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Effects of Video Club Participation on Teachers' Professional Vision

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This study investigates mathematics teacher learning in a video-based professional development environment called *video clubs*. In particular, the authors explore whether teachers develop professional vision, the ability to notice and interpret significant features of classroom interactions, as they participate in a video club. Analysis for the study is based on data from two year-long video clubs in which teachers met monthly to watch and discuss video excerpts from each others' classrooms. Participating in a video club was found to influence the teachers' professional vision as exhibited in the video club meetings, in interviews outside of the video club meetings, and in the teachers' instructional practices. These results suggest that professional vision is a productive lens for investigating teacher learning via video. In addition, this article illustrates that video clubs have the potential to support teacher learning in ways that extend beyond the boundaries of the video club meetings themselves.

Keywords: *teacher learning; video technology; mathematics education*

Over the past decade, dozens of video-based programs for teachers have been created, and more are currently in development. Although a range of design principles guide these varied programs, one key assumption is shared. Watching and reflecting on video is thought to be a valuable activity for teachers, one that has the potential to foster teacher learning.

This focus on video as a tool for teacher learning has prompted a number of recent studies on what and how teachers learn as they interact with video in professional development (e.g., Goldsmith & Seago, 2008; Nemirovsky & Galvis, 2004). Yet few studies examine the effects of viewing video on teachers' practices outside of the professional development environment. Although important exceptions do exist (e.g., Borko, Jacobs, Eiteljorg, & Pittman, 2008; Cohen, 2004), we believe that far too little is known about how video supports teacher learning, particularly given its extensive use in teacher education and professional development. The goal of this article is to make progress on this issue by studying mathematics teacher learning in a particular video-based professional development environment that we call *video clubs*. Furthermore, we bring a specific lens to our study of teacher learning in this context. We examine how teachers develop professional vision, the ability to notice and interpret significant features of classroom interactions, as they participate in a video club.

In brief, we found that participating in a year-long video club influenced the teachers' professional vision as it was exhibited in the video club meetings, in interviews outside of the video club meetings, and in the teachers' instructional practices. These results suggest that professional vision is a productive lens for investigating teacher learning via video. In addition, this work illustrates that video clubs have the potential to support teacher learning in ways that extend beyond the boundaries of the video club meetings themselves.

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Video-Based Professional Development for Mathematics Teachers

Although video-based materials for teachers have been created in a number of subject areas, mathematics education in particular has witnessed a wealth of development in this area. Mathematics teachers today can choose from a variety of video cases and multimedia tools as contexts for examining teaching and learning (e.g., Beardsley, Cogan-Drew, & Olivero, 2007; Boaler & Humphries, 2005; Seago, Mumme, & Branca, 2004). The continued popularity of video reflects, in part, the recent emphasis on practice-based professional development for mathematics teachers (Ball & Cohen, 1999). The claim is that teachers benefit from opportunities to reflect on teaching with authentic representations of practice. Video seems to offer precisely this, a window into the classroom that conveys "the complexity and subtlety of classroom teaching as it occurs in real time" (Brophy, 2004, p. 287).

In our work, we examine the potential of video to support teacher learning in the context of video clubs. In a video club, a group of teachers meets to watch and discuss excerpts of videos from each other's classrooms. Two key issues concerning teacher learning in this setting are the focus of the current study. First, we consider what teacher learning is exhibited in the video club meeting themselves. Specifically, we explore how the conversations that occur change over time. Second, we examine the influence of the video club experience on teachers' thinking outside of the video club. Thus, although teachers may exhibit certain changes in the video club context as they interact with peers, we also want to investigate whether similar changes are demonstrated in other contexts. To do so, we examine teachers' comments in interviews before and after the series of video club meetings. In addition, we investigate how teachers' experiences in the video club influence their subsequent teaching practices.

Using Video to Support Teacher Learning

A critical question for those who study the role of video in mathematics teacher learning concerns what it is that teachers are expected to learn from such interactions. In fact, reviews of video-based programs for mathematics teachers reveal that programs have been developed with a number of different learning goals in mind (Santagata, Gallimore, & Stigler, 2005; Sherin, 2004). For instance, some programs have as their purpose to help teachers learn new pedagogical techniques such as the use of manipulatives or problem-solving activities (Bitter & Hatfield, 1994). Along the same lines, Oonk, Goffree, and Verloop (2004) describe the development of the Multimedia Interactive Learning Environment as a way to illustrate national standards in mathematics instruction. The goal in doing so is to help teachers increase their repertoire of pedagogical strategies. Programs such as these generally use video to model exemplary practices that the viewer will subsequently emulate. Thus, the learning consists of being able to reproduce a specific set of practices in one's own classroom.

Other programs have been designed with the goal of developing teachers' mathematical knowledge for teaching (Ball & Bass, 2003), an understanding of mathematics that is "useful for, and usable in, the work that teachers do as they teach mathematics to their students" (Stylianides & Ball, 2008, p. 308). Such knowledge involves an in-depth understanding of mathematics on the part of the teacher, as well as knowledge of how students learn mathematics and how to select tasks, representations, and explanations to use in class (Ball, Thames, Phelps, & Hill, 2005). Programs that share this learning goal include Videocases for Mathematics Professional Development (Seago, 2004) and the Problem Solving Cycle (Koellner et al., 2007). In these cases, video serves to bring teachers into the "actual practice of teaching" in which they engage in "interpreting the mathematical logic of student thinking, analyzing the mathematical territory of a problem . . . [and] designing probes to elicit student mathematical understandings" (Seago, 2004, p. 276).

More recently, some video-based programs have undertaken the task to help teachers learn to notice important features of classroom interactions (e.g., Santagata, Zannoni, & Stigler, 2007; Star & Strickland, 2007; van Es & Sherin, 2008). These efforts are motivated in part by research that demonstrates that novice teachers tend to pay attention to surface-level features of classroom interactions while more expert teachers are able to discern interactions that are considered substantive (Berliner, 1994). The ability to attend to instruction in a discriminating manner is particularly important in the context of current U.S. mathematics education reform. Specifically, reform calls for teachers to pay close attention to a lesson as it unfolds. Moreover, there is a sense that mathematics instruction in the United States takes place to some degree in the moment as teachers recognize the direction that a lesson is moving (Smith, 1996). In light of such reforms, even veteran teachers may need to learn to notice new kinds of events in the classroom. Using video to help teachers learn to notice generally involves introducing teachers to specific frameworks for attending to instruction or directing teachers' attention to particular features of classroom interactions.

To be clear, an individual video-based program for teachers may not lie squarely in only one of the three paradigms presented. For example, although the Problem-Solving-Cycle has as a central goal to improve one's knowledge for teaching mathematics, helping teachers attend to noteworthy features of instruction is also a focus of the program's efforts (Borko et al., 2008).

The Development of Teachers' Professional Vision

Our own approach to using video with teachers focuses primarily on the third learning goal described above—using video to support learning to notice. Furthermore, we characterize the ability to notice in a particular way, in terms of what we call "teachers' professional vision" (Sherin, 2001, 2007). Thus, our goal is to examine how video clubs support the development of teachers' professional vision. Goodwin (1994) introduced the term *professional vision* as a way to describe the ability that members of a professional group share for interpreting phenomena central to their work. In Goodwin's words, professional vision involves "ways of seeing and understanding events that are answerable to the distinctive interests of a particular social group" (p. 606). For teachers, the phenomena of interest are classrooms. Thus, teachers' professional vision involves the ability to notice and interpret significant features of classroom interactions.

In previous work, Sherin (2007) describes professional vision as consisting of two main subprocesses: (a) selective attention and (b) knowledge-based reasoning. Selective attention concerns how the teacher decides where to pay attention at a given moment. Classrooms are complex environments, with many things happening at once. The teacher must choose from among this complexity where to focus his or her attention. Prior research discusses similar notions. For example, Bell and Cowie (2001) introduce the notion of "interactive formative assessment" (p. 541) in which teachers recognize learning and nonlearning on the part of students during instruction. In other work, Fraivillig, Murphy, and Fuson (1999) emphasize the importance of teachers' ability to "wait for and listen to" (p. 155) student ideas. Their point is that by carefully listening to the range of ideas that students offer, the teacher will recognize those that are particularly important, given the goals of the day's lesson.

The second process, knowledge-based reasoning, refers to the ways in which a teacher reasons about what is noticed based on his or her knowledge and understanding. For example, a teacher might reason about a particular event based on his or her knowledge of the subject matter, knowledge of the curriculum, or knowledge of students' prior comments. This process is similar to what Lampert (1985) reports as she considers key factors related to dilemmas she encounters during instruction. Likewise, Hammer (1997) provides an account of his own reasoning process, as he makes sense of unexpected situations with which he is faced while teaching.

Selective attention and knowledge-based reasoning interact in a dynamic manner. That is, the kinds of interactions that a teacher notices will likely influence how the teacher reasons about those events. In addition, a teacher's knowledge and expectations can be expected to drive what stands out to the teacher in any given situation.

Research Design

The data presented in this article come from two yearlong video clubs facilitated by the researchers. The first author was the primary facilitator for the Nile Video Club, and the second author was the primary facilitator for the Mapleton Video Club. Both video clubs were designed with the goal of supporting the development of teachers' professional vision in a particular area. Specifically, the video clubs shared a common goal of helping teachers learn to identify and interpret the ideas students raise about mathematics. This focus reflects recent research in mathematics education that emphasizes the need for teachers to be able to look closely at student mathematical thinking (Ball, Lubienski, & Mewborn, 2001). Such research suggests that when teachers pay close attention to students' ideas, the opportunities for student learning increase (Franke, Carpenter, Levi, & Fennema, 2001). Yet making sense of student thinking on the fly has been show to be quite challenging for teachers (e.g., Heaton, 2000). Thus, this seemed to be a valuable focus for our professional development efforts.

Video Club Designs

Four middle school mathematics teachers participated in the Nile Video Club, which met monthly across one school year for a total of seven meetings. On average, the meetings lasted 40 minutes. The teachers had a range of years of teaching experience, from 1 to 28 years. They volunteered to participate and were paid a nominal stipend at the end of the year. Nile Middle School is located in an affluent suburb of a major U.S. city on the West Coast, with over 70% of the student population reporting as Caucasian.

The Mapleton Video Club was composed of seven elementary school teachers who taught grades 4 through 5. The teachers met once or twice a month across one school year for a total of 10 meetings. The meetings, which took place after school, lasted approximately 1 hour. This group of teachers also had a range of teaching experience, from 1 to 19 years. Yet unlike the participants in the Nile Video Club, this group was selected by the school principal for participation in the video club. They were, however, still paid a small stipend at the end of the year. Mapleton School is located in an urban area near a large Midwestern city. The student population is primarily African American, and approximately 60% receive free or reduced lunch.

Teachers in the Mapleton Video Club not only participated in the video club meetings but also agreed to take part in individual pre- and post-"noticing interviews." In each interview, the teacher viewed a series of three short video clips from mathematics classes. The clips lasted, on average, 3 minutes and came from various published materials. The clips were selected because they illustrated instances in which student mathematical thinking was visible. Following each clip, the teacher was asked to describe what he or she noticed in the video. The same clips were viewed in the preinterview and postinterview.

Classroom observations were also conducted with the seven Mapleton Video Club participants. Specifically, three of the teachers were observed for 3 days early in the year and again for 3 days late in the school year. The remaining four teachers were each observed 1 day early and 1 day late in the school year. The early observations were conducted within 1 month of the initial video club meeting; later observations were conducted within 1 month of the final video club meeting.[1]

Across both video clubs, a researcher would videotape in one teacher's classroom and select a short clip (approximately 5 minutes) for the group to watch at the next meeting. Thus, those clips viewed at the video club meetings portrayed fairly recent classroom lessons. As with the interview clips, the goal was to select excerpts that portrayed students thinking about mathematics (see Sherin, Linsenmeier, & van Es, 2006, for more information on the selection of clips shown in the Mapleton Video Club). In the Nile Video Club, one video clip was typically viewed per meeting; in the Mapleton Video Club two clips were generally viewed each time the group met. Teachers were also provided with a transcript of the classroom excerpt that they viewed. All video club meetings and interviews were videotaped and transcribed. In addition, the classroom observations were videotaped and field notes were collected.

In facilitating the meetings, the researcher would prompt the teachers to talk about and elaborate on what they noticed in the videos. Specific prompts used include, "What do you notice?" "What stands out to you here?" Furthermore, the facilitator used direct prompts to see whether the teachers' attention might be drawn to issues of student thinking, and if so, how they would talk about student ideas: "So what is Daniel saying about the graph?" "What did you see in the video about [students'] understanding of fractions?" Although the facilitator had in mind the goal of helping teachers learn to attend student thinking, she was also aware of the importance of providing space for the teachers to discuss issues related to the video that they viewed as significant.

Analysis of the Video Club Meetings and Noticing Interviews

To examine changes in the video club discussions over time, analysis for each video club focused on the first and the last meeting: meetings 1 and 7 for the Nile Video Club and meetings 1 and 10 for the Mapleton Video Club.[2] To start, two researchers individually divided the transcripts into "idea units" (Jacobs & Morita, 2002), segments in which a particular idea was discussed. In other words, each time the conversation shifted to a new issue, it was coded as another idea unit. Interrater reliability was 91% for the Nile Video Club and 95% for Mapleton. Disagreements were resolved through discussion.

Each idea unit was then coded along the following dimensions. First, we noted who initiated each idea unit (whether it was a teacher or the facilitator) and the length of time of each idea unit. Next, to consider the nature of the teachers' selective attention at different points in time, we categorized the idea units in terms of: (a) actor—whom in the video the teachers discuss (the students, the teacher, or other such as an administrator or parent) and (b) the topic of conversation. Here, we applied Frederiksen, Sipusic, Sherin, and Wolfe's (1998) coding scheme and included the categories of management, climate, pedagogy, and mathematical thinking (Table 1). Idea units coded as management concern issues of classroom organization such as the use of time, handling of disruptions, and transitions between activities. In contrast, climate refers to the social environment of the classroom. This includes, for example, the rapport among students, and between the teacher and the students, and the level of engagement of students in the class. Pedagogy has to do with the teacher's presentation of information in the classroom and selection of tasks for the lesson. Finally, mathematical thinking refers to whether participants are engaged in sense making around mathematical ideas, whether they are talking

Table 1
Investigating Professional Vision in the Video Club Meetings

Professional Vision Component	Dimension of Analysis	Coding Categories
Selective attention	Actor	Student
		Teacher
		Other
	Topic	Management
		Climate
		Pedagogy
		Math thinking
Knowledge-based reasoning	Stance	Describe
		Evaluate
		Interpret
	Strategy used to explore student math thinking	Restate student ideas
		Investigate meaning of student idea
		Generalize and synthesize across student ideas

about mathematics or showing their ideas in some way. Efforts to understand another person's mathematical idea would also fall under this category.

To examine the nature of the teachers' knowledge-based reasoning, we first coded each idea unit in terms of the teachers' general approach for making sense of the issue under discussion—what we call the "stance" the teacher used to discuss the video: describe, evaluate, or interpret. When describing what he or she noticed, a teacher would provide an account focused on observable features of the activity in the video; evaluating included judgments about the quality of the interactions in the video; and interpreting included inferences about what took place in the video.

In addition, we looked more closely at those idea units in which the actor was coded as student and the topic was coded as mathematical thinking. Our goal in doing so was to identify any patterns in the ways that the teachers reasoned, in particular, about student mathematical thinking. As a result, we identified three distinct strategies that the teachers used to reason about students' ideas: (a) restate student ideas (i.e., quote what a student said), (b) examine the meaning of student ideas, and (c) synthesize across the ideas of several students. The relevant idea units were then coded in terms of these three categories.

Interrater reliability along each of the coding dimensions was at least 87% for the Nile Video Club and 88% for the Mapleton Video Club meetings. In both cases, disagreements were resolved through discussion. To be clear, examining the actor and topic of conversation does not capture all of the complexity inherent in teachers' selective attention. However, we think it serves as a useful indicator of selective attention, because it points to issues that are the teachers' primary focus at that moment. Similarly, teachers' knowledge-based reasoning encompasses a wide variety of cognitive skills; investigating the stance teachers take in talking about the video, as well as the ways in which the teachers reason about student mathematical thinking, addresses only some components of this process.

Analysis of the noticing interviews conducted with participants in the Mapleton Video Club proceeded along similar lines. The interviews were first segmented into idea units representing distinct topics of conversation. Then each idea unit was coded in terms of actor, topic, and stance. Interrater reliability on the interviews was 87%, and again, disagreements were resolved through discussion.

Analysis of the Mapleton Classroom Observations

As will be presented in our discussion of results, the teachers who participated in the Mapleton Video Club increased their focus on interpreting student mathematical thinking over time, in both the video club discussions and in the noticing interviews. In analyzing the classroom observations, we wanted to identify whether a similar shift had occurred with respect to the teachers' instruction.

Analysis proceeded in four stages. First, we identified all sections of whole-class or large-group discussions in each lesson observed. We focused our analyses on these portions of instruction to maximize the potential for observing a teacher explicitly focusing on and responding to students' mathematical ideas.

In the second phase of analysis, two researchers independently viewed the videotapes of these portions of the

Table 2
Investigating Professional Vision in the Classroom Observations

Event in Class Discussion	Professional Vision Component	Coding Categories	Coding Description
Student raises math idea	Selective attention	Disconfirming evidence	Teacher does not consider student idea as object of inquiry
		Confirming evidence	Teacher considers student idea as object of inquiry
	Knowledge-based reasoning	Disconfirming evidence	Teacher does not engage in reasoning about student idea
		Confirming evidence	Teacher reasons about student idea
		Strategy used to explore student math thinking	Restate student statement Investigate meaning of student idea Generalize and synthesize across student ideas

lessons and created analytic memos (Miles & Huberman, 1994) that discussed, among other things, teachers' responses to students' questions, comments, and strategies. The memos also summarized teachers' responses to both solicited and unsolicited ideas from students. Using this information, we created a table that listed examples of confirming and disconfirming evidence of teachers noticing student mathematical thinking (Thomas, Wineburg, Grossman, Oddmund, & Woolworth, 1998). Here, we defined "noticing student math thinking" as instances in which teachers treated students' ideas about mathematics as objects of inquiry (Cohen, 2004). This approach to analyzing the teachers' selective attention is somewhat different than the approach used to analyze selective attention in the video club discussions and noticing interviews. In those contexts, we identified the extent to which teachers focused on student math thinking relative to the attention they gave to other actors and topics. In contrast, in analyzing the extent to which teachers noticed student math thinking during instruction, we focused exclusively on moments in which student ideas[3] were raised in class and then identified whether or not teachers noticed these ideas.[4]

Similarly, we created a table that listed examples of confirming and disconfirming evidence of the teachers engaged in reasoning about student math ideas.[5] Furthermore, all examples of confirming evidence of the teachers reasoning about student thinking were coded in terms of the three strategies identified in our analysis of the video club meetings (Table 2).

These two tables served to guide the third phase of analysis. Here, we sought to identify the extent to which each teacher noticed and reasoned about student thinking in each of the classroom observations. To examine this, all portions of whole-class or large-group discussion were segmented into 2-min. intervals. For each interval, a researcher noted whether or not there was confirming or disconfirming evidence as outlined in Table 2. Moreover, all confirming evidence of the teachers engaged in reasoning about student thinking was also coded in terms of the specific strategy used to consider the student's idea. As did Borko et al. (2008), we found 2 minutes to be a feasible coding unit, long enough to include substantive interactions in the classroom and frequent enough to provide a way to gauge a teacher's practice over time. Lessons for three of the teachers were coded by two researchers; interrater reliability was 86%. Consensus was reached through discussion.

In the final phase of analysis, we compared the rate of confirming and disconfirming evidence in the early and late observations for each teacher to identify developments in selective attention and knowledge-based reasoning.

Results

Our discussion of the results begins by exploring teacher learning in the context of the video club meetings. We first describe the learning that occurred in the Nile Video Club and then turn to a similar discussion of the Mapleton Video Club. Following this, we present the results of the interview analysis with the Mapleton participants, and finally, we discuss teacher learning as it was exhibited in the classroom observations of the Mapleton teachers. Throughout our presentation of results, we emphasize the nature of the teachers' learning as the development of professional vision.

Teacher Learning in the Nile Video Club

David: I didn't understand what Daniel said.
John: He said that the [graph of the] conical [flask] is curved". . .
Nancy: Is it filling up slower? Or faster?
Ron: [Isn't the graph] of the conical [flask] d?
David: The height is increasing less per volume at the beginning. But then the more volume you put in, the [steeper the graph.]

John: So he's saying that the [graph of the plugged funnel] should be a curve because the shape is like [the conical flask] and that was a curve.
David: That's right. I think that's what he said. . .
Ron: Well, he says "I agree with Tina."
Nancy: [But] Tina is [arguing for graph a] . . . the one [that doesn't curve].
John: He's arguing against himself it seems.
David: What exactly did Tina say?

This dialogue from the Nile Video Club illustrates the teachers engaged in a rich discussion of student mathematical thinking. In this example, the teachers were discussing a video excerpt in which the class explored which of several graphs best illustrated the water level as two flasks (a conical flask and a plugged funnel) were filled with water at a constant rate. In the video club, the teachers focused on one student, Daniel, and his statement that "the conical is kind of curved." Specifically, David realized that he did not understand Daniel's statement, and the teachers then, together, worked to make sense of Daniel's idea. They explored what Daniel meant by the term "curved" and what features of the conical flask Daniel was likely considering. In addition, the teachers began to connect Daniel's idea with what another student, Tina, stated previously, about a graph comprising two connected line segments.

In-depth discussions, such as this, of student mathematical thinking, were not the norm in the initial Nile Video Club meetings. By the end of the year, however, teachers had come to pay increased attention to student thinking as well as to engage in detailed analyses of students' ideas. In what follows, we explore these changes through the lenses of selective attention and knowledge-based reasoning.

The Development of Selective Attention

In looking across the discussions in the Nile Video Club, we find evidence of the development of the participants' selective attention. Early on, the teachers gave little attention to mathematical thinking (Table 3), even when prompted to do so by the facilitator (Appendix A). Instead, the majority of the teachers' comments focused on pedagogical issues. Over time, however, attention to student mathematical thinking increased.[6] This pattern is apparent when looking at the number of teacher-initiated idea units for each topic as well as when comparing the total time spent in discussions of student thinking in the first and the last meeting. In fact, whether it was the facilitator or a teacher who raised an issue related to student thinking, the teachers' discussions of this issue increased in length.

Table 3
Teacher-Initiated Idea Units in the Nile Video Club

	Meeting 1		Meeting 7	
	n	%	*n*	%
Actor				
Student	2	29	6	86
Teacher	5	71	1	14
Other	0	0	0	0
Topic				
Management	0	0	0	0
Climate	1	14	0	0
Pedagogy	4	57	1	14
Math thinking	2	29	6	86
Stance				
Describe	3	43	1	14
Evaluate	3	43	0	0
Interpret	1	14	6	86
Total	7	100	7	100

The Development of Knowledge-Based Reasoning

The data also reveal developments in the teachers' knowledge-based reasoning. First, as shown in Table 3, the teachers initially commented on the video by describing or evaluating what took place. In the final meeting, in contrast, the majority of their comments consisted of interpretations of what they noticed. Thus, the teachers not only paid more attention to student mathematical thinking over time but they also came to discuss this issue in a new way from the first to the last video club meeting.

Our analysis of the reasoning strategies the teachers applied in these idea units illuminates this further. Specifically, in the early video club meeting, the teachers did not always respond to the facilitator's prompts to examine student thinking. And if they did, the teachers' comments were brief, generally consisting of simple restatements of a student's comment:

Facilitator: So what's happening. . . [what are] they saying about [graph] f?
David: Amy [says] "It's not very realistic."
Nancy: Jesse agrees.
David: Jesse agrees.
John: Brian doesn't get it.
Ron: Brian [says] "I goofed." (Mimics Brian's tone of voice.)

In contrast, in the later video club meeting, the teachers were observed working to make sense of student ideas. They did this by examining the meaning of individual student statements and also by working to synthesize and generalize across the ideas of several students (Table 4).

Table 4
Teacher Reasoning About Student Mathematical Thinking in the Nile Video Club

	Number of Idea Units	
Reasoning Strategies	Meeting 1	Meeting 7
Little or no reasoning about student math thinking		
Disregard facilitator prompt to discuss student ideas	2	0
Restate student ideas	4	0
In-depth reasoning about student math thinking		
Investigate meaning of student ideas	1	4
Generalize and synthesize across student ideas	2	4
Total number of student math thinking idea units	9	8

It was interesting that in Meeting 1, the facilitator initiated most of the cases in which the teachers explored the meaning of student ideas or synthesized across students' comments. In Meeting 7, by contrast, the teachers had taken responsibility for initiating these sense-making activities (Table 5). Thus, not only did the teachers, over time, come to use more sophisticated strategies for reasoning about student thinking (which serves as evidence of the development of knowledge-based reasoning), they also came to notice more complex issues of student thinking in the videos. This suggests that as their selective attention became more focused on student mathematical thinking, they also began to attend to increasingly complex issues related to this topic and actor.

Teacher Learning in the Mapleton Video Club

Our analysis of the Mapleton Video Club reveals changes quite similar to that of the Nile Video Club. In particular, the teachers developed an increased focus on student mathematical thinking and developed new ways to reason about student ideas. To illustrate this shift, consider the following excerpt from the first meeting. The teachers had just watched a clip from Wanda's classroom in which students were working with the teacher to determine the degree of angles in different sets of polygons. Students raised a number of questions, in the video, concerning the use of triangles as a way to determine the angles of polygons. At this point in the video club meeting, the clip had just ended and the facilitator turned to the group and asked, "What do you notice?"

Daniel: I noticed the enthusiasm of the group, all of the volunteering and even . . . though they were kind of . . . a bunch of them talking at the same time. And they all wanted to volunteer. Enthusiasm. I noticed the enthusiasm in that group. That's about it.

Yvette: It seems like a good base was laid here, because they were with you or what you were talking about. I look at the math and . . . I wonder how many are in there . . . from that ability group, because . . . [we made angles the year before but] they could not understand that two rays, there was space in the middle. . .

Wanda: From your group?

Daniel: They're mostly Mr. Halston's kids, I think [from the year before]. . .

Yvette: They seemed on task.

Wanda: That was a lesson that went very well. . .

Daniel: Did they all have [protractors] at their desks?

Wanda: Yes.

Daniel: I'm having the problem sometimes when they have these base-ten blocks and . . . certain children are back there building tepees with the blocks while I'm talking. [In the video, students] are so focused and not playing with the [protractors].

Facilitator: (to Daniel) You're saying they're all so focused and (turning to Yvette) you say they seem to have a base . . . What . . . in the video show[s] you they're focused? . . . That they're really talking about the math that is going on?

In commenting on the video, the teachers made several statements concerning the climate in the classroom—that students were enthusiastic and wanted to volunteer and that students seemed on task. They also discussed classroom management when Daniel mentioned the students' use of the protractors. Some attention was given to the mathematical ideas raised by students, but the group did not pursue these in their discussion. In fact, in response to the prompt from the facilitator at the end of the excerpt, the teachers commented on the benefits and drawbacks of having students raise their hands before responding in class. These kinds of discussions were typical early on in the Mapleton Video Club.

In contrast, over time, the conversations among the teachers focused more extensively on the ideas that students raised about mathematics in the video. In the last meeting, for example, one teacher interrupted the playing of the video to ask about a student's response. While viewing the clip, she stated, "I'm totally confused . . . what was he talking about, 1/12?" The facilitator stopped the videotape and the teachers proceeded to discuss how the student came up with that answer and why it might have seemed reasonable to the student.

As shown in Table 6, from Meeting 1 to Meeting 10, there was a shift in the topic of the teachers' comments as they came to primarily raise issues related to mathematical

Table 5
Initiating Discussion of Student Mathematical Thinking in the Nile Video Club

	Number of Idea Units			
	Meeting 1		Meeting 7	
Reasoning Strategies	Teacher Initiated	Facilitator Initiated	Teacher Initiated	Facilitator Initiated
Little or no reasoning about student math thinking				
Disregard facilitator prompt to discuss student ideas	N/A	2	N/A	0
Restate student ideas	1	3	0	0
In-depth reasoning about student math thinking				
Investigate meaning of student ideas	0	1	3	1
Generalize and synthesize across student ideas	0	2	3	1
Total number of student math thinking idea units	1	8	6	2

Table 6
Teacher-Initiated Idea Units in the Mapleton Video Club

	Meeting 1		Meeting 10	
	n	%	*n*	%
Actor				
Student	8	73	12	67
Teacher	3	27	5	28
Other	0	0	1	5
Topic				
Management	3	27	0	0
Climate	3	27	0	0
Pedagogy	2	18	7	39
Math thinking	3	27	11	61
Stance				
Describe	7	64	1	5
Evaluate	3	27	5	28
Interpret	1	9	12	67
Total	11	100	18	100

Note: Due to rounding, some of the percentage totals may not add up to 100.

Table 7
Teacher Reasoning about Student Mathematical Thinking in the Mapleton Video Club

	Number of Idea Units	
Reasoning Strategies	Meeting 1	Meeting 10
Little or no reasoning about student math thinking		
Disregard facilitator prompt to discuss student ideas	1	0
Restate student ideas	3	4
In-depth reasoning about student math thinking		
Investigate meaning of student ideas and methods	3	7
Generalize and synthesize across student ideas	1	5
Total number of student math thinking idea units	8	16

thinking. Furthermore, although students were the most common actor of focus in both the first and the last video club meeting, in Meeting 1, only 25% of the comments about the student (2 out of 8) concerned mathematical thinking. In contrast, in Meeting 10, 92% of the comments about the student (11 of 12) were coded as having to do with mathematical thinking. This indicates a shift in selective attention over the course of the video club as the teachers came to attend to different issues within the video clips. Table 6 also indicates a shift in the teachers' knowledge-based reasoning. Specifically, by the final meeting, the Mapleton teachers primarily used an interpretive stance to discuss what took place in the video.

As in the Nile Video Club, there was also a shift in the ways in which the Mapleton participants reasoned about student ideas. In particular, in Meeting 10, the teachers engaged in more in-depth analyses of student thinking than they did in Meeting 1 (Table 7).

This pattern is even more striking when looking exclusively at those ideas units initiated by the teachers (Table 8). Specifically, in Meeting 10, the teachers initiated 8 of the 12 discussions in which they reasoned in in-depth ways about student thinking. Thus, again, the important point is that not only were the teachers capable of engaging in rather sophisticated approaches to reasoning about student thinking, but they were also identifying these types of issues and raising them for discussion.

In sum, both the Nile Video Club and the Mapleton Video Club provided a context for the development of

Table 8
Initiating Discussion of Student Mathematical Thinking in the Mapleton Video Club

	Number of Idea Units			
	Meeting 1		Meeting 7	
Reasoning Strategies	Teacher Initiated	Facilitator Initiated	Teacher Initiated	Facilitator Initiated
Little or no reasoning about student math thinking				
Disregard facilitator prompt to discuss student ideas	N/A	1	N/A	0
Restate student ideas	2	1	3	1
In-depth reasoning about student math thinking				
Investigate meaning of student ideas	0	3	5	2
Generalize and synthesize across student ideas	0	1	3	2
Total number of student math thinking idea units	2	6	11	5

teachers' professional vision, as it was exhibited in the video club meetings. Although this is a significant result, an important question remains. Would the teachers' professional vision appear to have changed outside of the video club context as well?

Exploring the Influence of Professional Vision Outside of the Video Club Context

Noticing Interview Results

To investigate whether or not changes in the teachers' professional vision were exhibited outside of the video club context, we first examine the results of the noticing interview conducted with the Mapleton participants. In brief, analysis of the individual interviews revealed a shift quite similar to that of the video club discussions. Consider, for example Frances' response to one clip viewed in the preinterview context. In the video, a group of five elementary school students were counting a large number of unifix cubes. The students worked together, sorting the cubes into sets, and then the teacher checked in with the group and asked the students to explain their strategy. When prompted to explain what she noticed about this clip in the preinterview, Frances stated, "Students were [talking]. You didn't have just one child just sitting and watching and not contributing. They were all contributing." Frances' comment indicates an emphasis on the students in the video and on the classroom climate, the degree to which the students were engaged and working together. Furthermore, her comments were descriptive, as she pointed out that several students were talking. In addition, she did not comment on the mathematics.

In the postinterview, in contrast, Frances made the following comment after viewing the same excerpt: "Well, they were doing patterns . . . apparently, they were counting by 25s . . . [but] one child was confused . . . she didn't get it . . . but the other children in the group did, and they got to 400." Her comments indicate a continued focus on the students in the clip and a new focus on the mathematics that students are examining. Furthermore, she interpreted what she notices. She suggested that the students used a particular strategy to sort the cubes and that one member of the group was confused about this approach. Frances' comments were not unique. Across all seven teachers, comments in the preinterviews tended to focus on the students in the video and on issues of classroom climate, with the teachers being mostly descriptive and evaluative in their analyses (Appendix B). In contrast, in the postinterview, the teachers maintained a focus on the students but attended to issues of math thinking and interpreted what they noticed (Table 9).

We believe that these results from the noticing interview are quite important. It is not the case, then, that the teachers learned only to talk differently about classroom interactions, and student mathematical thinking in particular, in the video club meetings. We see that they exhibit this same kind of professional vision of student mathematical thinking in the interview format.

Classroom Instruction Results

Now we turn to address a final question. What, if any, influence did the video clubs have on the teachers' instruction? And in particular, did the teachers' professional vision, as it was exhibited during instruction, shift in ways similar to what was observed in the video club meetings? To address this question, we draw on our analysis of the Mapleton participants' classroom observations. We first discuss changes in the teachers' selective attention in this context and then describe changes in their knowledge-based reasoning.

The development of selective attention. As discussed earlier in this article, we characterized a shift in the teachers' selective attention in the video club meetings as

Table 9
Average Percentage of Idea Units in the Pre and Postnoticing Interview

	Preinterview	Postinterview
Actor		
Student	60	72
Teacher	38	25
Other	2	3
Topic		
Management	1	0
Climate	42	18
Pedagogy	24	12
Math thinking	29	68
Other	4	2
Stance		
Describe	43	31
Evaluate	30	17
Interpret	27	52
Total	100	100

Note: The average number of idea units per teacher in the prenoticing interview is 21.57 (SD = 11.21) and for the postinterview is 20.57 (SD = 5.38).

an increased focus on student mathematical thinking. In the later meetings, for example, it was common for the teachers to make comments such as, "I didn't understand what Michael was doing" or "I'm not sure I'm following Lisa's thinking." In addition, the teachers asked the facilitator to pause a clip when a student in the video raised an idea that was of interest. The key practice here is that in the video club, the teachers had begun to notice and pay attention to student ideas; they recognized that student ideas were often worthy of consideration.

Analysis of the classroom observation data revealed that early in the school year, the teachers generally did not visibly attend closely to student ideas, or if they did, this was not a consistent practice. In most of the teachers' classrooms, the lessons followed in a steady pace, with the teacher asking questions, students answering, and the teacher proceeding with the lesson. In one lesson in Frances' classroom, for instance, the class was comparing fractions and trying to determine which is bigger, 3/8 or 1/3. On the overhead, Frances projected a representation from the textbook that showed several unit rectangles evenly divided into different number of segments. Frances began by asking "Okay, we have to first find 3/8. How do I find 3/8? Natasha?" When Natasha responded "Umm . . . " Frances quickly moved on and said, "That's okay. Jeff?" Jeff then answered, "Count to three." Although one might have wondered what Jeff meant by his statement, and in particular, three of what item he was referring to, Frances accepted his answer without question, illustrated 3/8 on the board, and then continued to the next part of the problem. "What do I have to do to find 1/3?" And later when a student made an error, the teacher simply offered the correct answer in response. "No. Each one stands for 100." In this excerpt, Frances was not noticing student ideas—that is, she did not regard student comments as objects of inquiry.

Examples such as this were common in the early observations. As Table 10 shows, we identified disconfirming evidence of teachers noticing student thinking across all seven Mapleton participants early in the year. This evidence consisted of multiple instances in which students raised ideas that might have been considered objects of inquiry but which instead were dismissed or not commented on by the teachers. Note that we also identified confirming evidence of teachers' noticing student thinking in these early observations. For four of the teachers, the evidence consisted of a small percentage of segments; thus, these teachers did at times attend to students' ideas, but this was not a consistent practice. In contrast, for three of the seven teachers, there was more extensive confirming evidence (in 55% or more of the 2-min. segments). In these cases, the teachers exhibited a mixed practice—both responding to and disregarding students' ideas during instruction.

In contrast, in the later observations, we found evidence that all of the teachers treated student comments, to a greater degree, as objects of inquiry.[7] This often involved explicit statements by the teacher that a student idea was interesting, novel, or confusing. Specific comments include, "That's interesting," "I've never heard of this [method]," and "Let's try to understand what Mark is saying." Statements such as these suggest that the practice of identifying student mathematical ideas that had developed in the video club extended to the teachers' instruction as well.

For example, in an end-of-year observation in Drew's classroom, the students were given the following information: 1" = 60 miles, and asked to solve two related problems: 1/2" = _?_ miles, 1/4" = _?_ miles. After a brief period of individual work, Lamar described his solution strategy to the class. "I knew that one-half of 100 was 50 and that one-half of 50 is 25. So I knew then that one-half of 60 is 30 and the one-quarter of 30 is 15." Drew then asked Lamar to come to the board to explain his thinking and to draw a picture of what he had in mind. Drew's invitation to the student illustrates Drew's interest in learning more about the student's method and the thinking that led to his approach.

Although all of the teachers increased in the percentage of time they noticed student thinking in the end of-year observations, they continued to exhibit some disconfirming

Table 10
Teacher Noticing of Student Mathematical Thinking During Instruction

	Early Observation(s)			Late Observation(s)		
Teacher	*N*	% Disconfirming Evidence	% Confirming Evidence	*N*	% Disconfirming Evidence	% Confirming Evidence
Daniel	30	43	77	18	22	94
Drew	11	100	27	10	40	80
Elena	18	39	67	9	22	89
Frances	15	80	7	8	13	88
Linda	9	55	55	11	45	100
Wanda	20	80	15	28	2	75
Yvette	22	73	9	25	36	44

Note: *N* is the number of 2-min. segments coded. For Daniel, Wanda, and Yvette, three early and three late observations were conducted. So *N* is the number of 2-min. segments across the three lessons.

evidence as well. In particular, analysis of Drew, Linda, and Yvette reveals disconfirming evidence of noticing student thinking in over 35% of the coded segments coded. For these teachers, the practice of attending to student ideas had become more established, though they also continued to either directly dismiss an idea raised by a student or to simply not probe the idea in class.

The development of knowledge-based reasoning. Now let us consider the teachers' knowledge-based reasoning and specifically, whether or not the strategies that the teachers developed in the video club for reasoning about student ideas were applied in the classroom. Our analysis examined this issue by investigating the ways in which the teachers reasoned about student ideas in those cases when confirming evidence of noticing had been identified. As shown in Table 11, early in the year, the most common strategy used by the teachers to reason about student thinking was fairly basic, involving restatements by the teacher of student ideas: "Joel is cutting each of the 10 rows in half." "Ashley's method was to divide the hexagon into five triangles." "Melinda says to add them together. Is that correct?"

In contrast, by the end of the year, the teachers were, overall, engaged in more in-depth reasoning, during instruction, of the ideas students raised in class. For instance, in an end-of-year observation in Daniel's classroom, he invited students to the board to share how they solved the problem 8.0×0.2. One student, Maria, used a somewhat innovative version of the partial products method. As she described her approach a second time, Daniel asked a number of questions, including "So you're doing partial products as if there's no decimal point?"; "Stop, what do you mean 'since there are two things behind the line?'"; "What do you mean, 'two over'?" These questions illustrate Daniel's efforts to try to make sense of Maria's method in a detailed manner.

As show in Table 11, six of the seven teachers were working extensively (in 55% or more of the relevant 2-min. segments) to make sense of student ideas and methods while teaching in the end-of-year data. In addition, two teachers, Daniel and Elena, were found frequently to generalize across student ideas or methods, with statements such as, "Now these two approaches seem different," or "This approach looks similar to what Sharon did," and "Maria, this one looks like your method." Not only were these teachers making sense of individual student ideas, they were also making connections among them.

These results suggest that the Mapleton participants adopted strategies similar to those developed in the video club for reasoning about student thinking, during instruction as well. Furthermore, although all of the teachers did not use the most sophisticated strategies, each teacher increased in the depth to which he or she had come to reason about student mathematical thinking. For example, in observations of her classroom late in the year, Yvette engaged in what we consider to be an early stage of reasoning, that of restating student ideas. Yet we believe this represents a significant step for her as she begins to attend to student thinking in the classroom (Hufferd-Ackles, Fuson, & Sherin, 2004). At the other end of the spectrum are Daniel and Elena, who, early in the year, were already treating some student ideas as objects of inquiry and by the end of the year consistently engaged in in-depth reasoning of their students' ideas. Also of interest is the case of Linda. Late in the year, we observed several instances in which Linda investigated the meaning of her students' ideas and methods. Yet within the same lessons, there were also moments in which Linda did not attend to students' comments and made no attempt to reason about what her students were thinking. Thus, although she was certainly capable of noticing student thinking and reasoning in depth, this was not a consistent aspect of her practice.

Table 11
Evidence of Teacher Reasoning About Student Mathematical Thinking During Instruction

	Early Observation(s)					Late Observation(s)				
Teacher	Number of of relevant 2-min. segments	No reasoning of student ideas	Restate student ideas	Investigate meaning of student ideas	Generalize/ synthesize student ideas	Number of relevant 2-min. segments	No reasoning of student ideas	Restate student ideas	Investigate meaning of student ideas	Generalize/ synthesize student ideas
Daniel	23	0%	100%	17%	0%	17	0%	24%	82%	47%
Drew	3	0%	100%	0%	0%	8	0%	100%	63%	25%
Elena	12	17%	67%	58%	0%	8	0%	25%	88%	63%
Frances	1	0%	100%	0%	0%	7	0%	43%	57%	0%
Linda	5	40%	60%	0%	0%	11	36%	100%	55%	9%
Wanda	3	67%	0%	33%	0%	21	5%	62%	72%	5%
Yvette	2	50%	50%	0%	0%	11	9%	73%	18%	0%

Note: At times, teachers engaged in more than one reasoning strategy in a single 2-min. segment. For this reason, percentages may add up to more than 100.

Discussion

This article represents an important extension of our program of research on teacher learning in video clubs. Prior to this study, we primarily focused our analyses on the video club meetings themselves, trying to understand both what and how teachers learn in this context (Sherin, 2001, 2007; Sherin & Han, 2004; van Es & Sherin, 2008). Such work has helped us to explore, at a detailed level, the ways in which reflecting on video with peers can foster teacher learning. Furthermore, it yielded valuable information concerning the affordances of video for teacher learning as well as information on how to design and implement video-based professional development effectively.

Yet at the same time, teachers with whom we worked have told us over and over again that not only have the video clubs themselves been a valuable experience but that watching video, and the video clubs in particular, have influenced their teaching. One participant explained it as follows:

> What it's done for me . . . it's enabled me to be consciously, really listen and to try to understand what students are saying. 'Cause so often I find myself . . . almost saying something before a student's even done. I'm not even listening to what they're saying. And so it helped me to slow down my own thinking and the classroom discussion . . . I'm actually listening to what they're saying and responding to what they're saying, not to what I want to respond to. . . I think it's helped a little bit to make me more aware of the specific things that are being said in discussions.

Statements such as this intrigued us. We believed that the video clubs we had observed were powerful forums in which teachers could develop new analytic skills. Yet it was not obvious to us that these same analytic skills would apply during instruction. In fact, we thought it quite possible that the "analytic mind-set" (Sherin, 2004) that teachers use when watching video is available precisely because classroom interactions are examined without the constraints of instruction. (Such constraints include the need to respond immediately, to have a sense of what is happening throughout the classroom, to make on-the-spot decisions about how to proceed with the lesson, and so forth.) Thus, although we agreed with others (e.g., Fennema et al., 1996) that having the capability to closely analyze student thinking is a critical skill for mathematics teachers, we did not presuppose that teachers would apply the behaviors developed in the video club in any direct manner during their teaching. Recall that there were no explicit conversations in the video clubs concerning how to take the information discussed in any given meeting "back to the classroom."

Nevertheless, the analysis presented here suggests that the teachers' professional vision developed in the classroom in ways quite similar to the developments identified in the video club. In both contexts, teachers increased in their capacity to notice and attend to student mathematical thinking. Student ideas that, initially, were typically dismissed by the teachers, later on became the objects of focused analysis. Furthermore, we observed similar strategies for reasoning about student ideas being used in both contexts. Although our goal in this article was to highlight the similarities between these strategies as a way of emphasizing the development of knowledge-based reasoning in both contexts, we are aware that the strategies are likely somewhat different simply because of inherent differences in the two contexts. For example, the purpose of restating student ideas in the video club context may have been, in part, a way to focus the group's attention on a particular line of transcript. In contrast, in the classroom, restating a student idea may have been related to the notion of "revoicing," which has the dual goals of highlighting an idea while also making a clear attribution of an idea to an individual in the classroom (O'Connor & Michaels, 1996). In addition, investigating the meaning of a student idea or method may have taken on a different orientation for teachers in the classroom because they could directly question and probe the student; in the video club, no additional data from the student could be gathered.[8] Despite these potential differences, we do believe that there is a strong alignment between the reasoning strategies developed in the video club and those displayed in the later classroom observations. Although we are encouraged by these results, we recognize that they come from a small group of teachers and a small number of classroom observations. It will be important in the future to conduct similar studies to explore the robustness of the results reported here.

Before concluding, we wish to make two additional points. First, we claim that key to the analysis presented here is our focus on professional vision. One of the challenges of analyzing the influence of professional development on teachers' beliefs, knowledge, and practices is, in our opinion, choosing what beliefs, knowledge, or practices to examine. This choice, of course, depends in large part, on the goals of the professional development program. However, our decision to use professional vision as a lens to study teacher learning in the video club extends beyond this. We believe that professional vision provides a uniquely appropriate lens for examining the affordances of video for teacher learning more broadly. That is, we suggest that it can be productive to consider the learning that takes place as teachers interact around video as helping to change teachers' professional vision, rather than, for example, as changes in teachers' subject matter knowledge or pedagogical content knowledge.

Second, we have emphasized in this article the influence of the video clubs on the teachers' instruction. Yet it seems possible that there was a bidirectional influence at play; that the video clubs influenced the teachers' instruction, and vice versa. For example, perhaps when the teachers first began to examine student thinking in the video club and then returned to their classroom only to find themselves not engaged in these types of practices, this consciously or unconsciously prompted them to want to learn more about student thinking in the video clubs. Or perhaps it was the case that being able to interact with student ideas on a regular basis in between the video club meetings prepared the teachers, in some vital way, to be open and ready to extend themselves further in the video club. Related to this are questions about the relationship between professional vision as it is displayed in the video clubs and professional vision as it comes into play in the classroom. We suspect that the interaction between selective attention and knowledge-based reasoning in the classroom is quite complex—more so than in the video club and interview contexts when teachers were given only a small slice of instruction to consider and extended time to do so. Thus, a next step in our program of research will be to develop methods to look more closely at the nature of professional vision in the moment of instruction.

Clearly, we have much work ahead of us. Although we found that video clubs can foster the development of teacher's professional vision, and more specifically, can be an effective forum for learning to attend to and reason about student thinking, a number of questions remain. First, would video clubs designed around other aspects of instruction be successful in similar ways? For example, would a video club design be useful for helping teachers to consider issues of equity in the classroom? Second, we want to better understand the ways in which the learning that occurs in the video club interacts with other aspects of teachers' work. Do teachers focus more on student thinking when planning for instruction, for instance, or when developing assessment materials? Finally, we want to investigate how different features of the video clubs themselves influence the learning that takes place. The video clubs explored in this article reflected a number of similarities, including the programs' goals, process for selecting video clips, and type of facilitation. Yet they also differed in key areas, including the number of participants, length of meetings, grade level examined, and school contexts. Understanding the ways in which these and other features come into play in the video club setting will help us continue to make productive use of video clubs in the future.

Appendix A
Nile Video Club, Meeting 1

	Teacher-Initiated Idea Units		Facilitator-Initiated Idea Units		Teacher- and Facilitator-Initiated Idea Units	
	n	%	*n*	%	*n*	%
Actor						
Student	2	29	8	100	10	67
Teacher	5	71	0	0	5	33
Other	0	0	0	0	0	0
Topic						
Math thinking	2	29	8	100	10	67
Pedagogy	4	57	0	0	4	26
Climate	1	14	0	0	1	7
Management	0	0	0	0	0	0
Stance						
Describe	3	43	7	86	10	67
Evaluate	3	43	0	0	3	20
Interpret	1	14	1	14	2	13

Nile Video Club, Meeting 7

	Teacher-Initiated Idea Units		Facilitator-Initiated Idea Units		Teacher- and Facilitator-Initiated Idea Units	
	n	%	*n*	%	*n*	%
Actor						
Student	6	86	3	75	9	82
Teacher	1	14	1	25	2	18
Other	0	0	0	0	0	0
Topic						
Math thinking	6	86	3	75	9	82
Pedagogy	1	14	0	0	1	9
Climate	0	0	1	25	1	9
Management	0	0	0	0	0	0
Stance						
Describe	1	14	1	25	2	18
Evaluate	0	0	0	0	0	0
Interpret	6	86	3	75	9	82

Appendix B
Coding of Mapleton Participants Noticing Interviews

		Preinterview		Postinterview			Preinterview		Postinterview			Preinterview		Postinterview	
Teacher	Actor	*n*	%	*n*	%	Topic	*n*	%	*n*	%	Stance	*n*	%	*n*	%
Linda	Student	6	38	14	67	Math thinking	6	38	14	67	Describe	5	31	5	24
	Teacher	10	62	7	33	Pedagogy	5	31	3	14	Evaluate	8	50	5	24
	Other	0	0	0	0	Climate	5	31	3	14	Interpret	3	19	11	52
						Management	0	0	0	0					
						Other	0	0	1	5					
Elena	Student	14	78	12	80	Math thinking	5	28	7	47	Describe	7	39	6	40
	Teacher	4	22	3	20	Pedagogy	4	22	3	20	Evaluate	3	17	1	7
	Other	0	0	0	0	Climate	9	50	5	33	Interpret	8	44	8	53
						Management	0	0	0	0					
						Other	0	0	0	0					
Wanda	Student	10	63	9	75	Math thinking	5	31	9	75	Describe	5	31	2	17
	Teacher	5	31	3	25	Pedagogy	5	31	1	8	Evaluate	6	38	2	17
	Other	1	6	0	0	Climate	5	31	2	17	Interpret	5	31	8	66
						Management	0	0	0	0					
						Other	1	7	0	0					
Daniel	Student	22	48	19	73	Math thinking	8	17	22	85	Describe	25	54	8	31
	Teacher	21	46	7	27	Pedagogy	8	17	2	7	Evaluate	11	24	7	27
	Other	3	6	0	0	Climate	23	50	1	4	Interpret	10	22	11	42
						Management	3	7	0	0					
						Other	4	9	1	4					
Frances	Student	7	54	12	60	Math thinking	3	23	13	65	Describe	5	38	7	35
	Teacher	6	46	7	35	Pedagogy	4	31	3	15	Evaluate	5	38	5	25
	Other	0	0	1	3	Climate	5	38	4	20	Interpret	3	24	8	40
						Management	0	0	0	0					
						Other	1	8	0	0					
Yvette	Student	17	74	20	80	Math thinking	5	22	17	68	Describe	10	44	6	24
	Teacher	5	22	2	8	Pedagogy	4	17	3	12	Evaluate	4	17	3	12
	Other	1	4	3	12	Climate	13	57	5	20	Interpret	9	39	16	64
						Management	0	0	0	0					
						Other	1	4	0	0					
Drew	Student	12	63	18	72	Math thinking	9	47	18	72	Describe	12	63	12	48
	Teacher	7	37	6	24	Pedagogy	3	16	2	8	Evaluate	5	26	2	8
	Other	0	0	1	4	Climate	7	37	4	16	Interpret	2	11	11	42
						Management	0	0	0	0					
						Other	0	0	1	4					

Notes

1. Although we would have preferred to conduct multiple observations for all seven teachers, logistical constraints prevented us from doing so.

2. The first and last meeting from each video club were selected for analysis to focus on potential differences in the teachers' professional vision from the beginning to the end of the video clubs. Elsewhere, we report in more detail on shifts that took place in the teachers' comments at points throughout the series of meetings (see, specifically, van Es & Sherin, 2008).

3. We generally focused on instances in which students' comments about mathematics were nonroutine or unexpected given the topic of the lesson, or in which the meaning of a student's statement was incorrect or unclear.

4. For example, if the student's idea was not acknowledged by the teacher, we coded this as disconfirming evidence of a teacher noticing student math thinking. In contrast, if a teacher indicated that the student's comment was noteworthy or required further consideration, we considered this to be confirming evidence of teacher noticing.

5. For example, instances in which a teacher commented only that a student's idea was correct or incorrect were considered to be disconfirming evidence of reasoning about student math thinking, while moments in which a teacher actively worked to make sense of a student's method were coded as confirming evidence.

6. The six idea units coded as relating to "student" in Meeting 7 are in fact the same six idea units that were coded as relating to "mathematical thinking."

7. It seems possible that the different amounts of time spent in whole-class discussion would have influenced the extent to which student ideas were potentially visible to the teacher. However, although all seven teachers increased in the percentage of confirming evidence in the later observations, the amount of time spent in whole-class discussion did not increase uniformly.

8. At times, teachers in a video club meeting did request to review an earlier or later portion of a classroom video to gather additional information about a student idea.

References

Ball, D. L., & Bass, H. (2003). Toward a practice-based theory of mathematical knowledge for teaching. In B. Davis & E. Simmt (Eds.), *Proceedings of the 2002 Annual Meeting of the Canadian Mathematics Education Study Group* (pp. 3-14). Edmonton, Alberta, Canada: CMESG/GCEDM.

Ball, D. L., & Cohen, D. K. (1999). Developing practice, developing practitioners: Toward a practice-based theory of professional development. In G. Sykes & L. Darling-Hammond (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 3-32). San Francisco: Jossey Bass.

Ball, D. L., Lubienski, S., & Mewborn, D. (2001). Research on teaching mathematics: The unsolved problem of teachers' mathematical knowledge. In V. Richardson (Ed.), *Handbook of research on teaching* (4th ed., pp. 433-456). New York: Macmillan.

Ball, D., Thames, M. H., Phelps, G., & Hill, H. C. (2005, April). *Knowledge of mathematics for teaching: What makes it special?* Paper presented at the annual meeting of the American Educational Research Association, Montreal, Ontario, Canada.

Beardsley, L., Cogan-Drew, D., & Olivero, F. (2007). VideoPaper: Bridging Research and Practice for Pre-Service and Experienced Teachers. In R. Goldman, R. Pea, B. Barron, & S. Derry (Eds.), Video Research in the Learning Sciences, pp. 479-493, Mahwah, NJ: Erlbaum.

Berliner, D. C. (1994). Expertise: The wonder of exemplary performances. In J. M. Mangier & C. C. Block (Eds.), *Creating powerful thinking in teachers and students: Diverse perspectives* (pp. 161-186). Fort Worth, TX: Holt, Rinehart, & Winston.

Beardsley, L., Cogan-Drew, D., & Olivero, F. (2007). VideoPaper: Bridging research and practice for pre-service and experienced teachers. In B. Barron, S. Derry, R. Goldman, & R. Pea (Eds.), *Video research in the learning sciences* (pp. 479-493). Mahwah, NJ: Lawrence Erlbaum.

Bell, B., & Cowie, B. (2001). The characteristics of formative assessment in science education. *Science Education*, *85*, 536-553.

Bitter, G. G., & Hatfield, M. M. (1994). Training elementary mathematics teachers using interactive multimedia. *Educational Studies in Mathematics, 26*, 405-409.

Boaler, J., & Humphries, C. (2005). *Connecting mathematical ideas: Middle school video cases to support teaching and learning*. Portsmouth, NH: Heinemann.

Borko, H., Jacobs, J., Eiteljorg, E., & Pittman, M. E. (2008). Video as a tool for fostering productive discussions in mathematics professional development. *Teaching and Teacher Education, 24*, 417-436.

Brophy, J. (2004). *Using video in teacher education*. San Diego, CA: Elsevier.

Cohen, S. (2004). *Teacher's professional development and the elementary mathematics classroom: Bringing understandings to light*. Mahwah, NJ: Lawrence Erlbaum.

Fennema, E., Carpenter, T. P., Franke. M. L., Levi, L., Jacobs, V. R., & Empson, S. B. (1996). A longitudinal study of learning to use children's thinking in mathematics instruction. *Journal for Research in Mathematics Education, 27*, 458-477.

Fraivillig, J. L., Murphy, L. A., & Fuson, K. C. (1999). Advancing children's mathematical thinking in everyday mathematics classrooms. *Journal for Research in Mathematics Education, 30*(2), 148-170.

Franke, M. L, Carpenter, T. P., Levi, L., & Fennema, E. (2001). Capturing teachers' generative change: A follow-up study of professional development in mathematics. *American Educational Research Journal, 38*(3), 653-689.

Frederiksen, J. R., Sipusic, M., Sherin, M. G., & Wolfe, E. (1998). Video portfolio assessment: Creating a framework for viewing the functions of teaching. *Educational Assessment, 5*(4), 225-297.

Goldsmith, L. T., & Seago, N. (2008). Using video cases to unpack the mathematics in students' thinking. In M. S. Smith & S. N. Friel (Eds.), *Cases in mathematics teacher education: Tools for developing knowledge needed in teaching* (Association of Mathematics Teacher Educators Monograph No. 4, pp. 135-145). San Diego, CA: San Diego State University, Center for Research in Mathematics and Science Education.

Goodwin, C. (1994). Professional vision. *American Anthropologist, 96*, 606-633.

Hammer, D. (1997). Discovery learning and discovery teaching. *Cognition and Instruction, 15*(4), 485-529.

Heaton, R. M. (2000). *Teaching mathematics to the new standards*. New York: Teachers College Press.

Hufferd-Ackles, K., Fuson, K., & Sherin, M. G. (2004). Describing levels and components of a math-talk community. *Journal for Research in Mathematics Education, 35*(2), 81-116.

Jacobs, J. K., & Morita, E. (2002). Japanese and American teachers' evaluations of videotaped mathematics lessons. *Journal for Research in Mathematics Education*, *33*(3), 154-175.

Koellner, K., Jacobs, J., Borko, H., Schneider, C., Pittman, M. E., Eiteljorg, E., et al. (2007). The problem-solving cycle: A model to support the development of teachers' professional knowledge. *Mathematical Thinking and Learning*, *9*(3), 273-303.

Lampert, M. (1985). How do teachers manage to teach? Perspectives on problems in practice. *Harvard Educational Review*, *55*(2), 178-194.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage.

Nemirovsky, R., & Galvis, A. (2004) Facilitating grounded online interactions in video-case-based teacher professional development. *Journal of Science Education and Technology*, *13*(1), 67-79.

O'Connor, M. C., & Michaels, S. (1996). Shifting participant frameworks: Orchestrating thinking practices in group discussions. In D. Hicks (Ed.), *Discourse, learning, and schooling* (pp. 63-103). New York: Cambridge University Press.

Oonk, W., Goffree, F., & Verloop, N. (2004). For the enrichment of practical knowledge: Good practice and useful theory for future primary teachers. In J. Brophy (Ed.), *Using video in teacher education* (pp. 131-167). San Diego, CA: Elsevier.

Santagata, R., Gallimore, R., & Stigler, J. W. (2005). The use of videos for teacher education and professional development: past experiences and future directions. In C. Vrasidas & G. V.Glass (Eds.), *Current perspectives on applied information technologies: Preparing teachers to teach with technology* (Vol. 2, pp. 151-167). Greenwich, CT: Information Age Publishing.

Santagata, R., Zannoni, C., & Stigler, J. (2007). The role of lesson analysis in pre-service teacher education: An empirical investigation of teacher learning from a virtual video-based field experience. *Journal of mathematics teacher education*, *10*(2), 123-140.

Seago, N. (2004). Using video as an object of inquiry for mathematics teaching and learning. In J. Brophy (Ed.), *Using video in teacher education* (pp. 259-286). San Diego, CA: Elsevier.

Seago, N., Mumme, J., & Branca, N. (2004). *Learning and teaching linear functions: Video cases for mathematics professional development*. Portsmouth, NH: Heinemann.

Sherin, M. G. (2001). Developing a professional vision of classroom events. In T. Wood, B. S. Nelson, & J. Warfield (Eds.), *Beyond classical pedagogy: Teaching elementary school mathematics* (pp. 75-93). Hillsdale, NJ: Lawrence Erlbaum.

Sherin, M. G. (2004). New perspectives on the role of video in teacher education. In J. Brophy (Ed.), *Using video in teacher education* (pp. 1-27). New York: Elsevier Science.

Sherin, M. G. (2007). The development of teachers' professional vision in video clubs. In R. Goldman, R. Pea, B. Barron, & S. Derry (Eds.), *Video research in the learning sciences* (pp. 383-395). Hillsdale, NJ: Lawrence Erlbaum.

Sherin, M. G., & Han, S. (2004). Teacher learning in the context of a video club. *Teaching and Teacher Education*, *20*, 163-183.

Sherin, M. G., Linsenmeier, K., & van Es., E. A. (2006, April). *Selecting video clubs for teacher learning about student thinking*. Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Smith, J. P. (1996). Efficacy and teaching mathematics by telling: A challenge for reform. *Journal for Research in Mathematics Education*, *27*, 458-477.

Star, J. R., & Strickland, S. K. (2008). Learning to observe: Using video to improve preservice mathematics teachers' ability to notice. *Journal of Mathematics Teacher Education*, *11*(2), 107-125.

Stylianides, A. J., & Ball, D. L. (2008). Understanding and describing mathematical knowledge for teaching: Knowledge about proof for engaging students in the activity of proving. *Journal of Mathematics Teacher Education*, *11*, 307-332.

Thomas, G., Wineburg, S., Grossman, P., Oddmund, M., & Woolworth, S. (1998). In the company of colleagues: An interim report on the development of a community of teacher learners. *Teaching and Teacher Education, 14*(1), 21-32.

van Es, E. A., & Sherin, M. G. (2008). Mathematics teachers "learning to notice" in the context of a video club. *Teaching and Teacher Education, 24,* 244-276.

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