this choice to select clips intentionally, because the participating teachers were in the midst of a new curriculum adoption and the researchers did not want to burden them with and additional time commitment. The research team recognized that their decision was a trade-off, because some of the noticing they were trying to cultivate among participants occurred in the selection of clips. However, by choosing clips themselves, the facilitators were

able to more purposefully plan for the discussions because they were able to select, view, and study the clips before each meeting.

Teachers signed up to share a clip from their teaching, and between meetings, a member of the research team videotaped in the teachers' classrooms, highlighted potential segments to share in the meeting, and reviewed and selected segments with another member of the research team for the upcoming meeting. When videotaping, the camera focused on independent student work, student–student discussions, and whole class discussions to capture instances of student thinking for the teachers to discuss. The clips were roughly 5 to 7 min in length, with some being a continuous video segment and others consisting of several segments edited together. The clips featured students working through a mathematical problem or explaining how they solved a problem or highlighted teachers and students discussing a student's solution method. A corresponding transcript was prepared for each segment and given to the teachers in each meeting.

Each video club meeting lasted between 60 and 75 min and had the same structure. The group typically viewed segments from two of the club members' classrooms, viewing and discussing each clip for about 30 min. Before viewing each clip, the facilitator introduced the segment, providing a brief overview of the lesson and the mathematical topic and a summary of the particular segment of the lesson from which the clip was selected. The teacher whose clip was being viewed provided an additional context for the segment.

The second context was a group of eight middle and high school teachers from the Atwood school district who participated in the LTLF professional development program (Seago et al., 2004). This group met over the course of a school year as well, once a month from September to May. Here we report on teachers' work on the foundation module, which consists of eight 3-hr sessions devoted to conceptualizing and representing linear relationships. The last author of this article facilitated the meetings with the Atwood group. The LTLF sessions include classroom video of students discussing their work on a problem related to linear relationships, as well as time prior to viewing the video for teachers to work through, and discuss, the problem themselves. For the purposes of this study, we focus on the video discussion portions of the sessions only.

The two programs shared an underlying philosophy as well as similar goals and design features. They both conceived of teacher learning as being best supported in long-term, sustained professional development in which teachers examine issues grounded in the particulars of practice. They also both focused on increasing teachers' sensitivities to students' mathematical ideas and on developing their abilities to use classroom video to inquire into their practice. One important distinction between the two meetings is the mathematical focus. The LTLF video cased materials were designed to support teachers in deepening their mathematical knowledge for teaching (Ball et al., 2008), thus a substantial amount of time each session involved working on the mathematics that was the focus of the video segments. In contrast, the video club did not have a specific mathematical focus, so the design did not include time carved out to work on particular mathematics problems. However, the teachers often worked through the mathematics represented in the clips, typically within the context of the discussions of the video clips as they sought to interpret student thinking.

Data Collection

Data for this study include videotapes of the 10 video club meetings and the 8 foundation module meetings for LTLF. All of the meetings for both programs were videotaped. For the Mapleton Club, we transcribed all 10 meetings. For the Atwood program, we transcribed the portion of the meetings in which teachers discussed the video clips they viewed together.

Data Analysis

To begin, we narrowed the analysis to what we defined as *high-quality conversations* because we wanted to examine patterns in facilitation when teachers engaged in substantive discussions of video. We define high-quality conversations as those in which the group engaged in sustained discussions of the details of students' mathematical thinking, they sought to make sense of the details of their thinking, and they engaged in joint sense-making of student ideas (see Sherin, Linsenmeier, & van Es, 2009). This definition is consistent with other research that describes productive discussions as *generative dialogue, dialogic discourse*, or *progressing knowledge building discourse* (see Zhang et al., 2011). For all meetings, we reviewed the discussions that followed each video clip the groups viewed and coded them using three criteria: students ideas were the object of inquiry and the group sustained a focus on making sense of student thinking; the discussion of student thinking focused on substantive mathematical ideas, such as their underlying reasoning and understanding of mathematical concepts as well as their strategic use of mathematical procedures; and teachers consistently responded to and built on one another's ideas to jointly make sense of what they observed in the video. We used Sherin and colleagues' (2009) three-level coding framework for characterizing substantive discussions of student mathematical thinking and the second author coded all of the conversations related to each video clip for each meeting in both professional development settings. Across the 10 Mapleton meetings, the group viewed and discussed 26 clips from participants' classrooms. Fifteen of these discussions were coded as high quality. Across the eight Atwood meetings, the group viewed 16 video clips, 10 of which were identified as high quality.

To begin to examine the nature of facilitation in each setting, we randomly selected two high-quality discussions from each context, one from an early meeting and one from the middle of the series of meetings, and reviewed the facilitation practices in these discussions. Prior research showed that over the course of the video club, the teachers came to take on more central participation by the end of the series of meetings (van Es, 2009). Thus, we chose discussions from early and in the middle of the series of meetings because we thought that the facilitators would be more actively participating at these points in time. To begin to examine routine practices for engaging teachers in substantive talk about video, we drew on interaction analysis methods and fine-grained analysis of video data (Jordan & Henderson, 1995; Schoenfeld, Smith, & Arcavi, 1993). Interaction analysis foregrounds how individuals coordinate activity and their joint interaction with each other and material objects in the environment (Greeno, 2006). The initial analysis involved close review of the video data to begin to characterize how particular facilitation moves afforded opportunities for joint sense-making of video. The first and second authors viewed the video data for two of the randomly selected discussions together and noted when the facilitator participated in the discussions and identified noteworthy aspects of the facilitation practices. Our analysis was guided by prior research on facilitation of inquiry into artifacts of practice, teacher participation in professional development, and practices for leading substantive discussions in mathematics classrooms (Coles, 2012; Elliott et al., 2009; Harrison, Lawson, & Wortley, 2005; Jenlink & Kinnucan-Welsch, 2001; Stein et al., 2008; van Es, 2009; Zhang et al., 2011). As part of the interaction analysis method, the researchers jointly identified a preliminary set of moves that facilitators enacted to engage teachers in substantive discussions of video through an iterative cycle of viewing and discussing the two videos. At this point, we focused our analysis on particular strategies or moves to get a sense of how facilitation occurred within the discussions. In addition to documenting and defining an initial set of moves, we wrote analytic memos that captured interesting issues related to facilitation, including when facilitators appeared to adopt a move and how moves appeared to work together (Miles, Huberman, & Saldaña, 2013). These memos helped the researchers gain clarity on the definition and function of each move and also agreement on how to characterize facilitation in these contexts. Thus, this first phase of analysis was concerned with identifying particular moves or strategies that facilitators enacted and examining how they might work together to support the group engaging in productive discussions of video.

The first two authors then viewed the other two randomly selected discussions individually and analyzed the conversations in terms of this preliminary set of moves. Similar to the first phase, each researcher created analytic memos to capture the qualitative nature of facilitation, highlighting what moves emerged in the discussions, how these moves seemed to prompt teachers to further explore student thinking and the mathematical ideas captured in the videos, and how the facilitator's moves supported the group working together to make sense of the videos. The two researchers met again to refine the emerging analysis further (Corbin & Strauss, 2008), reviewing the videos and memos together to reach agreement on the types of moves facilitators enacted, to further refine our definitions and to construct a list of moves that we thought captured facilitation in the high-quality discussions for both settings. At this point, we did a member check (Lincoln & Guba, 1985) with the fourth author, the facilitator of the LTLF program and the third author, who had extensive experience with the LTLF project goals, to ensure that our characterization of facilitation moves captured those who were enacted in this context. The first author also confirmed the types of moves she made and the purpose of those moves to further refine the definitions. Through this process of jointly and independently viewing the data, discussing the memos by individual meeting, across meetings, and across the two programs, we developed a set of moves and associated definitions that capture facilitation in these conversations. This method ensured that the research team had a shared framework for characterizing facilitation in the meetings.

Guided by this framework, we then returned to the videos of all of the high-quality conversations across both contexts and constructed analytic memos to capture the nature of facilitation for each clip (Miles et al., 2013). These memos helped us develop a richer and more nuanced understanding of facilitation, as they provided the occasion for identification of moves that we observed facilitators adopt consistently throughout the discussion and moves that may not have been used frequently but that appeared to have an important function for keeping the group focused on the task. In these memos, we also explored the relationships among moves that helped the groups engage in sustained discussions of student mathematical thinking represented in the videos.

In the final phase of our analysis, we identified a set of routine practices that facilitators employed across the two settings. Drawing on Grossman and colleagues' work (Grossman et al., 2009; Hatch & Grossman, 2009), we sought to understand how these particular moves worked together to define a particular practice—one that takes place consistently across discussions, is a practice that promotes both teacher and facilitator learning, and becomes a routine way of working with video. As we reviewed the analytic memos, we noticed that the particular moves the facilitators adopted may not have been the same, yet they appeared to develop similar routines to engage the teachers in high-quality discussions of video. Using discourse analytic methods (Goffman, 1981; Goodwin, 1981), we reviewed the analytic memos together to understand whether particular moves worked together to accomplish particular goals of video-based professional development. That is, both programs shared similar goals—focusing on

student thinking, grounding discussions in worthwhile mathematics, helping teachers adopt an interpretive stance to their analyses, using evidence to make claims about student thinking and the influence of teaching on student learning, and working together to collaboratively analyze practice. We returned to our initial framework and examined how particular sets of moves constituted practices for achieving these goals. We grouped the practices in several categories related to launching the work of video analysis, sustaining discussions, maintaining a focus on the artifacts, and supporting group collaboration. We then returned to the data and reviewed the high-quality discussions one more time, along with the accompanying analytic memos, with these four broad categories of practice in mind to understand how they worked together within and across each context. We present our findings below.

Results

A Framework for Facilitating Video-Based Professional Development

The central contribution of this analysis is a framework for facilitation of video. The framework is useful because it articulates four practices for engaging teachers in substantive discussion of video in a group setting while also defining particular moves that are associated with each practice. The four categories that reflect central practices for using video in productive ways include: *Orienting the Group to the Video Analysis Task, Sustaining an Inquiry Stance, Maintaining a Focus on the Video and the Mathematics*, and *Supporting Group Collaboration* (see Table 1). Within each practice, we identified a variety of associated moves, consistent with other research (Borko et al., in press; Coles, 2012; Zhang et al., 2011), that reveal the complex nature of facilitating teacher learning with video. Below, we provide a brief description of each practice and then describe the moves associated with each. We then provide vignettes from each context to illustrate how the practices arise in each context and how they coordinate to accomplish the goals of the professional development programs.

Orienting the group to the video analysis task. The first practice concerns providing teachers entry into the videos. Simply showing teachers a video does not necessarily provide them a way into viewing it (Brophy, 2004). Thus, the facilitators oriented teachers to the work of viewing video by bounding the task before viewing the clip and by launching the discussions after viewing the video to provide the group with a lens for discussing the clip. Two moves are associated with this practice: *contextualizing* and *launching. Contextualizing* involves providing the group with information about the lesson, the unit, or classroom context to aid the group in making sense of the clip. *Launching* involves posing general prompts to elicit participant ideas. Questions such as "So, what did you notice?" or "What interesting mathematical moments stood out to you?" were typical prompts that signaled to the group that they were to begin the discussion of the events that stood out to them in the video. We view this practice category as essential because it is through *contextualizing* and *launching* that the facilitator frames the viewing of video, providing a way for participants to develop shared expectations of the task and develop routine ways of discussing mathematics instructional interactions captured in video. At the same time, by launching the discussions in more general ways, teachers have opportunities to share their noticings—the events and interactions that stood out to them—providing the facilitator with insight into their thinking about the episodes they viewed.

Sustaining an inquiry stance. The second practice concerns maintaining substantive and productive discussions of video. Six particular moves are associated with this practice: *highlighting* and *lifting up, pressing* and *clarifying*, and *offering an explanation* and *countering*. Notice that the moves appear in pairs. Through our analysis, we identified particular moves that achieve similar purposes but were enacted differently based on the interactions that unfolded in the discussions. For example, *highlighting* involves facilitators drawing attention to particular events or interactions *in the video* that teachers did not raise on their own. Similarly, *lifting up* refers to the facilitator taking up noteworthy participant ideas and making them the object of discussion. For instance, when viewing a video, one teacher may notice that a student used a novel counting strategy and another may comment on the set up of the classroom. By lifting up the teacher's remark about the novel counting strategy, the facilitator signals that this idea is worthy of further discussion. The idea behind both *highlighting* and *lifting up* then is that the facilitator is making intentional choices to direct the participants' attention to the interesting and important mathematical ideas and interchanges to pursue.

Two additional moves, *pressing* and *clarifying*, serve to invite participants to elaborate their ideas. *Pressing* explicitly prompts teachers to expand on an idea or further explain their reasoning. Like a mathematics teacher asking a student to further elaborate, a pressing move came in the form of questions such as "Can you tell me more about that?" or "I'm not sure I understand your idea. Can you explain what you mean?" When *clarifying*, the facilitators revoiced or rephrased a participant idea to ensure common understanding among the group and thereby encouraging participants to further articulate their thinking for the group. A typical clarifying move is to toss back to participants the idea that they raised in the form of a question: "So, what you're saying is that counting on the cards may not have helped him keep track of the groups?" Together, these moves both prompt teachers to further elaborate or explain their thinking and make it public to the group for further exploration.

Table 1. Framework for Facilitation of Video-Based Discussion.

	Facilitation move	Definition	Example
Orienting group to the video analysis task	Launching	Pose general prompts to elicit participant ideas	"So, what did you notice? What stood out to you?" "What were interesting mathematical moments or interchanges in the video?"
	Contextualizing	Provide additional information about the classroom context and mathematics lesson	"This was lesson on 2-digit multiplication and you were working the partial products method."
Sustaining an inquiry stance	Highlighting	Direct attention to noteworthy student ideas in the videos	"So it seems like we're all pretty interested in what Tyrone did here. What did he mean by one-fourth equals 25 and one-half is 50?"
	Lifting up	Identify an important idea that a participant raised in the discussion for further discussion	"I think you were bringing up the idea that maybe they understood what met goal exactly meant, but they had this way of thinking that it wasn't each student that got to 50 but rather collectively."
	Pressing	Prompt participants to explain their reasoning and/or elaborate on their ideas	"You said there was a lot she had to do there, can you piece apart for me all the things you think she had to do?"
	Offering an explanation	Provide an interpretation of an event, interaction, or mathematical idea, from a stance of inquiry	"I was thinking that he might have looked at his partner's cards and added the numbers on their two together. That might be why he said 51."
	Countering	Offer an alternative point of view	"You could be right but I was thinking that the sticks and dots weren't really helping Dante. He doesn't arrive at the correct answer . . ."
	Clarifying	Restate and revoice to ensure common understanding of an idea	"So you're saying no, she doesn't really think it's ten?"
Maintaining a focus on the video and the mathematics	Redirecting	Shift the discussion to maintain focus on the task of video analysis	"Can I just bring us back to the video for a second?"
	Pointing to evidence	Contribute substantively to the conversation, using evidence to reason about teaching and learning with video	"Well, what did Jerome say earlier? . . . because I'm wondering if maybe she's using what he said earlier to help her try to figure this out. So, if we look on the page before . . ."
	Connecting ideas	Make connections between ideas raised in the discussion	"So it's similar to what Tom was doing." "Do you have any predictions about what your students would do if they were given this problem?"
Supporting group collaboration	Standing back	Allow the group members time to discuss an issue	Not interjecting when the group is exploring an idea
	Distributing participation	Invite participants to share different ideas based on who is (and is not) participating	"Lisa, it looked like you wanted to say something . . ." "What do others think about that idea?"
	Validating participant ideas	Confirm and support participant contributions	"That's really hard." "That could make sense too. That could be another interpretation."

Finally, within this practice, we identified two moves that brought the facilitator into the work of analyzing video with the group, *offering an explanation* and *countering*. Like the other pairs of moves, they both functioned in similar ways—to introduce a way of interpreting or making sense of what was happening in the video. The idea is that they modeled to the group how to engage in collaborative critical conversations about teaching and learning. By *offering an explanation*, facilitators showed teachers how to engage in the interpretive work related to video analysis. Similarly, *countering* an idea demonstrated to the group that it was not only acceptable, but expected that they challenge one another's ideas, so that they can explore a range of explanations or interpretations of what they observed in the videos.

Maintaining a focus on the video and the mathematics. To take advantage of the affordances of video for teacher learning, a central practice involved helping the group keep their discussion grounded in the artifact under study. Three strategies related to this practice include the following: *redirecting, pointing to evidence*, and *connecting ideas. Redirecting* occurred when the participants moved the discussion outside

of the artifacts, to issues that were peripheral to those represented in the video. *Pointing to evidence* refers to moments when the facilitator directed the group to particular sources of evidence, either in the video, the transcript, or their own mathematical work, as a way to reason about mathematics teaching and learning captured in the video. And finally, *connecting* involved drawing connections between different ideas participants raised for discussion and issues related to the mathematics they identified in the clips and ones they discussed at other points in the meeting.

Supporting group collaboration. Finally, the work of facilitation involves enacting various moves to support the group in working together to inquire into the work of teaching. This practice of supporting group collaboration consisted of three different moves: *standing back, distributing participation*, and *validating participant ideas.* Facilitators were *standing back* when they allowed the participants time to pursue ideas together and did not interject an idea. *Distributing participation* involved attending to which members participated in the discussion and inviting different participants to share ideas as a way to include all members in the conversation. Finally, *validating participant ideas* included offering support when a participant made a contribution to the conversation, such as, "Ah, that's interesting. I hadn't thought of that" or "That could be." When participants appeared to take risks and offer an interpretation of what they saw happening, statements such as these expressed support for their participation and encouraged further contributions.

Important to this study is characterizing the four practices that emerged as well as the different moves that are associated with each. While these moves have been documented in the literature (Borko et al., in press; Coles, 2012; Zhang et al., 2011), understanding how they function within a category speaks to how the practices are taken up, enacted, and become routine ways of facilitating video-based professional development. At the same time, our analysis suggests that it is the coordination at the level of the practices that results in productive use and analysis of video in these two contexts. We now turn to illustrate how these practices were taken up in each setting.

Coordinating Practices for Productive Discussions

Essential to our framework is the relations between the four practices. Across the highly productive discussions, the facilitators in both contexts not only enacted all four practices we identified, but did so in a coherent and integrated way to promote productive conversation. The following vignettes from each setting illustrate how facilitators coordinated these practices to support these groups of teachers in learning to notice and analyze student thinking and important mathematical ideas as represented in the videos of classroom interactions. We also use these vignettes to illustrate similarities in the ways the two facilitators used these practices, as well as differences in the moves facilitators enacted, to accomplish the goals of the different professional development programs.

The case of the Mapleton Video Club. The first example comes from the fifth meeting in the Mapleton Video Club. In this meeting, the group viewed a clip from Wanda's classroom on positive and negative numbers on a number line. The problem involved children selling raffle tickets, with each child's goal being to sell US$50 worth of tickets. The handout included a table representing the extent to which five children met this goal, with one meeting the goal exactly, two falling short of the goal, and two exceeding the goal. The students were asked to complete the table by solving the amount that the children were above or below the goal and then to plot the number above or below the goal on a number line with end points of negative and positive 10. For example, in the scenario, Student B met the goal exactly so students would record Student B at 0 on the number line. Student C exceeded the goal by US$1.75, so the students would indicate this amount between positive 1 and 2 on the number line.

The video clip showed four students seated in a group, completing the table and plotting the numbers on the number line. As they worked on the problems, some of the group members had questions about what "met goal exactly" and "exceeded goal" meant. One student, Kandace, continued questioning another group member, Shawna, about where she placed her answer for Student B on the number line. At one point, Wanda approached the group and talked with another student about the difference between meeting the goal exactly and either falling short of or exceeding the goal. The students had little conversation about their reasoning for their answers.

Before viewing the clip, the facilitator oriented the group to the video by providing context for the lesson captured in the video.

> So this is what's happening in the clip. Students are working on this activity (refers to the first problem on the handout) on positive and negative numbers on the number line. They've solved number one by themselves, and then Wanda has students put their solutions on the board.

Wanda, a participant in the video club, added that they had been working in groups and that one member from each group went to the board. The facilitator continued,

> We're going to see that on the board. And we are going to see a class discussion of this information (points to handout) and then we're going to watch a couple of clips of a small group of students who are then going to work on number two by themselves.

While viewing the clip, the facilitator inserted a couple of comments to point out that the group they were watching is the same group they had been watching earlier in the video segment. This way of orienting to the video is important for two reasons. First, the facilitator bound the viewing of the

task by providing the handout, so the teachers knew the task the students completed, directing them to the mathematical work. In addition, she framed the task by explaining that they would be watching a particular group at different points in time—when a member puts the group's work on the board and when they proceed to work on the second problem.

Upon viewing and discussing the clip, the facilitator enacted various moves to orient the group to the task, sustain a productive discussion, maintain a focus on the video and the mathematics, and support group collaboration. To begin, before the clip ended, the facilitator noticed two group members talking to each other and pointing to the transcript. She paused the video and asked them share what they noticed. The following discussion then ensued:

Frances: We're just trying to figure out . . . . She talking about five dollars. She's saying B is five dollars.
Wanda: She says 10.
Daniel: She says B is 5 times 10 that was the first thing. She said it was 10. But then she says 5 times 10, 50 . . .
Facilitator: Tell me where you are?
Daniel: Well B, where it says "met goal exactly," I think that they were saying that was 10.
Facilitator: Right before 11:10 . . .
Daniel: I'm sorry I wasn't on the transcript. We were on the handout. (The group paused to find the place in the transcript where the student is saying B is 10.)
Facilitator: So, we've got this girl in white shirt who thinks it's $10?
Frances: Yeah, we're just trying to figure out how she's coming up with $10.
Facilitator: Did you figure it out?
Daniel: There's somewhere where she says 5 times 10. She said 5 times 10 somewhere . . .
Wanda: What page is it on?
Facilitator: On the second to the last page.
Daniel: I think it's $10 . . . . Oh there we go! Because it says 5 students. They read from the directions. They just picked out a couple key words. Five students . . . so 10 times 5 is 50. So they're trying to get from 5 students to $50 I think. So they're saying 5 students must have made times 10 . . . because 5 times 10 is $50.
Yvette: 50 . . . . So that reaches the goal altogether.
Daniel: Right, which makes 50. But I think that they have no idea of what they are trying to figure out. They're just trying to find a way for the answer to fit some kind of guess.
Yvette: Or they missed the word "each." The goal for each student was $50. So by missing that word they're not understanding . . .
Wanda: I think that the other ones were on target. Like where Shawna told Kandace, you just do whatever you want.
Elena: Right.
Facilitator: Oh, I see . . . . It's on top of the fourth page, "Yeah, but never mind, you just put what you want and I'll put what I want."

We pause here to consider how the practices emerge at the beginning of the discussion. First, the facilitator launched the task by inviting group members to share what they observed providing an opening for the discussion to begin with the participants' observations. This move also served to validate their ideas and distribute participation among the group. In addition, the facilitator pointed to particular points in the transcript to ensure that the group was collectively analyzing the same instance. Thus, the facilitator's practices oriented the teachers to the task of analyzing video by providing them an opportunity to share their noticings while also ensuring that they grounded their conversations in the particulars they viewed in the clip. We return to the discussion after this initial exploration of student thinking.

Daniel: I don't think they knew . . . . Well, we want to keep going.
Facilitator: No, we want to keep going with this.
Daniel: They weren't really in the situation, you know? I'm not so sure that they knew what they were looking for.
Elena: I'm wondering if they understood what "met goal" meant? Did anybody ask you? Did anybody ask you what "exceeded" meant or what "met goal" meant?
Wanda: They were discussing it actually . . .
Facilitator: Shawna is asking, "What does exceed goal by 50 mean?"
Wanda: The common mistake is they want to make the met goal exactly. So they make $50; exceeded goal is 50, 175. This is just supposed to be the amount above or below.
Elena: Nobody answered that question for her though . . . you know what I mean? It was asked and that was it. Derek never really gave her an answer.
Facilitator: Well he says, "I don't know . . . . I think it's up."
Elena: I don't see that . . .
Facilitator: A page before that. See where it says clip two . . . "I don't know, I think it's up." But I guess he doesn't respond.
Elena: Okay, so that was unclear then the meaning of exceeded . . . and then, you know, I also wonder if they understand what meeting the goal meant. And going back into the paragraph . . . I get the impression that . . .
Wanda: Should we go ahead and finish it though? Was there much more to watch?
Facilitator: No, let's talk about this first, and then we will watch the end.
Wanda: Well, I think we need to see where they end up before.
Facilitator: Okay . . . . Actually, I don't want to watch this yet . . . just one more second. So Elena, I just want to

ask, so you are suggesting that they didn't really understand what met goal meant.

Elena: Yeah.

Facilitator: Daniel and Frances, I think you were bringing up the idea that maybe they understood what met goal exactly meant, but they had this way of thinking that it wasn't each student that got to 50 but rather collectively.

Frances: Right.

Facilitator: So how could . . . is there a way that we can sort out between these two ideas? You know. Is there evidence for one or the other? Could they both be right? Not that it really matters . . .

As the discussion continued, the facilitator enacted a variety of moves within the four broad practices to ensure that they had a focused discussion on the students' mathematical thinking grounded in the videos. Here, the facilitator pointed to evidence in the transcripts to further probe claims that teachers made as well as to counter and press on some of their ideas. For instance, Elena asked whether anyone wondered what "met goal" or "exceeded goal" meant and the facilitator pointed out Shawna's question in the transcript to indicate that the students did ask this question. Just after that, Elena claimed that no one responded to Shawna, and the facilitator pointed out that Derek responded. In these instances, highlighting particular quotes in the transcript functioned to press Elena and the group to tease apart this interaction. However, to validate Elena's contribution, the facilitator also noted that he did not actually answer Shawna's question. The facilitator also navigated what portion of the clip they would watch and the ideas that were emerging. At the beginning of this segment, when Daniel wanted to propose an idea to explain why the student was thinking 10 but he stopped and said they wanted to continue viewing the video, the facilitator indicated that they did not need to proceed and that they would further explore his idea. This response sustained the conversation by pressing participants to explain their ideas further, and it also acknowledged that Daniel had an important idea to contribute. Later, Wanda thought that they should watch the rest of the clip before continuing the discussion, but the facilitator decided not to follow this suggestion and continued with the discussion. Her subsequent moves contributed to the discussion remaining at a high level, maintaining a focus on the clip, and sustaining group collaboration. In particular, she lifted up the two different ideas that group members proposed—Elena's idea that the group did not understand what "met goal exactly" meant and Daniel and Frances' idea that the students were thinking about the problem as a collective but not each child reaching the goal. Here, the facilitator distributed participation among the group and validated these different ideas, and she lifted them up and clarified them for the group to further explore. She also pressed the group to delve more deeply into these ideas by asking them whether there was a way to sort out the two ideas and also maintained the focus on the video by asking whether there was any evidence for one interpretation or another.

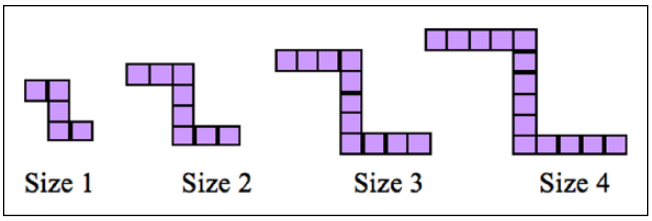

Figure 1. Assume the pattern continues to grow in the same manner. Find a rule or formula to determine the number of tiles in any size figure (Seago, et al, 2004).

This discussion, characteristic of the productive discussions in the Mapleton Video Club, illustrates the enactment of the four practices. The facilitator orients the group to the video and the task before viewing the clip to frame the task of making sense of student thinking. She sustained the discussion by highlighting particular events, lifting up participant ideas for further discussion, and countering participant ideas. While working to sustain the discussion, she also maintained a focus on the video by pointing out particular events in the clip and noting particular pages and quotes in the transcript. Finally, she supported group collaboration by validating different ideas and distributing participation by lifting up different group members' ideas. What is particularly noteworthy about this interaction is that the facilitator's comments were tightly focused on the particular interactions that unfolded in the video, the details of students' thinking, and the specific mathematical work the teachers and students explored. In addition, she attended to the participants' interpretations and sense-making and used those as the objects of discussion while also interjecting her own ideas for the group to consider.

The case of Atwood: Learning to Teach Linear Functions. Analysis of facilitation in the LTLF context revealed that the facilitator adopted similar practices; however, the particular moves that are used to enact those practices vary. Our example comes from the sixth meeting in the LTLF program. In this meeting, the group viewed a clip related to closed and recursive expressions. The goal of the session was to relate the geometry of the task to the symbolic expression and table. This session builds on the previous, with a focus on indexing and shifting the starting point, relating this to graphical representations, to deepen understanding of the slope and intercept. In the clip, the students were posed the problem shown in Figure 1.

The discussion we examine followed the first clip the teachers viewed in the meeting. This clip was chosen because it showed a student, Reymond, providing a verbal explanation of his method, which provided the group the opportunity to discuss strategies for having students communicate their

thinking verbally and visually. Before viewing the clip, the facilitator contextualized the viewing by giving the teachers a standard tool as part of the LTLF materials, the lesson graph, which summarized the structure and activities of the lesson, so teachers could situate this segment in the broader context of the lesson. She explained that the clip came from a school in New York and that at the time of the taping, the math classes took an integrated approach to the mathematics rather than being organized according to traditional math topics (Algebra, Geometry, Trigonometry, and Calculus). She also provided a more detailed description of the class, identifying it as a ninth-grade integrated class with 35 students, many of whom are English-language learners, and noting that the clip was captured in the springtime of the school year. She then explained that this is the first of two clips they would view from Giselle's class. The facilitator directed them to the lesson graph and pointed out the mathematical problem the students completed and the amount of much time they worked in groups, and then she highlighted the whole class discussion where they would "drop in" on the lesson—where Giselle asked the class, "How did we get those equations?" and Reymond shared his method.

The group viewed the clip and after Reymond shared his approach, the facilitator paused the clip and before launching the task, the participants made several comments about how the students interacted in the clip, noting that a student was at the front of the room leading the discussion and that the classroom teacher, Giselle, was off to the side. The facilitator then oriented the group to analyzing the video by asking them to "think about what you think Carol did and what she understood, what Reymond did, and what Jordan . . ." Before she could complete this prompt, Marie pointed to a particular point in the transcript and the group discussed the student's error:

> Janice: At 43:47, when Jordan's talking about, "so x times x is equal to $2x$." Well, x times x is x^2 . . .
> Tom: I think that's a language problem. They know but they use the wrong language.
> Janice: Right. Because then he went on and said, "x plus 1 is equal to $1x$."
> Trevor: That set my hair on end.
> Facilitator: That set your hair on end? I could see that. And so potentially, I think what Tom is saying is it could be a language issue.
> Annie: Not necessarily. My kids think that . . .
> Facilitator: And they don't have a language issue. So it could be . . .
> Annie: I think it's his conception . . .
> Janice: Either that or it was just choosing the wrong words.
> Tom: Because the minute she said, so you mean x times, and then he knew right away, oh yeah, I mean, $3x$.
> Walter: If you look at 00:42:49, Jordan again, he says, "In order to make it smaller, so $3x$ is actually x times x times x plus 2," and that's not correct either. I think it's a language thing, I think he's not able to put some of these sentences together.
> Anne: Well, she said it was an ESL class.

At the start of the discussion, the facilitator enacted several moves to orient the group to the video analysis task, to sustain the discussion, and to support group collaboration. She launched the discussion with a particular prompt to focus the group's attention on Carol's, Reymond's, and Jordan's methods. She also validated Trevor's comment—that the student's error set his hair on end—followed by lifting up Tom's idea for the group to discuss. When Annie countered the idea, the facilitator offered an explanation to build on Annie's comment and the group further explored the explanation that the student error was a result of a language issue.

As the conversation continued, the facilitator re-launched the discussion with a general prompt, "What other stuff did you notice?" Marie responded, "I had a hard time following Reymond's explanation." To sustain the discussion, the facilitator pressed her to explain, and Marie pointed to a particular point in time, 41:22 in the transcript, and then read Reymond's explanation: "I got that because I was looking at the center part of these, and I saw the first one was 1, and the second one was 2, and the third one, it was 3." Marie then followed by saying, "I don't know what he's talking about." The facilitator further sustained the conversation by clarifying Marie's statement and pressing further, "So you're saying you didn't understand, are you potentially thinking that maybe the rest of the class didn't understand?" Five of the seven participating teachers then explored what Reymond may have meant by his explanation. During this extended conversation, the facilitator stood back and allowed the group time to explore his reasoning. She then reentered the conversation and asked a question to the whole group, "So is there any method that you guys did that you think he did?" This connecting move question prompted the group to then focus on the mathematical ideas at the center of the lesson. During the subsequent conversation, the facilitator consistently pointed out particular mathematical ideas and pressed the group to think about the worthwhile mathematics: "So, for example, if you had x's that went 0, 2, 4, 6, 8, 10, and you still had the same numbers on the other side, would you have the slope . . . ?" She also attended to the teachers' ideas about the mathematics and clarified their explanations as a way to encourage them to press on their mathematical thinking:

> Well, potentially, I mean you're saying if you don't know, given another situation, where the difference among the y's was a constant, let's say, a plus 3 here, and the x's weren't, you're not convinced that he wouldn't just automatically say it was 3. There's a difference of 3, therefore it's linear, this is the slope . . .

The facilitator not only pointed to the mathematically important ideas, but she also posed a scenario that pressed

the group to consider how Reymond would respond when given a different problem.

Like the Mapleton facilitators, the LTLF facilitator enacted the four practices to engage the group in substantive discussions of video. She oriented the group to the work of analyzing video by contextualizing the video clip and launching their discussions with framing questions that directed them to look at student thinking with respect to the mathematics. She also sustained the discussions by lifting up participant ideas, pressing them to further elaborate on their thinking, clarifying an idea as a means of opening it up for exploration, and highlighting important mathematics and students' work for consideration. At the same time, she maintained a focus on the video and the mathematics by posing scenarios that prompted them to contemplate how the students would fare if given an alternative problem and by connecting to their own mathematical work that they completed in earlier in the session to Reymond's mathematical thinking. Finally, by standing back and validating ideas, the facilitator supported the group in working together to reason about the interactions they observed in the video. Even early on, the teachers had questions about the roles students adopted in Giselle's class and the facilitator allowed the group to explore this unfamiliar approach to leading mathematics discussions in the classroom.

Importantly, it is not the case that particular moves were consistently taken up across each productive discussion. However, the categories of practices emerged consistently throughout these discussions, suggesting that these practices capture the routine ways that the facilitators engaged teachers in worthwhile, substantive discussions of mathematical thinking represented in video. We now turn to discuss these results.

Discussion and Conclusion

We sought to understand how facilitators engaged teachers in productive analysis of video. We found in prior studies that in both programs we investigated, the teachers learned to focus on the mathematically important details of student thinking (Goldsmith & Seago, 2008; van Es, 2011; van Es & Sherin, 2008), yet we knew very little about how the facilitators helped promote this learning. It can be difficult for teachers to see among the "buzzing, blooming confusion" of classroom interactions (Brown, 1992, p. 141) what is noteworthy with respect to student thinking and learning (Erickson, 2011). Teachers need guidance from facilitators who are deeply familiar with the content of the clips, and the important features captured therein, to help them learn to identify and make sense of what is captured in video. Moreover, they need support to learn how to use video as a tool for their learning—to not only see what is worthwhile but also how to dissect the details of the interactions represented in this video and use them as evidence to draw informed interpretations of teaching and learning.

We view this study as contributing to the limited, but growing, body of research that examines how facilitators orchestrate productive discussions with video, so that the affordances of this tool can be realized in professional development. Consistent with prior research (Borko et al., in press; Coles, 2012; Elliott et al., 2009; Zhang et al., 2011), we identified a variety of strategies, or moves, facilitators enacted to promote productive discussions of video. However, we extend prior research by offering a framework of four core practices—what we might call high-leverage practices for facilitation—that consist of a variety of moves for facilitating video-based discussions. These findings contribute to a body of research that seeks to decompose and represent the work of teaching (Grossman et al., 2009). Rather than focusing on teaching, however, our study decomposes the work of facilitation and the framework can be used to guide future efforts to prepare leaders for engaging in this work. We also suggest that it is not the particular moves that result in productive discussions; rather, it is the coordination of the four practices that guide productive use of video for teacher learning. An important contribution of this study is that it draws attention to the multiple layers that are involved in navigating meaningful discussions with video. Understanding facilitation practices at the level of these broad categories provides guiding principles for the design of professional development that can be tested more widely and can be used to develop a knowledge base for teacher education (Hiebert et al., 2002; Hill, Beisiegel, & Jacob, 2013).

The situative perspective offered a useful lens for analyzing the work of facilitation. This perspective draws attention to the interactions between participants as they engage in the activities valued by a community, and in this case, how facilitators support teachers in using video in meaningful ways for teacher learning. Facilitators cannot necessarily expect teachers participating in video-based professional development to have become socialized into a community that uses video to analyze classroom practice. The four practices can therefore serve to provide a structure that facilitators can use to help teachers learn to take advantage of the affordances of video. More specifically, *orienting the group to the video analysis task* provides the framing for the video analysis task, and the two practices *sustaining an inquiry stance* and *maintaining a focus on the video and the mathematics* together model routine ways of inquiring into the events and interactions captured in video and using what is represented in this artifact to make evidence-based claims about teaching and learning. Finally, *supporting group collaboration* ensures that all participants have opportunities to engage in the activity and that the different perspectives and expertise that they bring to the learning setting are represented, taken up, and valued. We also propose that these practices provided a framework for the group to develop a critical discourse for inquiring into the work of teaching with colleagues. Together, these practices shifted the conversation away from the teacher and focused on noteworthy student thinking and

mathematically important ideas. At the same time, by sustaining an inquiry stance in the discourse and maintaining a focus on the video, the group's goal was not to evaluate one another's work but rather, their analysis was in service of understanding how students experience and think about the mathematics during instruction. Such a shift enabled the group to develop the kind of collaborative discourse advocated for teacher learning rooted in the work of teaching (Lord, 1994).

The findings of this study are also important, given the goals of mathematics education. In this vision of teaching, mathematics discussions are central to the classroom activity, where teachers are called on to create classroom communities in which students grapple with complex tasks and communicate their solution strategies and mathematical reasoning in small group and whole class contexts (NCTM, 2000; Stein, Smith, Henningsen, & Silver, 2009). Mathematics education research has made important progress in identifying high-leverage practices for orchestrating productive mathematics discussions (Kazemi et al., 2009; Stein et al., 2008). This requires shifting roles for teachers and students, with students explaining and questioning one another and taking on increased responsibility for one another's learning (Hufferd-Ackles, Fuson, & Sherin, 2004) and teachers increasingly focusing on student thinking, making sense of those ideas and responding to their ideas based on the goals of the lesson (Sherin et al., 2011). Yet, teachers have few opportunities to develop these skills in practice. While practice-based approaches to teacher education can prepare teachers to engage in this work (Smith, 2001), video-based professional development allows teachers to slow down and study the details of student thinking as it arises during instruction. Like the practices for orchestrating mathematics discussions, the four facilitation practices we have identified provide a framework for guiding teachers to engage in this work in purposeful and meaningful ways.

We conclude by addressing some of the limitations of our study. First, we recognize that this analysis reveals facilitation practices in what we defined as high-quality conversations. We chose to focus on high-quality conversations because we wanted to understand routine facilitation practices that were at play when the group was successfully engaged in the work of each program. However, because we did not analyze those conversations we considered to be less productive, we cannot be sure that these same practices were not enacted in those contexts as well. Understanding the nature of facilitation in different types of conversations is an important area for future inquiry. Such an analysis would also provide greater insight into how the system of activity—the video clips, facilitation, and mathematical work —coordinates to achieve the goals of the professional development. Second, by examining facilitation in two different professional development contexts we were able to develop a more generalizable framework. However, our analysis did not provide insight into how facilitation practices develop over time. Prior research shows that the video club participants came to take on new roles and participate more centrally in the video club activities over time (van Es, 2009). This raises questions then about the evolution of facilitation over the course of the professional development as the routine practices are established with the groups, and whether participating teachers themselves begin to take on some of the facilitation practices as they become more central participants in the analytic work. Finally, we intentionally focused our analysis on facilitators with extensive experience leading professional development and working with video, both as a research tool and as a tool for teacher learning. By focusing on facilitators with such expertise, we were able to identify effective practices for skillfully orchestrating and navigating conversations about teaching and learning represented in video. An important area of future inquiry concerns how to prepare other leaders to engage in a similar work. Just like other tools for teaching and teacher learning, video is effective only when used skillfully and when facilitators are able to take advantage of its affordances to support learning. Given that video is increasingly becoming a popular tool for teacher professional development, it is incumbent on the research community to continue to develop our understanding of how to take advantage of video artifacts of practice to support mathematics teachers' efforts to improve their instructional practice.

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