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Mathematics teachers' "learning to notice" in the context of a video club

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Abstract

This study examines changes in teachers' thinking as they participated in a video club designed to help them learn to notice and interpret students' mathematical thinking. First, we investigate changes in teachers' talk about classroom video segments before and after participation in the video club. Second, we identify three paths along which teachers learned to notice students' mathematical thinking in this context: Direct, Cyclical, and Incremental. Finally, we explore ways the video club context influenced teacher learning. Understanding different forms of teacher learning provides insight for research on teacher cognition and may inform the design of video-based professional development.

Keywords: Teacher learning; Teacher cognition; Professional development; Mathematics education; Video

1. Introduction

Mathematics education reform calls on teachers to base their instruction on the lesson as it unfolds in the classroom, paying particular attention to the ideas that students raise (National Council of Teachers of Mathematics [NCTM], 2000). This ability to adapt one's teaching in the midst of instruction requires that teachers be able to notice aspects of reform pedagogy and interpret what is happening in their classrooms in new ways (Ball & Cohen, 1999). Drawing on Goodwin (1994) and Sherin (2001), we refer to this as *professional vision for reform teaching*. Professional vision refers to the ability to notice features of a practice that are valued by a particular social group. By using the term professional vision for reform pedagogy, we emphasize that teachers' current professional vision may not always be in line with the goals of reform. Furthermore, research suggests that it can be a challenge for teachers to learn to notice and interpret instruction in these ways (Franke, Carpenter, Fennema, Ansell, & Behrend, 1998).

Video clubs are used as the context of this study. A video club consists of a group of teachers who meet to watch and discuss excerpts of videotapes of their instruction (Frederiksen, Sipusic, Sherin, & Wolfe, 1998; Tochon, 1999). Video has been used for decades in teacher learning and it appears to show promise in supporting teachers in learning to notice. Video is able to capture much of the richness of classroom interactions, and it can be used in

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contexts that allow teachers time to reflect on these interactions (Feltovich, Spiro, & Coulson, 1997; Jordan & Henderson, 1995; Spiro, Coulson, Feltovich, & Anderson, 1988). However, we have yet to fully understand the nature of teacher learning in this context. In this paper, we use the *Learning to Notice Framework* introduced in previous work (van Es & Sherin, 2002) to investigate the development of teachers' professional vision for reform pedagogy. We then present three different trajectories that teachers follow as they learn to notice significant classroom interactions in the context of a video club. Investigating the different forms that teacher learning can take provides insight for research on teacher cognition and can be used to inform the design of video-based professional development.

To be clear, the goal of this paper is to understand changes in teachers' thinking in the video club context. Such research allows us to understand at a detailed level the development of teacher thinking as they interact with peers around the use of video. We recognize, however, that examining what influenced the teachers to make these changes is also critical to fully understand how we can use this forum to aid in teacher learning. Therefore, while not the focus of this paper, in the conclusion, we begin to consider several aspects of the video club that may have influenced teacher development in this context.

2. Learning to notice in the context of reform

While we argue that noticing and interpreting are important skills for teaching in the context of reform, we want to point out that discussion of these skills in the research literature is not entirely new. Prior research explains that experts are good at seeing meaningful patterns in their area of expertise (Lesgold et al., 1988). For example, early research on the difference between expert and novice chess players (DeGroot, 1965) showed that expert players were able to see more meaningful patterns and that they used this information to consider moves that were superior to those of less experienced players. Research on teacher expertise has described similar phenomena (Berliner, 1994; Furlong & Maynard, 1995). However, while experienced teachers may already have the ability to recognize meaningful patterns in teaching, we argue that in the context of reform, noticing is a skill that teachers may need to develop further. In fact, recent research points to the value of teachers learning to examine classrooms in new ways in the context of reform (Ball & Cohen, 1999; Lampert & Ball, 1998; Rodgers, 2002). This study builds on prior research in an effort to clearly articulate what it means to look at classroom interactions in new ways and how teachers learn to do so.

2.1. Learning to notice framework

In previous work (van Es & Sherin, 2002), we describe the *Learning to Notice Framework*. Here, we provide a summary of this framework. Based on prior research, we propose that the skill of noticing for teaching consists of three main aspects: (a) identifying what is important in a teaching situation; (b) using what one knows about the context to reason about a situation; and (c) making connections between specific events and broader principles of teaching and learning (see Table 1).

Frederiksen (1992) refers to the first aspect of noticing as making a "call-out." The act of making a call-out signifies an ability to hone in on what is important in a very complex situation. Similarly, Leinhardt, Putnam, Stein, and Baxter (1991) find that expert teachers have "check points" in mind during instruction that they use to assess the progress of a lesson and to decide how to proceed. Like call-outs, being able to identify check points suggests that more experienced teachers may be able to recognize what is important to attend to as a lesson is implemented. Along the same line, Goodwin (1994) refers to "highlighting," the ability to bring to the fore certain events. Highlighting is

Table 1
Learning to notice framework

Noticing for teaching involves:
(a) Identifying the significant events in a teaching situation
(b) Using knowledge from one's context to reason about these events
(c) Making connections between specific events and broader principles of teaching and learning

similar to the notion of making a call-out, in that it is the act of deciding what is noteworthy and deserves further attention.

Prior research in the field of psychology has examined what people attend to as they interact with their surroundings (Mack & Rock, 1998; Olson, Roese, & Zanna, 1996; Simons, 2000) and provides insight into how individuals determine what is worthy of attention. Specifically, research on ''inattentional blindness'' shows that individuals do not see everything in a situation, and they often do not attend to the events that we might expect would capture one's attention (Simons & Chabris, 1999). For example, some types of car accidents occur because drivers do not expect to see certain things, such as a deer, in the road. Because they do not expect to see these things, their presence is often not noticed until it is too late. In addition, people often see and hear things that do not exist (Mack & Rock, 1998). For instance, we may think we hear the doorbell ring when we are waiting for a guest, but when we open the door, we see that no one has yet arrived.

The second dimension of noticing involves teachers using knowledge of their context to reason about events they analyze. This is in line with research that has found that as individuals gain more experience in a particular domain, they become more adept at making sense of situations they encounter within this domain (Brown, Collins, & Duguid, 1989; Chi, Glaser, & Farr, 1988; Lesgold et al., 1988). For teachers, this means using knowledge of the subject matter, knowledge of how students think about the subject matter, as well as knowledge of their local context to reason about events as they unfold (Dreyfus & Dreyfus, 1987; Perkins & Solomon, 1989; Schon, 1983). Prior research on the concept of ''expectancies'' is relevant here as well. This research shows that different people see different things in the same situation and that what one sees is influenced by one's prior experiences, knowledge and beliefs (Olson et al., 1996). Research on teacher cognition also shows that teachers' knowledge and beliefs influence what they determine as important to attend to in complex situations (Schoenfeld, 1998). For example, teachers of mathematics will more accurately reason about a classroom interaction from a mathematics classroom than they will from a literature or science classroom. Likewise, algebra teachers will better interpret students' understanding of variables than geometry teachers would interpret students' thinking of the same concept. And finally, algebra teachers are better able to interpret their own students' understanding about algebra than the thinking of a group of students from another teacher's algebra class.

The third characteristic of noticing is the ability to make connections between specific events and the broader principles they represent. Prior research has shown that experts consider problems in terms of the concepts and principles that specific situations represent (Glaser & Chi, 1988; Larkin & Simon, 1987). The same can be said for expert teachers (Copeland, Birmingham, DeMeulle, D'Emidio-Caston, & Natal, 1994; Hughes, Packard, & Pearson, 2000). When analyzing a video of a class discussion, for example, expert teachers will describe the segment in terms of principles, using phrases such as, ''I see this as scaffolding students' learning.'' Shulman (1996) refers to the importance of extrapolating from the specific to the general when he encourages teachers and teacher educators to ask themselves, upon analysis of a teaching episode, ''What is this a case of?'' Responding to this question helps teachers to look at a situation and recognize it as an instance of something, a principle of teaching and learning, rather than to see each instance as an isolated event. Teachers can then build a repertoire of cases to illustrate abstract principles and can call on these cases to reason in similar future situations. While teaching is certainly complex, and we have yet to label the kinds of complicated interactions that play out in classrooms, prior research suggests that being able to categorize and extrapolate from the specific to the general is useful for teachers, as it equips them with knowledge and skills they can use to respond to student learning in the midst of instruction (Barnett, 1998). Further, as teachers strive to identify instances of teaching as cases of broader principles, they begin to develop a language for reform pedagogy (Collins, 1999), as they have a chance to view a ''community of learners'' or ''equity pedagogy'' first hand.

2.2. *Teacher reflection*

This research is also situated in prior research on teacher reflection. Much has been written about the need for teachers to reflect on their practice (Dewey, 1933; Schon, 1983; Zeichner & Liston, 1987). At the heart of this research is the claim that reflection is key to improving one's teaching. Engaging in reflection allows teachers to make sense of their experiences and to then use this knowledge to inform future decisions. We argue that learning to notice is one important dimension within the process of reflection that deserves additional attention. For example, Rodgers (2002) describes a framework for reflection, the "reflective cycle" consisting of several stages. In this cycle, teachers first describe in detail selected noteworthy situations from their classrooms, then ascribe meaning to those events, and then decide a course of action to take. The *Learning to Notice Framework* unpacks the second phase of what it means to ascribe meaning to events that teachers notice.

Prior research on reflection also highlights the need for teachers to step back and make sense of events that happened in practice. Along those lines, in defining what it means to "notice" here, we want to emphasize the importance of *interpreting* classroom events. Thus, how individuals reason about what they notice is as important as the particular events they notice. Recently, several researchers have argued that it is valuable for teachers to adapt an interpretive stance as they reflect on their practice, rather than an evaluative stance (Heaton, 2000; Putnam & Borko, 2000; Rodgers, 2002). For Rodgers (Introduction section, para 4), the reflective cycle is powerful because it "slows down teachers' thinking so that they can attend to what is rather than what they wish were so." The goal then is for teachers to look at teaching situations for the purpose of understanding what happened, for example, to consider what students understand about the subject matter or how a teaching strategy influenced student thinking, as opposed to examining a situation for criticism or to take action. While teaching certainly involves making judgments about what went well or poorly in a lesson, we believe it is critical for teachers to first notice what is significant in a classroom interaction, then interpret that event, and then use those interpretations to inform their pedagogical decisions. And we argue that these are requisite skills that reformers have in mind when they call for teachers to be flexible in their instructional plans as they teach.

Now, this work is not intended to suggest that teachers do not currently notice important events or that they do not reason about them to accomplish their goals. Instead, we propose that, in the context of reform, what is deemed as important to attend to is often not what teachers focus on when they examine classroom interactions. The question then becomes how can we help teachers learn to examine classrooms in new ways and, more specifically, how video-based professional development might be used to support teachers in learning to do so.

2.3. Video-based professional development

Over the last decade, several video-based programs have been developed to support mathematics teachers in learning to teach in new ways. The corresponding research on these programs often examines how teachers transform beliefs about teaching and learning, as well as, what teachers learn about subject matter or pedagogical knowledge as they use these tools (Hatfield & Bitter, 1994; Wang & Hartley, 2003). For example, using video from their own classrooms, Lampert and Ball (1998) designed a hypermedia system to support novice teachers in developing pedagogical content knowledge for use in teaching. This tool consisted of video records of practice, as well as seating charts, student work, and teacher lesson plans and reflections. The tool presented a variety of situations to support the development of subject matter knowledge for teaching, and it was represented in such a way so users could see the complexity of real-life classrooms. Other multimedia tools have been developed to model exemplary teaching practices in order for teachers to learn new pedagogical strategies (Andre, Schmidt, Nonis, Buck, & Hall, 2000; Goldman & Barron, 1990). These systems demonstrate alternative practices of teaching for teachers to observe, model, and reflect on so they can adapt these techniques for use in their own classrooms. In this work, we take another approach and study how video clubs might be used to support teachers in developing a different type of knowledge and skill, namely, noticing. Specifically, we use the *Learning to Notice Framework* to examine how teachers learn to look at classroom interactions in new ways as they participate in video club meetings.

3. Research design

3.1. Video club design

Subjects in the study were seven fourth and fifth grade elementary teachers from an urban school whose teaching experience ranged from one to over twenty years. The teachers were in their third year of implementing a reform-based mathematics curriculum. The teachers were encouraged to participate in the video club by a district-level administrator and the school principal, and they were paid for their participation. The video club met 10 times throughout the 2001–2002 school year, one or two times each month from October to May. Each teacher shared clips from his or her own classroom two or three times throughout the year, with an average of two clips being watched and discussed at each meeting.

The ten meetings shared the same format. Prior to each meeting, a researcher videotaped two teachers' mathematics lessons. While videotaping in the teachers' classrooms, the researcher attempted to capture the central activities of the lesson. Specifically, during whole-class activities the video camera was zoomed out in order to record much of the interactions and discourse that took place. In contrast, during small group work, the camera remained focused on one or two groups of students working together. During individual seat-work, the camera typically followed the teacher as he or she moved throughout the classroom. While there were clearly limits in what we were able to capture on video, three microphones were spread throughout the classroom in order to record as much of the classroom talk as possible.

After taping, the same researcher then reviewed the tapes and identified brief excerpts highlighting mathematical issues that were raised in the lessons. For example, the researcher might select an excerpt in which a student illustrated an invented method or in which there appeared to be some confusion on the part of the students about the mathematical issues being discussed. Other excerpts might illustrate students' questions about a particular concept, the teacher's corresponding explanation, and the class's discussion about the issue raised. In all, one 5–7 min long excerpt from each classroom was selected and a corresponding transcript was prepared. These excerpts were then shown in the next video club meeting.

At each meeting, the researcher, in the role of facilitator, began the discussion by framing the viewing of the first clip the group would analyze, summarizing the mathematical topic and the lesson. For example, the facilitator would say something like, "This clip comes from Yvette's classroom. They were working on multi-digit multiplication. And this was the third lesson in the unit." The teacher whose clip was being shared was also invited to provide background about the lesson. Generally, the first half of the meeting was used to discuss the first clip and the second half was spent analyzing the second clip.

In each meeting, the facilitator's goal was to help teachers learn to notice and interpret students' mathematical thinking. Thus, the facilitator[1] prompted the teachers to examine students' ideas about the mathematics, to use evidence to support claims they made about students' thinking, and to interpret the students' understanding about the mathematics. The nature of the prompts ranged from general questions (e.g. "What did you notice?" or "What stood out to you?") to more specific questions focused on students' mathematical understanding (e.g. "If we had to guess if James knows his times tables, what would you say?"). To direct teachers to use evidence from the clips, the facilitator would ask questions such as, "What did you see in the video that makes you think that?" And finally, to encourage teachers to interpret what they noticed, the facilitator asked questions of the following type, "What do you think that says about James's understanding?" While the facilitators reviewed and selected clips and facilitated the discussions in the ways described above, they did not have predetermined notions of what were "acceptable" interpretations. Rather, the teachers offered, discussed, and debated a variety of interpretations. In this way, both the facilitators and teachers played important roles in shaping the discussions that ensued in the meetings.

Following is a typical example of the kind of conversation that ensued in the 10 meetings. In the following excerpt, the video club group had just viewed a video clip in which the teacher was facilitating a discussion about area. Specifically, the class was determining the height of a rectangle, given that the base was 12 ft and the area of the figure was 360 ft^2 (see Fig. 1). Several students had solved the problem by dividing 360 by 12.[2] One student, Maria, was exploring if the height could be determined by using the squares that comprised the rectangle in the figure. Maria was unclear, however, as to the value of the height and base of these

[1]For seven of the 10 meetings, the first author was the facilitator. The second author was the facilitator for the other three meetings. In addition, a second researcher attended each meeting, with primary responsibility for videotaping the session. This researcher also participated in the discussions, but often to a lesser extent than the main facilitator.

[2]Because the base of the rectangle is given as 12 ft, one can determine that each square has a height and base of 6 ft. Therefore, the height of the rectangle is 30 ft.

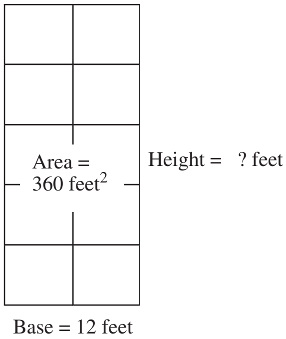

Fig. 1. What is the height of a rectangle with base 12 f and area 360 ft^2?

squares, and she was working with all 10 squares rather than one column of five squares.

Facilitator: So, what did you notice? What stood out to you?
Yvette: I didn't understand when [Maria said], "Since there's five going down, you can just put one up and over, and then since there's five, just put one up…"
Wanda: She was wanting to…
Frances: She was just wanting to count.
Wanda: …repeat out. Right.
Frances: She was just wanting to count the boxes.
Wanda: But to figure out one [column] and then just add it again to find the next one.
Elena: …That's what Tracey did, right?
Frances: Yeah.
Wanda: So, she wanted to…it's one, two, three, four, five. She wanted to do five and then just double it to find the area, which is a valid method.
Frances: Right.
Facilitator: What does she mean by, "Can you just put a one up over that?"

This focus on examining students' mathematical thinking is supported by recent research on teacher learning and professional development (Ball & Cohen, 1999; Smith, 2001), as well as, by research on mathematics teaching and learning (Carpenter & Fennema, 1992; Schifter, 1998). For example, Rodgers (2002, Principles Underlying the Reflective Cycle section, para 5) argues that "student learning should guide teaching. Teachers' classroom practice must be seen as an integrated, focused response to student learning rather than as a checklist of teaching behaviors." Similarly, Ball and Cohen (1999) emphasize that teachers "need to become insightful in listening to and interpreting children's ideas about academic subjects" (p. 8). They go on to claim that "teachers need to learn how to read children to know more about what they are thinking and learning" (p. 9), as well as, "how to investigate what students are doing and thinking" (p. 11). In addition, research finds that having teachers attend closely to students' ideas can increase the opportunities for student learning. Specifically, longitudinal studies from the Cognitively Guided Instruction project identified gains in student achievement as teachers became more aware of their students' thinking and problem-solving abilities (e.g., Fennema et al., 1996). Moreover, related research explains that attention to student thinking is generative—as teachers learn about their students' thinking and apply this information during instruction, they learn even more about students' understanding and a cycle of both teacher and student learning is established (Franke, Carpenter, Levi, & Fennema, 2001). Following these claims, this particular video club was designed to support teachers in learning to attend to students' mathematical thinking.

While the facilitator had as the central goal supporting teachers in examining students' mathematical thinking, the teachers may have had other goals in mind. In an initial meeting, several of the teachers commented that they were interested in participating in the video club because it would allow them time to collaborate with their colleagues around a new curriculum they were using. In addition, the teachers mentioned being interested in participating in order to earn professional development credit from their school district. Further, several teachers expressed an interest in joining the club because they had prior experience working with video or with other professional development programs that were valuable, and they thought they would benefit from participating in the video club as well. The teachers clearly had different reasons for participating, but overall, the group agreed that the purpose was to understand how video might be used as a tool to reflect on mathematics teaching and learning.

3.2. Data

Data for this study include videotapes and transcripts of the video club meetings and videotapes and transcripts of two individual interviews with each teacher, as well as, with four elementary teachers from the same school who participated in a control group.[3] The first interview took place before the first video club meeting,[4] and the second interview took place following the final video club meeting. In the interviews, teachers viewed three 2–5 min long video segments of elementary mathematics lessons that were selected from published professional development programs (Hatfield & Bitter, 1995; Schifter, Bastable, & Russell, 1999a, b). Similar to the excerpts shown in the video club, the selected segments illustrated students in a range of classroom activities explaining their mathematical thinking. Both the teacher and the students were visible in each clip. After viewing the clips, the teachers were asked to respond to the prompt "What do you notice?" After the teachers responded to this question, the researcher asked, "Is there anything else you noticed?", until the teachers responded that there was nothing else they noticed. The same segments were viewed in the pre- and post-interviews.[5]

3.3. Data analysis

3.3.1. Analysis of interview data

To study individual development, qualitative methods, based primarily on fine-grained analyses of videotapes (Schoenfeld, Smith, & Arcavi, 1993), were used to examine teachers' analyses of classroom interactions. The first step in the data analysis consisted of analyzing the pre- and post-interviews for changes in teachers' analyses over time. The coding categories were initially created based on prior research (van Es & Sherin, 2002; Frederiksen et al., 1998; Hughes et al., 2000). However, the codes evolved to account for additional issues teachers raised in their analyses. Following is a description of the categories.

The first dimension concerned which Actor in the clip the teachers commented on (student, teacher, or other). The second dimension examined what the teachers noticed (mathematical thinking, pedagogy, climate, management, or other). We refer to this dimension as the Topic. Mathematical thinking refers to mathematical ideas and understandings. Pedagogy refers to techniques and strategies for teaching the subject matter. Climate refers to the social environment of the classroom (e.g. "That was a fun lesson" or "The students seemed like they really enjoyed that lesson"), and management refers to statements about the mechanics of the classroom (e.g. "The students aren't exhibiting off-task behavior while working in groups" or "The teacher handled that disruption really well"). The third dimension focused on how the teachers analyzed practice, or the Stance they adopted (describe, interpret, or evaluate). Describe refers to statements that recounted the events that occurred in the clip. Evaluate refers to statements in which the teachers commented on what was good or bad or could or should have been done differently. Interpret refers to statements in which the teachers made inferences about what they noticed. The fourth dimension focused on the level of Specificity teachers used to discuss events they noticed (general or specific), and finally, the fifth dimension, Video-focus, examined whether their comments were based on the video segment they viewed or on events outside of these segments (video or non-video based).

Two researchers jointly segmented the interview transcripts based on when the teachers raised a new issue about the video segment they viewed. This method draws from Jacobs and Morita's (2002) notion of dividing a transcript into "idea units," similar to what Grant and Kline (2004) refer to as "meaningful chunks." Once the transcripts were segmented, two researchers coded the transcripts independently along the five dimensions just described to determine if there were changes in teachers' analyses of classroom interactions over time. The transcripts were blind coded; the researchers did not know whose interview they were coding or if they were coding a control or participant transcript. Overall inter-rater reliability was initially 87%. Any differences between the two coders were discussed and resolved through

[3]The teachers in the control group taught grades 1, 2, 4, and 5. The fourth and fifth grade teachers chose not to participate in the video club for personal reasons, but they agreed to participate in the study as members of the control group. The school principal recommended the two other teachers. All four teachers had over ten years of teaching experience.

[4]Two teachers, Elena and Linda, joined the video club at the third meeting. The video interviews were conducted with them prior to their participation at that meeting.

[5]In order to compare individual teacher's analyses of video over time, we chose to have the teachers view the same clips. While the teachers' comments in the post-interview may have been influenced by viewing these clips previously, they were asked if they remembered seeing these clips and if they felt their comments were influenced by a previous viewing. Several of the teachers did not recall viewing the clips previously, and those who did recall viewing them reported that the previous viewing did not influence their comments.

consensus. Based on this analysis, a table was created indicating the number and percent of comments a teacher made relating to each dimension in the pre- and post-interview. These percentages were then examined to identify differences in teachers' analyses of classroom interactions from the pre- to the post-interview.

Statistical methods were also used to assess significance in the changes in teachers' analyses from the pre- to the post-interview. Specifically, a z-test for dependent samples was conducted to identify significant differences in the percentages of comments teachers made for a single aspect per dimension from the pre- to the post-interview. The z-test for dependent samples was selected because it is the standard statistical test for analyzing proportions of dependent and independent samples (Kirk, 1990). In particular, we examined differences in the percentages of the teachers' comments related to the student in the dimension of actor, mathematical thinking in the dimension of topic, and interpret, specific, and video-based in the final three dimensions.[6] Given that our research hypothesis is that post-interview percentages will be greater than the pre-interview percentages in these areas, we used a one-tailed z-test. Thus, z-values greater than 1.645, the critical value of the standard normal distribution at the 0.05 level, indicate statistically significant differences between pre- and post-interview percentages.

In addition, statistical methods were used to determine if the differences between the percentages of the comments of the teachers who participated in the video club were significantly different than the control teachers' percentages of comments in these same areas. Statistical significance was determined using a z-test for independent samples. Again, given that our research hypothesis is that the comments for teachers who participated in the video club will be greater than the comments of teachers in the control group in the areas previously identified, we used a one-tailed z-test, with z-values greater than 1.645 indicating statistically significant differences in the comments between the two groups.

3.3.2. Analysis of video club data

The second stage in the data analysis involved examining the video club data. First, the video club transcripts were segmented based on when a new topic was raised for discussion in this context (Grant & Kline, 2004; Jordan & Henderson, 1995). Then, each teacher's participation within each segment was coded along the same five dimensions, as had been done with the interview data. However, additional categories were added to the dimension of actor to reflect other actors that the teachers focused on in the video club meetings, specifically, self and curriculum developers (in addition to teacher, student, and other). For instance, in the meetings, the teachers would refer at times to their own teaching or their own thinking about mathematics. Therefore, it seemed important to create a code to clearly note when the self was the actor of focus, as opposed to the teacher in the clip. In addition, they would often comment on the intended goals of the curriculum developers. Rather than code such comments as other, we chose to create a new category within the dimension of actor to capture this focus.

Because of the dynamic nature of the conversations in the video club meetings, individual teachers may have participated in different ways within a given segment. In order to characterize how the individual teachers analyzed video in this context, however, each teacher received one code per dimension for each segment based on his or her primary focus. This primary focus was determined by looking at the context in which his or her comments were made. Prior research suggests that this is a valid method. Research on quantifying analysis of verbal data (Chi, 1997) highlights the value of conceptualizing segments at different grain sizes, while research on discourse analysis points to the importance of considering the broader context of the conversation in which individual utterances are made (Goffman, 1981; Hymes, 1974).

One researcher coded all 10 of the video club meetings in this way, while a second researcher coded five of the 10 meetings.[7] Again, the transcripts were blind-coded, with the two researchers coding independently of one another. Inter-rater reliability was initially 88%. Again, differences between the two coders were discussed and resolved through consensus. Once all of the segments were coded, percentages were calculated for each category within the five dimensions. This was done

[6]We hypothesized that the teachers' analyses would shift in these areas because, as stated previously, the video club was designed to help participants learn to interpret students' mathematical thinking as it appeared in video.

[7]The five meetings that were double coded were randomly selected but represented meetings from the beginning, middle, and end of the series of meetings.

for each teacher, for each meeting. Based on this analysis, a table was created indicating these percentages.

With these codes in mind, analysis of the video club data proceeded through two additional stages. First, to examine whether the teachers changed in their analyses of video from the beginning to the end of the series of meetings, the percentages for each dimension, per teacher, for the second meeting in which the teachers were present[8] and for the final video club meeting were compared. This allowed examination of whether the teachers talked about classroom interactions differently at the beginning of the series of meetings compared to the end of the series of meetings. Statistical methods were again used to test the significance of any changes in teachers' analyses from the early to the late video club meetings. Specifically, a z-test for dependent samples was conducted to examine the significance of the differences in the percentages of comments the teachers made in the areas of student, mathematical thinking, interpret, specific, and video-based, from the early to the late meetings.[9] Given that our research hypothesis is that the percentages from the late meeting will be greater than the percentages from the early meeting in these areas, we used a one-tailed z-test. As before, z-values greater than 1.645 indicate statistically significant differences in comments between early and late meetings.

Second, the percentages for each meeting were used to create characterizations of the teachers' overall participation in each of the ten meetings (see Table 2). We chose to use this method in order to gain a more holistic image of the teachers' analytic methods over the course of the series of meetings. In other words, these characterizations served to elucidate if teachers focused on a specific dimension within a category, regardless of which one, or if they were more varied in their analyses within each category, noticing a range of events and talking about them in multiple ways.

Table 2
Example coding of teacher's vision per dimension and overall for meeting

Actor	
Student	(9) 69%
Teacher	(2) 15%
Self	(1) 8%
Curriculum developers	(1) 8%
Other	(0) 0%
Vision on dimension	Narrow
Topic	
Mathematical thinking	(6) 46%
Pedagogy	(4) 31%
Climate	(3) 23%
Management	(0) 0%
Vision on dimension	Broad
Stance	
Describe	(4) 31%
Evaluate	(5) 38%
Interpret	(4) 31%
Vision on dimension	Broad
Specificity	
General	(6) 46%
Specific	(7) 54%
Vision on dimension	Broad
Video-focus	
Video-based	(7) 54%
Non-video based	(6) 46%
Vision on dimension	Broad
Overall vision	Broad

Note: Values in parentheses indicate the number of comments made in a particular category. The percentages follow.

Specifically, for each dimension, we identified whether a teacher had a single, primary focus or had multiple foci. When one of the percentages within a dimension was greater than 50%, then the dimension was coded as a Narrow focus. For instance, Table 2 shows a teacher who made 69% of her comments about the student, 15% about the teacher, 8% about herself, and 8% about the curriculum developers. She was considered to have a narrow focus on the actor dimension because greater than 50% of her comments were focused on the student. However, if a second category received a percentage whose difference was 10% or less than the category receiving greater than 50%, then the

[8]The first video club meeting was not used because the discussion focused on introductory and management issues so it was not representative of the kind of discussion that took place in the other video club meetings.

[9]Again, the z-test for dependent and independent samples was used because we wanted to understand, on average, if the teachers changed in their analyses of video over time. We recognize that there may be differences between individual teachers. However, we were interested in a statistical test that would provide us with an overall summary of the changes in teachers' analyses, and the z-test was appropriate for this purpose (Kirk, 1990).

dimension was coded as a Broad focus. For example, in Table 2, on the dimension of specificity, the percentages were 46% and 54%, respectively, so her vision on this dimension was characterized as broad. In contrast, on the dimension of topic, she had what we call a broad focus because she commented on several of the categories within this dimension, with none of the categories making up 50% or more of the comments she made. In particular, 46% of her comments were about mathematical thinking, 31% were about pedagogy, and another 23% were about climate.

At this point, within a particular video club, a teacher's vision was coded as broad or narrow on each of the five dimensions. If three or more of the dimensions were coded as broad, then the overall vision for the meeting was characterized as broad. If three or more of the dimensions were coded as narrow, then the overall vision for the meeting was characterized as narrow. Thus, the overall vision for the example in Table 2 was coded as broad because on four of the five dimensions, the teacher's comments were coded as broad in this meeting. These characterizations allowed us to examine patterns in each teacher's development across all five dimensions over the course of the series of meetings. This analysis was used then to understand the paths these teachers followed as they came to examine classroom video segments in new ways over time.

Finally, interview data was used to interpret findings from this analysis. Specifically, all of the teachers participated in a Mathematics History Interview and an Exit Interview. The purpose of the Mathematics History Interview was to understand the extent to which teachers' prior experiences as mathematics learners and teachers influenced how they perceived themselves presently, and in the future, as mathematics teachers and learners. In addition, the Exit Interview was intended to give the teachers an opportunity to share their impressions of their experience as participants in the video club. These interviews provided insights concerning the teachers' knowledge, beliefs, and experiences as teachers and learners of mathematics and were used to offer explanations of the findings herein.

4. Results

Data analysis reveals two key results. First, the data suggests that the teachers talked about classroom interactions in new ways from the beginning to the end of the series of video club meetings. Specifically, in both the interview and video club settings, the teachers' analyses of video shifted in terms of who and what they found noteworthy, how they analyzed these interactions, and their level of specificity. The second finding is that the teachers followed different paths as they learned to notice in new ways. In what follows, we elaborate on each of these findings.

Table 3
Video club teachers' overall analytic focus in the pre- and post-interview

	Pre-interview	Post-interview
Actor		
Student	(88) 59%	
Teacher	(57) 38%	(35) 24%
Other	(5) 3%	(5) 4%
Topic		
Math thinking	(41) 29%	(100) 69%
Pedagogy	(29) 19%	(17) 12%
Climate	(68) 45%	(24) 17%
Management	(5) 3%	(0) 0%
Other	(7) 5%	(3) 2%
Stance		
Describe	(69) 46%	(46) 32%
Evaluate	(42) 28%	(25) 17%
Interpret	(39) 26%	(73) 51%
Specificity		
General	(78) 52%	(37) 26%
Specific	(72) 48%	(107) 74%
Total	(150) 100%	(144) 100%

Note: Values in parentheses indicate the number of comments made in a particular category. The percentages follow.

4.1. Changes in teachers' noticing: interview results

Analysis of the video interviews reveals that the teachers who participated in the video club shifted in their noticing from the pre- to the post-interview. Table 3 highlights the four dimensions along which this shift occurred. For a detailed summary of the individual teachers' analyses of the video segments in the pre- and post-interview, see Appendix A.[10]

[10]Appendix A reveals that a large percentage of the teachers' comments in both the pre- and post-interview were based on the events in the video clips. Since the interview task specifically asked the teachers to comment on what they noticed in these clips, it was not surprising to see that over 90% of their comments were based on the events they viewed in the video segments.

Consider first the dimension of actor. Table 3 reveals that early on the teachers' comments were focused on the student in the pre-interview. However, the teachers increased in the percentage of comments they made about this actor in the post-interview, shifting from 59% to 72% of their comments focused on this actor. This shift was statistically significant at the .05 level (one-tailed z-test statistic $= 2.3$).

Second, in terms of the topic, the teachers' commented more on issues of climate in the pre-interview, but in the post-interview, their comments were directed to mathematical thinking. For example, one of the clips that the teachers viewed in the interview showed a group of students organizing sets of 25 cubes into groups of 100. After viewing the clip in the pre-interview, Frances responded, "Ok, that looked like an interesting lesson. They were really engaged, and seemed to be enjoying it a lot." Comments such as this, that an activity seemed interesting or that students were enjoying the work, reflects a focus on the overall classroom climate.

In contrast, in the post-interview, Frances's comments focused on the mathematics that the students were exploring and what they understood. "Well, they were doing patterns. They were counting by 25's… I didn't know if they were counting by, somebody said they were counting by 20… Apparently, they were counting by 25's and that was correct in the end, so I don't know if the child was confused, if she didn't get it, but the other children in the group did and obviously, they got to 400." Like Frances, all seven teachers' comments became more focused on issues of mathematical thinking in the post-interview. Furthermore, this shift was statistically significant at the .05 level (one-tailed z-test statistic $= 6.6$).

A third shift that took place concerned the dimension of stance. In the pre-interview, the teachers' remarks were generally descriptive in nature, but in the post-interview, they were more interpretive. In a descriptive statement, the teachers recounted the events in the clip as they unfolded over time. For instance, another clip the teachers viewed in the interviews showed a class discussing area and perimeter. In the clip, the students used manipulatives to create different representations of a pizza with a perimeter of 12, and then the class discussed which pizza they would prefer to purchase (e.g. which pizza appeared to have the largest area). When Yvette viewed this clip in the pre-interview, she remarked, "They are working on…area and perimeter…The use of the squares and the counting of the sides and then going back and seeing how many [the students] had used and what that would be." Here, Yvette names the mathematical topic of the lesson, area and perimeter, and lists the sequence of activities that comprise the lesson.

In the post-interview, rather than simply recount what she observed, Yvette interpreted what she noticed.

> They knew the vocabulary "arrangement" because when [the teacher] asked, "Could someone create a different arrangement?" there was no discussion…as to what he was meaning with that. They have the knowledge of area…For them to be understanding… "I want this pizza because it's the square units…" and then the distance around…they understood. I think I heard the word "perimeter," but they could tell the difference.

Yvette's comments above are interpretive in nature. She inferred that the students understood area because they could choose which pizza to order based on the area, even though each representation had the same perimeter. The other teachers also increased in the percentage of interpretive comments they made and came to focus on explaining the meaning behind events they noticed. Again, this shift was statistically significant at the .05 level (one-tailed z-test statistic $= 4.2$).

Fourth, in terms of specificity, while the teachers' comments in the pre-interview were both general and specific, their comments became more specific in the post-interview. For instance, the third clip the teachers viewed in the interview showed a student at the board explaining how she solved the problem $159 \div 13$. After viewing this clip, Elena responded quite generally that, "The teacher … asks questions of the students." This is considered general because she does not refer to the specific questions asked. Elena also commented on the clip in a specific manner: "[The student] had good recall…I think there was a key word that [she] used… landmark." Here, she recalled a specific term, namely "landmark," she heard the student use throughout the video segment.

In the post-interview, in contrast, Elena's comments were primarily specific in nature, providing detailed information about the events that occurred in the clip. She stated:

> [The student] seemed…to have a good understanding of partial products…She used the term

"landmark" [and explained] "We know it is a landmark…we know that 10 is a landmark and so all I have to do is add a zero to the 13 to get 130, and that was a close enough landmark for her…and when there was 26 left…or 29, it would go in 2 times." Then when she looked at the answer and said "oh, no" and she was able to add up… "I used 10 here and I used 2 here" to come up with the correct answer.

Elena once again noted that the student used the term "landmark," but here Elena described specifically how the notion of a "landmark" helped the student to solve the math problem. In addition, Elena provided many more details from the clip in the post-interview, such as quoting the student and referring to particular numbers in the problem. This shift was also statistically significant at the .05 level (one-tailed z-test statistic $= 4.4$).

Another way to examine the significance of the changes in the participating teachers' comments is to compare them to changes in the control group's comments. The statements made by the two groups of teachers were essentially the same in the pre-interview setting.[11] However, analysis of the control group interviews reveals that those teachers did not shift on any of the dimensions from the pre- to post-interview (see Table 4).

Further, the differences between the two groups of teachers' comments in the post-interview were found to be statistically significant. Using the z-test to examine differences in the percentages of comments made by independent samples reveals that in three areas, namely student, mathematical thinking, and interpret, there was a statistically significant difference in the nature of their comments in the post-interview at the .05 level. In particular, the one-tailed z-test statistic for the difference between the video club participants' and the control teachers' comments in the post-interview on student was 2.5; on mathematical thinking was 5.1; and on interpret was 2.0. For a detailed summary of the control teachers' comments in the pre- and post-interview, see Appendix B.

[11]The z test revealed a significant difference between the control teachers and video club teachers on the dimension of specificity in the pre-interview. This means that the two groups of teachers started off using different levels of specificity, with the control group being more specific in their comments early on. However, what is significant to this research is that the teachers who participated in the video club became more specific in their comments over time and that the control teachers' level of specificity did not change over time.

Table 4
Control teachers' overall analytic focus in the pre- and post-interview

	Pre-interview	Post-interview
Actor		
Student	(43) 57%	(54) 57%
Teacher	(31) 40%	(40) 42%
Other	(3) 3%	(1) 1%
Topic		
Math thinking	(29) 38%	(35) 37%
Pedagogy	(18) 23%	(23) 24%
Climate	(20) 26%	(33) 35%
Management	(2) 3%	(1) 1%
Other	(8) 10%	(3) 3%
Stance		
Describe	(33) 42%	(40) 42%
Evaluate	(15) 20%	(21) 21%
Interpret	(29) 38%	(35) 37%
Specificity		
General	(23) 30%	(31) 33%
Specific	(54) 70%	(64) 67%
Total	(77) 100%	(95) 100%

Note: Values in parentheses indicate the number of comments made in a particular category. The percentages follow.

These findings suggest that that the teachers who participated in the video club meetings developed in a particular way in terms of the kinds of comments they made about the events they noticed and how they talked about these events, from the pre- to the post-interview. Another important issue concerns how these teachers analyzed video in the video club context and whether or not the teachers made a similar shift throughout the series of meetings. We will now turn to a discussion of teachers' noticing in that context.

4.2. Changes in teachers' noticing: video club results

The video club was a different situation from the video interview in several ways. In contrast to the video interview setting, in the video club meetings, the teachers analyzed their own video and video of their colleagues. Because the teachers were analyzing video directly related to their own school, they had greater knowledge of their context (e.g., the curriculum being used, the students who were in the clips, the overall school and district climate). In addition, they analyzed video as a group, rather than individually as they had in the interview. Despite these differences, analysis reveals shifts that

Table 5
Teachers' overall analytic focus in second and final video club meetings teachers attended

	Early meeting	Late meeting
Actor		
Student	(36) 44%	(53) 70%
Teacher	(14) 17%	(5) 6%
Curriculum developers	(12) 15%	(9) 12%
Self	(16) 20%	(9) 12%
Other	(3) 4%	(0) 0%
Topic		
Math thinking	(41) 51%	(57) 75%
Pedagogy	(30) 37%	(15) 20%
Climate	(7) 8%	(4) 5%
Management	(3) 4%	(0) 0%
Stance		
Describe	(26) 32%	(17) 22%
Evaluate	(34) 42%	(12) 16%
Interpret	(21) 26%	(47) 62%
Specificity		
General	(31) 38%	(13) 17%
Specific	(50) 62%	(63) 83%
Video-focus		
Video-based	(26) 32%	(52) 68%
Non-video based	(55) 68%	(24) 32%
Total	(81) 100%	(76) 100%

Note: Values in parentheses indicate the number of comments made in a particular category. The percentages follow.

were quite similar to those in the interview context (see Table 5).[12]

Specifically, the teachers increased in the percentage of comments they made about the students and mathematical thinking over time. In addition, their comments became more interpretive and specific, and they based the majority of their comments in the video segments that were viewed. For a more detailed summary of the individual teachers' analyses in the early and late video club meetings, see Appendix C.

Again, using the z-test to examine differences in the percentages of comments made by dependent samples reveals that in all five areas in which we hypothesized there would be an increase, there was a statistically significant difference at the .05 level. In particular, the one-tailed z-test statistic for the difference between the teachers' comments in the early and late meetings on student was 3.17; on mathematical thinking; the one-tailed z-test statistic was 3.0; on interpret was 6.0; on specificity was 2.3; and on video-based was 5.6.

To be clear, the teachers' comments in the early video club meeting were somewhat different than those we described earlier from the pre-interview. For example, in the pre-interview, the teachers initially focused on issues of climate, whereas, in the video club setting, the majority of the teachers' initial comments were about mathematical thinking. In addition, their comments were both general and specific in the pre-interview context and mainly specific in the early video club meeting. To some extent, these differences are not surprising. The facilitators specifically asked the teachers to discuss mathematical issues in the meetings, so they were more likely to talk about these events in this context. Also, because the teachers viewed video from two participants' classrooms in the early meeting, they had detailed knowledge of the students and the curriculum, which they could use to make specific comments about what was viewed. Even with these initial differences, however, over time the teachers came to talk about video in the same ways in both the post-interview and the final video club meeting.

In summary, the teachers appear to have made important changes in their analyses of video both in the pre- and post-interviews, as well as, from the beginning to the end of the series of video club meetings. Further, the control teachers did not change in the same ways as the teachers who participated in the video club meetings. While this data reveals that the teachers made important shifts in their noticing, it does not reveal the nature of their development over time. In the next section, we propose three different trajectories the teachers followed as they began to examine students' mathematical thinking in new ways.

4.3. The paths along which teachers learned to notice

Thus far, we have argued that the teachers shifted in what they noticed and how they talked about these events from the beginning to the end of the series of video club meetings. An important issue to consider next is the pathways along which this development occurred. Research on expertise shows that learning does not take place in one easy step

[12] One teacher, Drew, a first-year teacher, was eliminated from this analysis because he made only two comments in the second meeting he attended and one comment in the final meeting. With so few comments, it was difficult to determine the nature of his noticing in this context.

Table 6
Learning to notice developmental paths

		Video Club 1	Video Club 2	Video Club 3	Video Club 4	Video Club 5	Video Club 6	Video Club 7	Video Club 8	Video Club 9	Video Club 10
Direct Path	Frances, Linda[a], & Yvette	Broad Vision						Narrow Vision			
		Multiple Actors Multiple Topics Multiple Stances Specific & General Video & Non-video →						Student Math Thinking Interpret Specific Video-based →			
Cyclical Path	Daniel	Broad Vision			Narrow Vision				Broad Vision		Narrow Vision
		Multiple Actors Multiple Topics Multiple Stances Specific & General Video & Non-video →			Student Math Thinking Interpret Specific Video-based →				Multiple Actors Multiple Topics Multiple Stances Specific & General Video & Non-video →		Student Math Thinking Interpret Specific Video-based
Incremental Path	Wanda & Elena[b]	Broad Vision		Narrowing of Vision (one or two dimensions at a time)							Narrow Vision
		Multiple Actors Multiple Topics Multiple Stances Specific & General Video & Non-video →		Student Math Thinking Interpret Specific Video based →							Student Math Thinking Interpret Specific Video-based

[a]Linda joined the club at the third meeting so her path begins at Meeting 3.
[b]Elena joined the club at the third meeting. Her path begins at Meeting 3 and resembles Wanda's vision at Meeting 3.

and that there is more than one trajectory to competence (Lajoie, 2003). Here, we examine the different ways teachers learned to notice in order to understand whether there are particular aspects of noticing reform pedagogy that are more or less accessible for teachers. Such analysis also highlights key video club meetings in which change occurred, which is useful for investigating features of the context that may influence teacher learning.

Our analysis reveals that the teachers followed three different paths as they learned to notice: *Direct Path, Cyclical Path*, and *Incremental Path* (see Table 6). To be clear, we do not intend to imply that these paths apply broadly, nor do we suggest that these are the only paths teachers might follow as they learn to notice students' mathematical thinking. Instead, we claim only that these paths illustrate key features of the development of teachers' noticing in this particular video club context. In what follows, we first describe the three paths in detail. Then, in the discussion, we examine several features of the context that may have interacted with the teachers' development.

4.3.1. Direct path

Development along what we call the *Direct Path* can best be characterized as a single qualitative shift in noticing. The three teachers on this path initially noticed a range of actors and topics and used different stances and levels of specificity. At one point, however, the way they talked about video shifted—they moved from a broad perspective on all dimensions, to a narrow perspective on all dimensions. Furthermore, this narrow perspective was of a particular nature: the teachers' comments became focused on the student and mathematical thinking, they adopted an interpretive stance, and they grounded their comments in the specifics of the events in the video clips. In addition, once they made this shift, they maintained this narrow perspective through the end of the series of meetings.

Consider, for example, Frances's development over the course of the ten meetings (see Table 7).[13]

In Meetings 1 through 6, Frances's method of analyzing video was generally broad in nature. For

[13]Table 7 illustrates the different stages in Frances's vision. In addition, it indicates whether Frances's vision is broad or narrow on each dimension, in each video club. And if it is narrow, the table identifies the specific focus. Furthermore, the table identifies whether Frances's overall vision for each meeting was characterized as broad or narrow. Recall that these characterizations of broad or narrow were based on the percentage of comments Frances made in each category, for each dimension. For the reader's information, these percentages and corresponding characterizations as broad or narrow, can be found in Appendix D. The percentages and corresponding characterizations for Yvette and Linda can be found in Appendices E and F.

Table 7
Frances's development on the direct path

Dimension	Stage 1							Stage 2		
	Video Club 1	Video Club 2	Video Club 3	Video Club 4	Video Club 5	Video Club 6	Video Club 7[a]	Video Club 8	Video Club 9	Video Club 10
Actor	Broad	Broad	Broad	Broad	Broad	Broad		Narrow (student)	Narrow (student)	Narrow (student)
Topic	Broad	Narrow (math thinking)	Broad	Broad	Broad	Broad		Narrow (math thinking)	Narrow (math thinking)	Narrow (math thinking)
Stance	Narrow (describe)	Broad	Broad	Broad	Broad	Broad		Broad	Narrow (interpret)	Narrow (interpret)
Specificity	Broad	Narrow (specific)	Narrow (specific)	Broad	Broad	Narrow (general)		Narrow (specific)	Narrow (specific)	Narrow (specific)
Video focus	Narrow (video-based)	Narrow (non-video based)	Broad	Broad	Narrow (video-based)	Broad		Narrow (video-based)	Narrow (video-based)	Narrow (video-based)
Overall vision	Broad	Narrow	Broad	Broad	Broad	Broad	—	Narrow	Narrow	Narrow

[a]Frances was absent in the seventh meeting.

instance, in Meeting 1, she spoke about various topics and actors and was both specific and general in her comments. While her remarks were mostly descriptive and based on the events in the video segments viewed, recall that her overall vision for this meeting is defined as broad because her comments were broad on three of the five dimensions of noticing. Her vision in Meetings 3 through 6 were similarly characterized as broad. Interestingly, her overall vision in Meeting 2, in contrast, was narrow. But because she did not sustain this narrow way of talking about the segments she viewed, this was not considered a major shift.

In Meeting 8, in contrast, Frances began to talk quite differently. Now, when she remarked on what she noticed in the video segments, she focused her comments on the students and their mathematical thinking. Her comments were interpretive in nature, specific, and based on the events in the clips. Yvette, and Linda made similar shifts—they spoke broadly about the video clips early on, and in Meeting 7 adopted a narrow approach that they maintained through Meeting 10.

Identifying the *Direct Path* suggests that a particular strategy for viewing video can be adopted and used holistically. In a sense, learning to examine classrooms in new ways for this group of teachers did not appear to be particularly difficult. While it took several meetings to adopt a new approach to talking about video records of practice, they did so on all dimensions at once, and they sustained this analytic method until the end of the series of meetings.

4.3.2. Cyclical path

A second path we identified is what we call the *Cyclical Path*. Whereas the teachers on the *Direct Path* adopted and maintained a narrow perspective, the *Cyclical Path* is characterized by a teacher cycling between a broad and narrow perspective over time. To illustrate the nature of development on this path, consider Daniel's comments throughout the series of meetings (see Table 8).[14]

In the first three meetings, Daniel's perspective was broad in nature. He talked about multiple actors and topics in the videos, and he reasoned about what he noticed in a variety of ways. In Meeting 4, Daniel's perspective became narrow in focus. His change here looks similar to the teachers who followed the *Direct Path* in that his comments shifted holistically along all dimensions of noticing. In particular, Daniel's comments were focused on the students and mathematical thinking, and he interpreted what he noticed. His comments were also specific and based on the events in the clips that

[14]The precise percentages and corresponding characterizations as broad or narrow can be found in Appendix G.

Table 8
Daniel's development on the cyclical path

Dimension	Stage 1			Stage 2				Stage 3		Stage 4
	Video Club 1	Video Club 2	Video Club 3	Video Club 4	Video Club 5	Video Club 6	Video Club 7	Video Club 8	Video Club 9	Video Club 10
Actor	Narrow (student)	Broad	Broad	Narrow (student)	Narrow (student)	Narrow (student)	Narrow (student)	Narrow (student)	Broad	Narrow (student)
Topic	Broad	Broad	Narrow (math thinking)	Narrow (math thinking)	Narrow (math thinking)	Narrow (math thinking)	Narrow (math thinking)	Broad	Broad	Narrow (math thinking)
Stance	Broad	Narrow (describe)	Broad	Narrow (interpret)	Narrow (interpret)	Narrow (interpret)	Narrow (interpret)	Broad	Broad	Narrow (interpret)
Specificity	Broad	Broad	Broad	Narrow (general)	Narrow (specific)	Narrow (specific)	Narrow (specific)	Broad	Narrow (specific)	Narrow (specific)
Video focus	Narrow (video-based)	Narrow (non-video based)	Broad	Narrow (video-based)	Narrow (video-based)	Narrow (video-based)	Narrow (video-based)	Broad	Broad	Narrow (video-based)
Overall vision	Broad	Broad	Broad	Narrow	Narrow	Narrow	Narrow	Broad	Broad	Narrow

the group viewed. Daniel continued to comment in this focused way about the video segments through Meeting 7. In addition, he was not only narrow on each dimension, but the content of his vision for each dimension was the same throughout these four meetings. For example, he did not comment primarily about mathematical thinking in one meeting and pedagogy in another. Across all four meetings, he was consistent in his noticing across all five dimensions, remarking on students' mathematical thinking, and his comments were interpretive, specific, and video-based.

Then, in Meetings 8 and 9, his comments broadened again. Specifically, while his remarks remained focused on the student, especially in Meeting 8, he also addressed a range of other actors, namely himself and the curriculum developers. When addressing himself as the actor, Daniel remarked on his own teaching, which was distinct from focusing on the teacher whose clip was being viewed. In addition, his comments focused on mathematical thinking, as well as, issues of pedagogy and classroom management. Further, Daniel interpreted and described the events he noticed, and his comments were both video and non-video based.

Then, in the final meeting, his perspective shifted again holistically, back to the narrow stance he adopted in Meetings 4 through 7. His remarks focused on the students and their mathematical thinking. Further, they were interpretive in nature, specific, and grounded in the events in the video segments. While it is not possible to know whether Daniel would have continued to discuss video in this way had there been additional meetings, it nevertheless appears to be a noteworthy shift as his perspective is again narrow on all five dimensions.

In sum, unlike the teachers on the *Direct Path*, who shifted holistically one time and then continued to analyze classroom interactions with a narrow perspective, Daniel appears to cycle between two different strategies over the course of the meetings. In particular, his vision was broad initially, then narrowed in Meeting 4, then broadened again in Meeting 8, and then narrowed again in the final meeting. In addition, when his perspective did narrow, the content of his vision was the same, noticing the students' mathematical thinking and interpreting these events in detailed ways based on the events in the video clips. It is this movement back and forth between two approaches, one that is narrow and another that is broad in scope, that characterizes this path.

4.3.3. Incremental path

Finally, we observed two teachers developing in a somewhat different way, what we call the *Incremental Path*. This path is distinct from the others in that these teachers appear to develop

Table 9
Wanda's development on the incremental path

Dimension	Stage 1		Stage 2						Stage 3	
	Video Club 1	Video Club 2	Video Club 3	Video Club 4	Video Club 5	Video Club 6	Video Club 7[a]	Video Club 8	Video Club 9	Video Club 10
Actor	Broad	Broad	Narrow (student)	Narrow (student)	Narrow (student)	Narrow (student)		Narrow (student)	Narrow (student)	Narrow (student)
Topic	Broad	Broad	Narrow (math thinking)	Narrow (math thinking)	Broad	Narrow (math thinking)		Narrow (math thinking)	Narrow (math thinking)	Narrow (math thinking)
Stance	Broad	Broad	Narrow (interpret)	Narrow (interpret)	Broad	Broad		Broad	Narrow (interpret)	Narrow (interpret)
Specificity	Broad	Narrow (specific)	Narrow (specific)	Broad	Broad	Narrow (specific)		Narrow (specific)	Narrow (specific)	Narrow (specific)
Video focus	Narrow (video-based)	Narrow (non-video based)	Narrow (video-based)	Narrow (video-based)	Broad	Broad		Narrow (video-based)	Narrow (video-based)	Narrow (video-based)
Overall vision	Broad	Broad	Narrow	Narrow	Broad	Narrow		Narrow	Narrow	Narrow

[a]Wanda was absent in the seventh meeting.

gradually in their noticing, as if they are changing step by step in how they analyze video over the course of the meetings. In particular, the teachers who followed this path began the video club with a broad vision toward commenting on the video excerpts. However, as early as Meeting 3, they adopted a more narrow perspective. While their overall vision was generally characterized as narrow throughout the remaining meetings, a closer look reveals that they first sustained a narrow focus on just two dimensions, actor and topic, and later moved step-by-step to a narrow vision on the dimensions of stance, specificity, and video-focus.

This path is defined as *Incremental* because in a sense, the teachers were integrating a narrow focus on one or two dimensions at a time, rather than holistically adopting a narrow focus on all dimensions at once. This contrasts sharply with the teachers on the *Direct Path*, who having shifted to a narrow approach, shifted on all dimensions at once and continued to use this perspective for analyzing video through the final meeting. Similarly, the step-by-step process of narrowing represents a different approach than is seen in the *Cyclical Path* in which a teacher generally cycles between two different approaches over the course of the video club.

To illustrate, consider Wanda's trajectory over the course of the video club meetings (see Table 9).[15]

Wanda began the video club with a broad vision. In Meetings 1 and 2, Wanda commented on a range of actors and topics, and she adopted multiple stances in her analyses. In addition, her comments were both general and specific in nature, and they were both video- and non-video based.

Between Meetings 3 through 8, Wanda's approach to analyzing video narrowed incrementally. Specifically, in Meeting 3, Wanda focused on the students in the clips and their mathematical thinking, and she maintained a focus on this topic and actor through the end of the series of meetings.[16] Next, in Meeting 6, Wanda's comments became more specific, but her comments continued to be broad on the dimensions of stance and video-focus. Then, in Meeting 8, Wanda's vision narrowed on the dimension of video-focus, as she shifted to

[15]Elena joined the club at the third meeting. Her path begins at Meeting 3 and resembles Wanda's vision at Meeting 3. The only difference is that rather than being Specific in her analyses at this point, her comments were General in nature. The precise percentages and corresponding characterizations for both Wanda and Elena can be found in Appendices H and I.

[16]While Wanda also adopted a narrow focus on the other three dimensions in Meeting 3, she did not maintain a narrow focus on these dimensions during this stage.

focusing her remarks on the events viewed in the segments. Finally, at the ninth meeting, Wanda's comments narrowed on the dimension of stance, as they were predominantly interpretive in nature. While Elena started at a slightly different point than Wanda, their trajectories were similar in the *gradual* nature in which they developed. This is quite different from the other video club participants who, having made a shift, did so on all dimensions simultaneously. Specifically, both of these teachers' vision appears to develop step-by-step, as their perspective shifted one or two dimensions at a time.

Of particular interest, is that the *content* of the changes for both teachers on the *Incremental Path* was similar. Specifically, the teachers initially maintained a narrow focus on the dimensions of actor and topic. This was followed by a narrowing of their vision on specificity, video-focus, and stance.

This similarity in content raises a number of questions concerning the relationships among the various dimensions of a teacher's vision. For example, is narrowing on the dimensions of actor or topic simply less difficult for teachers than narrowing on stance, specificity or video-focus? It certainly seems plausible that the actor and topic of a video segment tend to stand out to the viewer, thus individuals can attend to those particular aspects more easily as they view the video clips. In contrast, perhaps it is challenging for teachers to shift on the dimension of stance because an important part of teaching involves making judgments about what to do next in the classroom. Therefore, it may be difficult for teachers to step back and take time to examine what events occurred in the clips for the purpose of interpretation.

Similarly, shifting on the dimensions of specificity and video-focus may pose challenges. First, because teaching generally involves continual decision-making at a rapid pace, teachers may not be accustomed to honing in on the details of what occurred and to studying these events in an in-depth way. Second, because teachers have knowledge and beliefs about their specific contexts, it may be difficult to put that information aside and focus on the events in the video segments and use those details to inform their analyses.

A related question concerns how a shift on the dimensions of actor and topic might prompt shifts in other dimensions of a teacher's vision. For instance, once focusing on students' mathematical thinking, a teacher may find that a more specific type of analysis is needed than was initially the case. In other words, a prior shift in actor and topic might be a catalyst for change on the dimension of specificity. Similarly, in order to explore a student's idea in detail, a teacher may find that the video is an important resource. In these ways, the *Incremental Path* not only highlights a teacher learning trajectory that is quite different from the *Direct* and *Cyclical Paths*, it also raises important questions for future research concerning the relationships among the varied dimensions of a teacher's vision.

4.3.4. A silent participant

Before turning to a discussion of these results, we address the development of Drew, the first year teacher. Drew was eliminated from the analysis of the early and late video club meetings, as well as, from the analysis of the paths the teachers followed as they learned to notice because of the lack of data available from his participation in the meetings. However, the video interview data revealed that he made important developments from the pre- to the post-video interview. This leads to an important question to consider: how to explain the development of a teacher who was essentially a silent participant in the series of meetings. One explanation is that he could have been influenced in his thinking about teaching and learning outside of the video club because he was co-teaching with a veteran teacher, Elena, who had a reform-oriented perspective. It could be that she prompted him to think about teaching and learning outside of the video club meetings in similar ways to those being used in the meetings, so he was learning to reflect on teaching and learning in this way, through her influence. Perhaps as she adopted new ways of analyzing video and thinking about students' mathematical thinking, she was engaging him in this kind of thinking while teaching, as she viewed her role in the school as a promoter of new ways of thinking about mathematics teaching and learning. Another explanation is that he was what Lave and Wenger (1991) refer to as a legitimate peripheral participant. In other words, while he did not appear to actively participate in the video club, he had access to the practices of the community, and he had adopted this community's way of examining classroom interactions.

5. Discussion

The data presented here suggest that the teachers who participated in the video club meetings began to talk about classroom interactions in new ways over time. They did so both in the video interview and video club contexts. Evidence of change in these two contexts strengthens our argument that the teachers developed in their noticing. Specifically, in conversations with their peers in the video club meetings, the teachers began to attend to different features of the classroom videos over the course of the year. In addition, they changed in how they analyzed the events that stood out to them. The individual interviews confirmed that the teachers had adopted new ways of examining classroom interactions via video.

Furthermore, the changes that were observed were of a particular sort: the teachers increased their focus on interpreting students' mathematical thinking in detailed ways. This shift in focus is key to the successful implementation of mathematics education reform (NCTM, 2000). In particular, extensive research has shown that learning to interpret students' mathematical ideas helps teachers to effectively manage the complex demands of reform (Ball & Cohen, 1999; Franke et al., 1998).

In addition to examining changes in the teachers' thinking over time, we also identified three paths teachers followed as they learned to notice students' mathematical thinking. What is particularly important about this analysis is that it provides a window into the process by which teachers made this shift in thinking over time. Because we characterize teachers' noticing along multiple dimensions, it was important to look closely to see how and when teachers shifted along each dimension and whether this occurred in similar or different ways for all of the participating teachers. Such analysis also provides insight into the relationship among these dimensions of teachers' noticing. Prior research argues that identifying the pathways that teachers take as they reorganize their perceptions of teaching and learning is valuable for several reasons. First, the complexity of teachers' thinking suggests that there is not a single path to changing one's thinking or one's practice (Goldsmith & Schifter, 1997; Lajoie, 2003). Second, identifying multiple pathways has the potential to highlight key challenges that arise for teachers in transition (Lubinski & Jaberg, 1997; Simon, Tzur, Heinz, Kinzel, & Smith, 2000). Finally, understanding the different trajectories of teacher change better equips researchers and teacher educators to support teacher learning in the future (Franke et al., 1998; Hufferd-Ackles, Fuson, & Sherin, 2004).

5.1. Understanding the factors that influenced teacher learning

The results presented thus far are important in that they illustrate that the video clubs can be an effective forum for helping teachers learn to interpret students' mathematical thinking as it appears on video. Yet, two key questions remain: (a) what about the video club context influenced this change? and (b) why did the teachers follow different paths in their learning to notice? Before concluding, we highlight several characteristics of the video club meetings and of the participants that are likely to have had a strong influence on the results reported here. A more detailed analysis of these features and the related learning will be the focus of future research.

To begin, we first consider two dimensions of the video club, namely the video clips and the facilitator's roles, that influenced the particular way in which the teachers came to examine classroom interactions over time. Prior research cites the importance of the artifacts that communities examine together (Luria, 1928). In the case of the video club, we suggest that the video clips themselves served a pivotal role in influencing the teachers' thinking (Sherin, Linsenmeier, & van Es, 2006). As described earlier, the video club was designed to help the teachers learn to interpret students' mathematical ideas. Toward that end, each selected video segment viewed in the meetings had, as its central element, some aspect of student thinking—a student explaining a strategy, asking a question, or working with a partner. Thus, if the teachers were inclined to examine students' mathematical ideas, the clips, at the very least, gave them something to discuss.

The role of the facilitator is important to consider as well. Recent research on teacher learning and professional development reveals the important role the facilitator plays in supporting teacher learning (Heller, 1999; John, 2002; Le Fevre & Richardson, 2002). In the video club discussed herein, the facilitator adopted various roles, some of them more managerial in nature and others more substantive and connected to the goals of the club. For example, the facilitator was primarily responsible for setting up and concluding the meetings, managing the clips that were viewed, and determining how the time would be utilized. In addition, the facilitator asked teachers to comment on what they found noteworthy upon viewing a clip and used their ideas as the starting point for discussions. This design was chosen because prior research shows the value of using learners' knowledge and experiences as a starting point for learning (Cobb, 1994; Vosniadou & Brewer, 1989).

If the teachers did not raise issues related to students' mathematical thinking, the facilitator then prompted the group to discuss these issues. To accomplish this goal, the facilitator identified particular ideas that students raised in the clips and asked the group to comment on these issues, with a focus on interpreting students' understanding and using the video and transcripts as evidence for their interpretations. These facilitation methods, therefore, likely had a strong influence on teachers coming to focus their comments on interpreting students' mathematical thinking (Heller, 1999).

Here, we have made general claims about the ways that the video clips and the facilitator may influence the teachers' learning in the video club. However, these claims do not reveal the specific ways these features influenced their learning in this particular video club. To pursue this further, we now consider the interaction among these features of the video club with the different trajectories that these teachers followed.

One consequence of identifying the different paths the teachers followed is that they reveal specific points in time when the teachers shifted in their noticing (see Table 6). Interestingly, several teachers shifted in unison at particular points throughout the series of meetings. In addition, the content of their shifts at these points were the same (e.g. at Meeting 7, both Linda and Yvette shifted to a focus on the student as the actor and mathematical thinking as the topic, as well as, being interpretive, specific, and focused on the video. This suggests that understanding what occurred in the meetings where these changes took place can lead to important insights concerning how the context of the video club influenced the teachers' learning.

Following our previous discussion, we first examine the video clips in terms of the identified change points. Two issues are worth noting here. First, the facilitator was committed to showing clips of students' mathematical thinking from all of the teachers' classrooms. This was somewhat challenging as students shared their ideas in different forms and participated to varying degrees across the teachers' classrooms. As a result, some clips seemed to provide greater access to student thinking than other clips. This was the case with clips from Drew and Elena's classroom.[17] When we consider the nature of student thinking that occurred in this classroom, we see that there was a great deal of probing of students' ideas, students consistently shared their work at the board, and the class worked on mathematical ideas. Analysis of the change points reveals that each time video was shown from Drew and Elena's classroom, one or more veteran teachers experienced a shift in their noticing. In fact, all of the change points for the veteran teachers were meetings in which a clip from this same classroom was viewed. Thus, it appears that having greater access to students' ideas in the clips was an important component of the veteran teachers being able to shift their thinking. Clearly defining the features of clips that lead to substantive discussions of student thinking is needed to better understand the interaction between the clips and teacher development.

Interestingly, clips from Drew and Elena's classroom did not have the same influence on Daniel, the novice teacher. Instead, he shifted to a focus on students' mathematical thinking when he viewed clips from his own classroom. Thus, Daniel was generally narrow on viewing his own clips and broad when discussing clips from his colleagues' classrooms. One explanation is that viewing clips from other teachers' classrooms provided him with an opportunity to learn about a range of pedagogical issues, thus he maintained a broad perspective. In contrast, the insights he had about his students, the curriculum, and his own teaching goals allowed him to adopt a narrow perspective when clips from his classroom were shown in the video club meetings. This suggests that in addition to understanding the features of clips, future research also needs to consider other clip-related issues: how the clips are selected and ordered over the course of the meetings; whether the segments come from participants' classrooms or published materials; whether the teachers viewing themselves or their colleagues. Future research will explore these issues in an effort to understand how video mediates and interacts with teacher learning.

Now, we consider the roles participants played in relation to the change points. Previously, we discussed the important role of the facilitator and that the facilitator's strategies likely influenced the

[17]Recall that Drew and Elena co-taught a fourth grade class.

nature of the discussions in the meetings. In other research, we identified various roles that the facilitator and the teachers played in the meetings (van Es, 2006; Meiling, 2004). This research reveals that the facilitator generally maintained the same roles over the series of meetings, managing the direction of the meetings and establishing norms for exploring students' mathematical thinking. At the same time, the participants played important roles, also influencing the nature of the discussions in the meetings. For example, one role, the Critic, is defined as an individual who challenges ideas and interpretations. When we consider Meeting 7, the point at which Linda and Yvette on the Direct Path shifted in their noticing, we see that one teacher, Wanda, who often dominated the Critic role, and in this role was particularly evaluative, was not present. In her absence, several other teachers took on new roles, including that of the Critic. This, in turn, may have enabled those in attendance to engage in examinations of video in new ways.

Thus far, our discussion has focused on the interaction between teachers' learning and the video club context. In particular, we identified features of the club that may have influenced their learning. By attending to the points at which teachers changed, we can understand in a more detailed way how those design elements functioned to support or constrain teacher learning. While attending to ways the contextual features influenced learning is important, we also want to address how individual differences may have resulted in a teacher following a particular path. For example, the teachers who followed the *Direct* and *Incremental Paths* were all veteran teachers. As veterans, it is likely that it would be difficult for these teachers to immediately adopt a new way of analyzing classroom interactions, as they had been using an existing strategy for many years. This might explain why it took some time for these teachers to shift in their method of analysis, with the teachers on the *Incremental and Direct Paths* beginning to narrow in their analyses roughly two-thirds of the way through the series of meetings.

In contrast, the teacher on the *Cyclical Path*, Daniel, was a novice teacher. As a second year teacher, he had less established strategies for making sense of classroom interactions. Thus, it follows that it might be easier for Daniel to shift his focus, and in fact, this is what was observed. Daniel made his first shift to a narrow focus in Meeting 4. However, Daniel's lack of pedagogical expertise likely made it difficult for him to maintain this new perspective. As a new teacher, Daniel may have been interested in learning a variety of teaching methods. Therefore, he may have moved back and forth between a narrow and broad perspective, using the video club as a context to accomplish his goals of exploring a repertoire of pedagogical strategies, as well as, to learn to notice and interpret student mathematical thinking.

Furthermore, differences in individual teachers' beliefs may distinguish those veteran teachers who are on the *Direct Path* from those who are on the *Incremental Path*. While all of the teachers expressed personal beliefs about the nature of effective mathematics instruction (Sherin, Drake, & Wrobbel, 2006), two of the teachers, Wanda and Elena, consistently used the video club as a place to advocate for a specific pedagogical approach. In the case of Wanda, she frequently asserted that the teacher should control the classroom discourse, that students learn mathematics by applying formulas, and that the discipline of mathematics is about precision and accuracy. In contrast, Elena often stated that good mathematics teaching and learning included the teacher asking students questions to elicit their thinking, having students explain their methods for solving problems to the class, and engaging students in discourse with one another.

Recall that Wanda and Elena followed the *Incremental Path*, engaging early on in Meeting 3 with the goals of the video club by shifting to a focus on students' mathematical thinking. However, shifting on the dimensions of stance, specificity, and video focus took more time. We contend that the process of change for these teachers was incremental precisely because they viewed the video club as a context for advocating for particular teaching methods that reflected their beliefs. For example, these teachers would often evaluate or call into question the teachers' pedagogical approaches as viewed in the clip, offering advice on what the teachers should have done differently. This approach to video analysis is different from the interpretive stance that was promoted in the meetings. Similarly, rather than look closely at the specific events in the video, these teachers drew more from their own classroom experiences as a foundation for their comments. It was not until Meeting 10 that these two teachers' comments shifted on all dimensions, to interpreting students' mathematical thinking in detailed ways.

Here, we addressed several factors that may have influenced the paths teachers followed, namely, the nature of the clips and the roles of the facilitator and participants, as well as the teachers' knowledge, beliefs, and experiences. In addition, we explored unique aspects of the video clubs at the change points for each developmental path. By examining the meetings in which the nature of the teachers' comments changed, we begin to uncover ways that various features of the video club influence learning. However, future work needs to pursue this more fully in order to understand at a detailed level the interaction between these contextual features and the different ways teachers developed in their analyses of classroom interactions over time.

6. Conclusions and implications

We conclude by addressing additional questions that arise from this work. First, one may argue that it is not surprising that the teachers came to focus their analyses on students' mathematical thinking because the video club was designed to support them in doing just that. However, prior research shows that teachers do not typically respond in ways directed in professional development contexts, nor do they sustain these changes over time (Cohen, 1990; Cohen & Hill, 2000; Cuban, 1984; Porter, Garet, Desimone, Yoon, & Birman, 2000; Wilson, 2003). In fact, these findings show that it was hard for these teachers to examine video in the ways they were asked. Early on, several of the teachers often focused on actors other than the student, particularly, the teacher or the curriculum developers. In addition, they raised other topics, namely, pedagogy and climate, and they continued to describe or evaluate what they noticed. For several teachers, they adopted a narrow analytic perspective, but then they became more broad in their analyses before integrating all dimensions and ultimately becoming focused in their vision. In fact, this study reveals that it was not a simple matter for this group of teachers to talk about classroom interactions in the ways they were being prompted by the facilitator.

A second important question to consider is to what extent the teachers may have adopted a way of talking about teaching and learning simply because the facilitator wanted them to do so. In other words, were the teachers talking about classroom interactions in new ways without really learning anything new? The data for this study suggests this was not the case. First of all, early on in the series of meetings, they seemed to be willing to discuss these issues when the facilitator raised them but would soon shift the discussion to talk about other issues. Later in the series of meetings, they maintained a focus on interpreting students' mathematical thinking as they raised multiple interpretations for what they noticed in the clips, discussed them at greater length, and remained focused on these issues rather than shifting the discussion to other topics. In addition, the teachers began to take on the role of raising issues of students' mathematical thinking and prompting one another to discuss those issues in an in-depth way (van Es, 2006). The fact that they took on this role suggests that they genuinely wanted to understand these issues more deeply.

Further, in an interview conducted at the end of the series of meetings, all of the teachers commented that the video club helped them to think about classrooms in new ways. While they valued the meetings for providing them with images of one another's teaching, they also came to see that viewing video helped them learn more about their students' understanding. Further, the teachers commented that viewing video helped them to realize the importance of students having the opportunity to explain their ideas in class. This provided teachers with important insights into their students' thinking. In addition, the teachers also began to identify moments in their teaching that would be appropriate for further analysis in the video club context. Daniel, for example, turned to the researcher while videotaping his class and said, "This is a great clip for the video club meeting." The fact that this teacher could now identify moments in his classroom teaching where interesting student mathematical thinking was happening suggests that he was beginning to notice different kinds of noteworthy events in his classroom. For these reasons, it seems likely that the teachers came to think about classroom interactions in new ways.

At the same time, it may be unrealistic to expect all teachers to make fundamental shifts in how they reflect on what they see happening in classrooms after just 1 year of participating in a video club. Research on professional development shows that teacher learning needs to be sustained for long periods of time (Little, 1993), and research on teacher learning reveals that it is difficult to make substantive changes in teachers' knowledge and beliefs (Franke et al., 1998). Those teachers, who, like Daniel, began to identify interesting student thinking while teaching, seem to have made an important shift. Other teachers, such as Wanda, may have only been in the beginning stages of a longer-term development of learning to notice aspects of teaching and learning key to mathematics reform pedagogy. In this case, a 1-year program may have only been the start of what they need for substantive change. However, the findings here suggest that all the teachers were on their way to looking at classroom interactions in new ways.

Finally, a third point to address is how learning to notice in the video club context influences teachers' classroom practice. While this study does not examine the relationship between teachers' participation in the video club and their students' learning, it seems that participation in the meetings did influence the teachers' practice to some extent. First, the teachers remarked that participating in the meetings helped them learn that it is important to attend to students' thinking, as well as, to examine the teachers' pedagogy. One teacher commented, "The video club taught me to really look at, not so much what the teacher was doing, [but] what are the children actually doing at their seats while the teacher is teaching, and see if they are understanding and participating." Further, some of the teachers in this study appeared to slow down their instruction and asked more questions of their students while teaching.[18] This suggests that they were starting to value students sharing their ideas and probing students' thinking, both of which are important goals of mathematics education reform. Future research will examine more closely the influence of teachers participating in video-based professional development on their classroom practice.

[18]Preliminary analysis of the videotapes of the classroom sessions over the course of the year suggest that all seven teachers began to recognize and value students sharing their ideas, they slowed down the pace of instruction, and they asked substantively different types of questions later in the year that elicited students' thinking (van Es & Sherin, 2005).

Appendix A

See Table A1.

Appendix B

See Table B1.

Appendix C

See Table C1.

Appendix D

See Table D1.

Appendix E

See Table E1.

Appendix F

See Table F1.

Appendix G

See Table G1.

Appendix H

See Table H1.

Appendix I

See Table I1.

Table A1
Individual video club teachers' comments in the pre- and post-interview

Teacher	Actor	Pre-interview	Post-interview	Topic	Pre-interview	Post-interview	Stance	Pre-interview	Post-interview	Specificity	Pre-interview	Post-interview	Video-focus	Pre-interview	Post-interview
Linda	Student	(6) 38%	(14) 67%	Math thinking	(6) 38%	(14) 67%	Describe	(5) 31%	(5) 24%	General	(9) 56%	(8) 38%	Video-based	(16) 100%	(18) 86%
	Teacher	(10) 62%	(7) 33%	Pedagogy	(5) 31%	(3) 14%	Evaluate	(8) 50%	(5) 24%	Specific	(7) 44%	(13) 62%	Not video-based	(0) 0%	(3) 14%
	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%	General	(8) 44%	(5) 33%	Video-based	(18) 100%	(14) 93%
	Teacher	(4) 22%	(3) 20%	Pedagogy	(4) 22%	(3) 20%	Evaluate	(3) 17%	(1) 7%	Specific	(10) 56%	(10) 67%	Not video-based	(0) 0%	(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%	General	(7) 44%	(0) 0%	Video-based	(16) 100%	(12) 100%
	Teacher	(5) 31%	(3) 25%	Pedagogy	(5) 31%	(1) 8%	Evaluate	(6) 38%	(2) 17%	Specific	(9) 56%	(12) 100%	Not video-based	(0) 0%	(0) 0%
	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%	General	(18) 39%	(5) 19%	Video-based	(41) 89%	(25) 96%
	Teacher	(21) 46%	(7) 27%	Pedagogy	(8) 17%	(2) 7%	Evaluate	(11) 24%	(7) 27%	Specific	(28) 61%	(21) 81%	Not video-based	(5) 11%	(1) 4%
	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%	General	(7) 54%	(5) 25%	Video-based	(13) 100%	(17) 85%
	Teacher	(6) 46%	(7) 35%	Pedagogy	(4) 31%	(3) 15%	Evaluate	(5) 38%	(5) 25%	Specific	(6) 46%	(15) 75%	Not video-based	(0) 0%	(3) 15%
	Other	(0) 0%	(1) 5%	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%	General	(17) 74%	(10) 40%	Video-based	(22) 96%	(23) 92%
	Teacher	(5) 22%	(2) 8%	Pedagogy	(4) 17%	(3) 12%	Evaluate	(4) 17%	(3) 12%	Specific	(6) 26%	(15) 60%	Not video-based	(1) 4%	(2) 8%
	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%	General	(8) 42%	(4) 16%	Video-based	(19) 100%	(23) 92%
	Teacher	(7) 37%	(6) 24%	Pedagogy	(3) 16%	(2) 8%	Evaluate	(5) 26%	(2) 8%	Specific	(11) 58%	(21) 84%	Not video-based	(0) 0%	(2) 8%
	Other	(0) 0%	(1) 4%	Climate	(7) 37%	(4) 16%	Interpret	(2) 11%	(11) 44%						
				Management	(0) 0%	(0) 0%									
				Other	(0) 0%	(1) 4%									

Note: Values in parenthesis indicate the number of comments made in a particular category. The percentages follow.

Table B1
Individual control teachers' comments in the pre- and post-interview

Teacher	Actor	Pre-interview	Post-interview	Topic	Pre-interview	Post-interview	Stance	Pre-interview	Post-interview	Specificity	Pre-interview	Post-interview	Video-focus	Pre-Interview	Post-Interview
Debbie	Student	(9) 60%	(9) 35%	Math thinking	(1) 7%	(10) 38%	Describe	(5) 33%	(12) 24%	General	(5) 33%	(10) 38%	Video-based	(12) 80%	(19) 73%
	Teacher	(6) 40%	(17) 65%	Pedagogy	(7) 46%	(9) 35%	Evaluate	(2) 13%	(4) 24%	Specific	(10) 67%	(16) 62%	Non-video based	(3) 20%	(7) 27%
	Other	(0) 0%	(0) 0%	Climate	(1) 7%	(4) 15%	Interpret	(8) 53%	(10) 52%						
				Management	(0) 0%	(1) 4%									
				Other	(6) 40%	(2) 8%									
Rosa	Student	(13) 48%	(15) 63%	Math thinking	(12) 44%	(3) 13%	Describe	(15) 56%	(9) 38%	General	(9) 33%	(6) 25%	Video-based	(25) 93%	(24) 100%
	Teacher	(11) 41%	(9) 37%	Pedagogy	(4) 15%	(7) 29%	Evaluate	(5) 18%	(7) 29%	Specific	(18) 67%	(18) 75%	Non-video based	(2) 7%	(0) 0%
	Other	(3) 11%	(0) 0%	Climate	(9) 33%	(14) 58%	Interpret	(7) 26%	(8) 33%						
				Management	(0) 0%	(0) 0%									
				Other	(2) 8%	(0) 0%									
Nancy	Student	(7) 39%	(9) 47%	Math thinking	(9) 50%	(10) 53%	Describe	(5) 28%	(9) 47%	General	(3) 17%	(7) 37%	Video-based	(15) 83%	(16) 84%
	Teacher	(11) 61%	(9) 47%	Pedagogy	(4) 22%	(3) 16%	Evaluate	(7) 39%	(0) 0%	Specific	(15) 83%	(12) 63%	Non video-based	(3) 17%	(3) 16%
	Other	(0) 0%	(1) 6%	Climate	(4) 22%	(5) 26%	Interpret	(6) 33%	(10) 53%						
				Management	(1) 6%	(0) 0%									
				Other	(0) 0%	(1) 5%									
Helen	Student	(14) 82%	(21) 81%	Math thinking	(7) 41%	(12) 46%	Describe	(8) 47%	(10) 39%	General	(6) 35%	(8) 31%	Video-based	(17) 100%	(25) 96%
	Teacher	(3) 18%	(5) 19%	Pedagogy	(3) 18%	(4) 15%	Evaluate	(1) 6%	(9) 35%	Specific	(11) 65%	(18) 69%	Non-video based	(0) 0%	(1) 4%
	Other	(0) 0%	(0) 0%	Climate	(6) 35%	(10) 39%	Interpret	(8) 47%	(7) 26%						
				Management	(1) 6%	(0) 0%									
				Other	(0) 0%	(0) 0%									

Note: Values in parenthesis indicate the number of comments made in a particular category. The percentages follow.

Table C1
Individual video club teachers' comments in the early and late video club meetings

Teacher	Actor	Early meeting	Late meeting	Topic	Early meeting	Late meeting	Stance	Early meeting	Late meeting	Specificity	Early meeting	Late meeting	Video-focus	Early meeting	Late meeting
Linda	Student	(4) 45%	(7) 70%	Math thinking	(4) 44%	(9) 90%	Describe	(1) 11%	(3) 30%	General	(4) 45%	(1) 10%	Video-based	(5) 55%	(7) 70%
	Teacher	(5) 55%	(0) 0%	Pedagogy	(3) 33%	(1) 10%	Evaluate	(5) 56%	(1) 10%	Specific	(5) 55%	(9) 90%	Non-video based	(4) 45%	(3) 30%
	Self	(0) 0%	(1) 10%	Climate	(2) 22%	(0) 0%	Interpret	(3) 33%	(6) 60%						
	Curriculum developers	(0) 0%	(2) 20%	Management	(0) 0%	(0) 0%									
	Other	(0) 0%	(0) 0%												
Elena	Student	(4) 80%	(5) 83%	Math thinking	(3) 60%	(5) 83%	Describe	(2) 40%	(1) 17%	General	(2) 40%	(0) 0%	Video-based	(3) 60%	(5) 83%
	Teacher	(0) 0%	(1) 17%	Pedagogy	(1) 20%	(1) 17%	Evaluate	(1) 20%	(1) 17%	Specific	(3) 60%	(6) 100%	Non-video based	(2) 40%	(1) 17%
	Self	(1) 20%	(0) 0%	Climate	(1) 20%	(0) 0%	Interpret	(2) 40%	(4) 66%						
	Curriculum developers	(0) 0%	(0) 0%	Management	(0) 0%	(0) 0%									
	Other	(0) 0%	(0) 0%												
Wanda	Student	(6) 33%	(11) 69%	Math thinking	(9) 50%	(11) 69%	Describe	(7) 39%	(4) 25%	General	(7) 39%	(3) 19%	Video-based	(5) 28%	(11) 69%
	Teacher	(5) 28%	(1) 6%	Pedagogy	(8) 44%	(3) 19%	Evaluate	(7) 39%	(2) 12%	Specific	(11) 61%	(13) 81%	Non-video based	(13) 72%	(5) 31%
	Self	(5) 28%	(2) 12%	Climate	(0) 0%	(2) 12%	Interpret	(4) 22%	(10) 63%						
	Curriculum developers	(2) 11%	(2) 12%	Management	(1) 6%	(0) 0%									
	Other	(0) 0%	(0) 0%												
Daniel	Student	(7) 44%	(9) 64%	Math thinking	(7) 44%	(10) 71%	Describe	(8) 53%	(1) 7%	General	(8) 50%	(5) 36%	Video-based	(5) 35%	(9) 64%
	Teacher	(1) 6%	(2) 14%	Pedagogy	(7) 44%	(4) 29%	Evaluate	(5) 29%	(4) 29%	Specific	(8) 50%	(9) 64%	Non-video based	(11) 65%	(5) 36%
	Self	(5) 31%	(2) 14%	Climate	(1) 6%	(0) 0%	Interpret	(3) 18%	(9) 64%						
	Curriculum developers	(3) 19%	(1) 8%	Management	(1) 6%	(0) 0%									
	Other	(0) 0%	(0) 0%												
Frances	Student	(9) 47%	(12) 74%	Math thinking	(12) 63%	(13) 81%	Describe	(5) 26%	(4) 25%	General	(3) 16%	(2) 13%	Video-based	(6) 32%	(9) 56%
	Teacher	(0) 0%	(0) 0%	Pedagogy	(5) 26%	(2) 13%	Evaluate	(7) 37%	(2) 13%	Specific	(16) 84%	(14) 87%	Non-video based	(13) 68%	(7) 44%
	Self	(5) 26%	(2) 12.5%	Climate	(2) 11%	(1) 6%	Interpret	(7) 37%	(10) 63%						
	Curriculum developers	(4) 21%	(2) 12.5%	Management	(0) 0%	(0) 0%									
	Other	(1) 6%	(0) 0%												
Yvette	Student	(6) 43%	(9) 64%	Math thinking	(6) 43%	(9) 64%	Describe	(3) 21%	(4) 29%	General	(7) 50%	(2) 14%	Video-based	(2) 14%	(11) 79%
	Teacher	(3) 22%	(1) 8%	Pedagogy	(6) 43%	(4) 28%	Evaluate	(9) 65%	(2) 14%	Specific	(7) 50%	(12) 86%	Not video-based	(12) 86%	(3) 21%
	Self	(0) 0%	(2) 14%	Climate	(1) 7%	(1) 8%	Interpret	(2) 14%	(8) 57%						
	Curriculum developers	(3) 21%	(2) 14%	Management	(1) 7%	(0) 0%									
	Other	(2) 14%	(0) 0%												

Note: Values in parenthesis indicate the number of comments made in a particular category. The percentages follow.

Table D1
Frances's characterizations per dimension and per video club

	VC 1	VC 2	VC 3	VC 4	VC 5	VC 6	VC 7	VC 8	VC 9	VC 10
Actor										
Student	(3) 50	(9) 47	(1) 50	(7) 50	(4) 45	(4) 40		(16) 80	(5) 71	(12) 75
Teacher	(0) 0	(0) 0	(1) 50	(4) 29	(0) 0	(2) 20		(4) 20	(0) 0	(0) 0
Self	(2) 33	(5) 26	(0) 0	(2) 14	(3) 33	(1) 10		(0) 0	(1) 14	(2) 12.5
Curriculum developers	(0) 0	(4) 21	(0) 0	(1) 7	(2) 22	(2) 20		(0) 0	(1) 14	(2) 12.5
Other	(1) 17	(1) 6	(0) 0	(0) 0	(0) 0	(1) 10		(0) 0	(0) 0	(0) 0
	Broad	Broad	Broad	Broad	Broad	Broad		Narrow	Narrow	Narrow
Topic										
Math thinking	(3) 50	(12) 63	(1) 50	(6) 43	(4) 44	(5) 50		(16) 80	(5) 71	(13) 81
Pedagogy	(1) 17	(5) 26	(1) 50	(7) 50	(4) 44	(5) 50		(3) 15	(2) 29	(2) 13
Climate	(1) 17	(2) 11	(0) 0	(1) 7	(1) 11	(0) 0		(0) 0	(0) 0	(1) 6
Management	(0) 0	(0) 0	(0) 0	(0) 0	(0) 0	(0) 0		(0) 0	(0) 0	(0) 0
Other	(1) 17	(0) 0	(0) 0	(0) 0	(0) 0	(0) 0		(1) 5	(0) 0	(0) 0
	Broad	Narrow	Broad	Broad	Broad	Broad		Narrow	Narrow	Narrow
Stance										
Describe	(4) 67	(5) 26	(1) 50	(3) 21	(4) 45	(3) 30		(5) 25	(1) 14	(4) 25
Evaluate	(0) 0	(7) 37	(0) 0	(6) 43	(2) 22	(3) 30		(5) 25	(2) 29	(2) 13
Interpret	(2) 33	(7) 37	(1) 50	(5) 36	(3) 33	(4) 40		(10) 50	(4) 57	(10) 63
	Narrow	Broad	Broad	Broad	Broad	Broad		Broad	Narrow	Narrow
Specificity										
General	(3) 50	(16) 84	(2) 100	(7) 50	(5) 55	(3) 30		(5) 25	(2) 29	(14) 87
Specific	(3) 50	(3) 16	(0) 0	(7) 50	(4) 45	(7) 70		(15) 75	(5) 71	(2) 13
	Broad	Narrow	Narrow	Broad	Broad	Narrow		Narrow	Narrow	Narrow
Video-focus										
Video-based	(4) 67	(6) 32	(1) 50	(7) 50	(5) 55	(5) 50		(14) 70	(5) 71	(9) 56
Non-video based	(2) 33	(13) 68	(1) 50	(7) 50	(4) 45	(5) 50		(6) 30	(2) 29	(7) 44
	Narrow	Narrow	Broad	Broad	Broad	Broad		Narrow	Narrow	Narrow
Overall vision	Broad	Narrow	Broad	Broad	Broad	Broad		Narrow	Narrow	Narrow

Note: Values in parentheses indicate the number of comments made in a particular category. The percentages follow.

Table E1
Linda's characterizations per dimension and per video club

	VC 1	VC 2	VC 3	VC 4	VC 5	VC 6	VC 7	VC 8	VC 9	VC 10
Actor										
Student			(2) 100	(4) 45	Absent	(2) 40	(5) 83	(8) 80	(6) 60	(7) 70
Teacher			(0) 0	(5) 55		(2) 40	(1) 17	(2) 20	(2) 20	(0) 0
Self			(0) 0	(0) 0		(1) 20	(0) 0	(0) 0	(1) 10	(1) 10
Curriculum developers			(0) 0	(0) 0		(0) 0	(0) 0	(0) 0	(1) 10	(2) 20
			Narrow	Broad		Broad	Narrow	Narrow	Narrow	Narrow
Topic										
Math thinking			(2) 100	(4) 44		(2) 40	(5) 83	(8) 80	(6) 60	(9) 90
Pedagogy			(0) 0	(3) 33		(2) 40	(1) 17	(2) 20	(3) 30	(1) 10
Climate			(0) 0	(2) 22		(1) 20	(0) 0	(0) 0	(1) 10	(0) 0
Management			(0) 0	(0) 0		(0) 0	(0) 0	(0) 0	(0) 0	(0) 0
			Narrow	Broad		Broad	Narrow	Narrow	Narrow	Narrow
Stance										
Describe			(0) 0	(1) 11		(2) 40	(2) 33	(3) 30	(1) 10	(3) 30
Evaluate			(1) 50	(5) 56		(1) 20	(0) 0	(0) 0	(3) 30	(1) 10
Interpret			(1) 50	(3) 33		(2) 40	(4) 67	(7) 70	(6) 60	(6) 60
			Broad	Narrow		Broad	Narrow	Narrow	Narrow	Narrow
Specificity										
General			(1) 50	(4) 45		(3) 60	(2) 33	(9) 90	(7) 70	(9) 90
Specific			(1) 50	(5) 55		(2) 40	(4) 67	(1) 10	(3) 30	(1) 10
			Broad	Broad		Narrow	Narrow	Narrow	Narrow	Narrow
Video-focus										
Video-based			(1) 50	(5) 55		(2) 40	(4) 67	(7) 70	(6) 60	(7) 70
Non-video based			(1) 50	(4) 45		(3) 60	(2) 33	(3) 30	(4) 40	(3) 30
			Broad	Broad		Narrow	Narrow	Narrow	Narrow	Narrow
Overall vision			Broad	Broad		Broad	Narrow	Narrow	Narrow	Narrow

Note: Values in parentheses indicate the number of comments made in a particular category. The percentages follow.

Table F1
Yvette's characterizations per dimension and per video club

	VC 1	VC 2	VC 3	VC 4	VC 5	VC 6	VC 7	VC 8	VC 9	VC 10
Actor										
Student	(7) 78	(6) 43	(5) 71	(9) 69	(3) 38	Absent	(5) 63	(1) 100	(7) 58	(9) 64
Teacher	(1) 11	(3) 21	(2) 29	(2) 15	(2) 25		(1) 12	(0) 0	(1) 8	(1) 8
Self	(1) 11	(0) 0	(0) 0	(1) 8	(2) 25		(1) 12	(0) 0	(1) 8	(2) 14
Curriculum developers	(0) 0	(3) 21	(0) 0	(1) 8	(1) 12		(1) 12	(0) 0	(3) 25	(2) 14
Other	(0) 0	(2) 15	(0) 0	(0) 0	(0) 0		(0) 0	(0) 0	(0) 0	(0) 0
	Narrow	Broad	Narrow	Narrow	Broad		Narrow	Narrow	Narrow	Narrow
Topic										
Math thinking	(4) 45	(6) 43	(4) 57	(6) 46	(3) 38		(6) 75	(1) 100	(7) 58	(9) 64
Pedagogy	(1) 11	(6) 43	(2) 29	(4) 31	(2) 25		(2) 25	(0) 0	(5) 42	(4) 28
Climate	(3) 33	(1) 7	(1) 14	(3) 23	(2) 25		(0) 0	(0) 0	(0) 0	(1) 8
Management	(1) 11	(1) 7	(0) 0	(0) 0	(1) 12		(0) 0	(0) 0	(0) 0	(0) 0
	Broad	Broad	Narrow	Broad	Broad		Narrow	Narrow	Narrow	Narrow
Stance										
Describe	(3) 33	(3) 21	(0) 0	(4) 31	(5) 63		(1) 12	(1) 100	(2) 17	(4) 29
Evaluate	(3) 33	(9) 65	(3) 43	(5) 38	(1) 12		(2) 25	(0) 0	(3) 25	(2) 14
Interpret	(3) 33	(2) 14	(4) 57	(4) 31	(2) 25		(5) 63	(0) 0	(7) 58	(8) 57
	Broad	Narrow	Narrow	Broad	Narrow		Narrow	Narrow	Narrow	Narrow
Specificity										
General	(8) 89	(7) 50	(6) 86	(6) 46	(2) 25		(8) 100	(1) 100	(9) 75	(12) 86
Specific	(1) 11	(7) 50	(1) 14	(7) 54	(6) 75		(0) 0	(0) 0	(3) 25	(2) 14
	Narrow	Broad	Narrow	Broad	Narrow		Narrow	Narrow	Narrow	Narrow
Video-focus										
Video-based	(5) 55	(2) 14	(6) 86	(7) 54	(4) 50		(5) 63	(1) 100	(7) 58	(11) 79
Non-video based	(4) 45	(12) 86	(1) 14	(6) 46	(4) 50		(3) 37	(0) 0	(5) 42	(3) 21
	Broad	Narrow	Narrow	Broad	Broad		Narrow	Narrow	Narrow	Narrow
Overall vision	Broad	Broad	Narrow	Broad	Broad		Narrow	Narrow	Narrow	Narrow

Note: Values in parentheses indicate the number of comments made in a particular category. The percentages follow.

Table G1
Daniel's characterizations per dimension and per video club

	VC 1	VC 2	VC 3	VC 4	VC 5	VC 6	VC 7	VC 8	VC 9	VC 10
Actor										
Student	(7) 88	(7) 44	(1) 50	(19) 85	(7) 78	(8) 73	(4) 57	(6) 55	(4) 50	(9) 64
Teacher	(0) 0	(1) 6	(0) 0	(0) 0	(0) 0	(1) 9	(1) 14	(1) 9	(0) 0	(2) 14
Self	(1) 12	(5) 31	(1) 50	(1) 5	(1) 11	(1) 9	(2) 29	(1) 9	(3) 38	(2) 14
Curriculum developers	(0) 0	(3) 19	(0) 0	(1) 5	(1) 11	(1) 9	(0) 0	(2) 18	(1) 12	(1) 8
Other	(0) 0	(0) 0	(0) 0	(1) 5	(0) 0	(0) 0	(0) 0	(1) 9	(0) 0	(0) 0
	Narrow	Broad	Broad	Narrow	Narrow	Narrow	Narrow	Narrow	Broad	Narrow
Topic										
Math thinking	(3) 38	(7) 44	(2) 100	(13) 59	(7) 78	(8) 73	(4) 57	(5) 45	(4) 50	(10) 71
Pedagogy	(0) 0	(7) 44	(0) 0	(2) 9	(1) 11	(2) 18	(3) 43	(3) 27	(3) 38	(4) 29
Climate	(3) 38	(1) 6	(0) 0	(4) 18	(1) 11	(1) 9	(0) 0	(1) 9	(0) 0	(0) 0
Management	(1) 12	(1) 6	(0) 0	(1) 5	(0) 0	(0) 0	(0) 0	(1) 9	(1) 12	(0) 0
Other	(1) 12	(0) 0	(0) 0	(2) 9	(0) 0	(0) 0	(0) 0	(1) 9	(0) 0	(0) 0
	Broad	Broad	Narrow	Narrow	Narrow	Narrow	Narrow	Broad	Broad	Narrow
Stance										
Describe	(4) 50	(8) 53	(1) 50	(6) 27	(1) 11	(2) 18	(2) 29	(4) 37	(3) 38	(1) 7
Evaluate	(1) 12	(5) 29	(0) 0	(4) 18	(2) 22	(2) 18	(2) 29	(2) 18	(2) 25	(4) 29
Interpret	(3) 38	(3) 18	(1) 50	(12) 55	(6) 67	(7) 64	(3) 42	(5) 45	(3) 38	(9) 64
	Broad	Narrow	Broad	Narrow	Narrow	Narrow	Broad	Broad	Broad	Narrow
Specificity										
General	(4) 50	(8) 50	(1) 50	(13) 59	(3) 33	(3) 27	(2) 29	(5) 45	(2) 25	(5) 36
Specific	(4) 50	(8) 50	(1) 50	(9) 41	(6) 67	(8) 73	(5) 71	(6) 55	(6) 75	(9) 64
	Broad	Broad	Broad	Narrow	Narrow	Narrow	Narrow	Broad	Narrow	Narrow
Video-focus										
Video-based	(7) 88	(5) 35	(1) 50	(16) 73	(7) 78	(7) 64	(4) 57	(6) 55	(4) 50	(9) 64
Non-video based	(1) 12	(11) 65	(1) 50	(6) 27	(2) 22	(4) 36	(3) 43	(5) 45	(4) 50	(5) 36
	Narrow	Narrow	Broad	Narrow	Narrow	Narrow	Narrow	Broad	Broad	Narrow
Overall vision	Broad	Broad	Broad	Narrow	Narrow	Narrow	Narrow	Broad	Broad	Narrow

Note: Values in parentheses indicate the number of comments made in a particular category. The percentages follow.

Table H1
Wanda's characterizations per dimension and per video club

	VC 1	VC 2	VC 3	VC 4	VC 5	VC 6	VC 7	VC 8	VC 9	VC 10
Actor										
Student	(7) 54	(6) 33	(5) 100	(14) 70	(9) 64	(6) 60	Absent	(13) 59	(9) 56	(11) 69
Teacher	(0) 0	(5) 28	(0) 0	(5) 25	(1) 8	(2) 20		(2) 9	(3) 19	(1) 6
Self	(6) 46	(5) 28	(0) 0	(1) 5	(2) 14	(2) 20		(4) 18	(2) 12.5	(2) 12.5
Curriculum developers	(0) 0	(2) 11	(0) 0	(0) 0	(2) 14	(0) 0		(2) 9	(2) 12.5	(2) 12.5
Other	(0) 0	(0) 0	(0) 0	(0) 0	(0) 0	(0) 0		(1) 5	(0) 0	(0) 0
	Broad	Broad	Narrow	Narrow	Narrow	Narrow		Narrow	Narrow	Narrow
Topic										
Math thinking	(5) 38	(9) 50	(5) 100	(11) 55	(5) 36	(7) 70		(16) 72	(10) 63	(11) 69
Pedagogy	(3) 23	(8) 44	(0) 0	(4) 20	(2) 14	(2) 20		(3) 14	(5) 31	(3) 19
Climate	(4) 31	(0) 0	(0) 0	(4) 20	(6) 43	(0) 0		(2) 9	(1) 6	(2) 12
Management	(1) 8	(1) 6	(0) 0	(1) 5	(1) 7	(0) 0		(0) 0	(0) 0	(0) 0
Other	(0) 0	(0) 0	(0) 0	(0) 0	(0) 0	(1) 10		(1) 5	(0) 0	(0) 0
	Broad	Broad	Narrow	Narrow	Broad	Narrow		Narrow	Narrow	Narrow

Table H1 (*continued*)

	VC 1	VC 2	VC 3	VC 4	VC 5	VC 6	VC 7	VC 8	VC 9	VC 10
Stance										
Describe	(6) 46	(7) 39	(0) 0	(3) 15	(5) 36	(3) 30		(6) 27	(4) 25	(4) 25
Evaluate	(5) 38	(7) 39	(1) 20	(6) 30	(4) 28	(4) 40		(9) 41	(3) 19	(2) 12
Interpret	(2) 16	(4) 22	(4) 80	(11) 55	(5) 36	(3) 30		(7) 32	(9) 56	(10) 63
	Broad	Broad	Narrow	Narrow	Broad	Broad		Broad	Narrow	Narrow
Specificity										
General	(6) 46	(7) 39	(5) 100	(10) 50	(7) 50	(4) 40		(4) 18	(5) 31	(3) 19
Specific	(7) 54	(11) 61	(0) 0	(10) 50	(7) 50	(6) 60		(18) 82	(11) 69	(13) 81
	Broad	Narrow	Narrow	Broad	Broad	Narrow		Narrow	Narrow	Narrow
Video-focus										
Video-based	(8) 62	(5) 28	(4) 80	(15) 75	(7) 50	(5) 50		(15) 68	(9) 56	(11) 69
Non-video based	(5) 38	(13) 72	(1) 20	(5) 25	(7) 50	(5) 50		(7) 32	(7) 44	(5) 31
	Narrow	Narrow	Narrow	Narrow	Broad	Broad		Narrow	Narrow	Narrow
Overall vision	Broad	Broad	Narrow	Narrow	Broad	Narrow		Narrow	Narrow	Narrow

Note: Values in parentheses indicate the number of comments made in a particular category. The percentages follow.

Table I1
Elena's characterizations per dimension and per video club

	VC 1	VC 2	VC 3	VC 4	VC 5	VC 6	VC 7	VC 8	VC 9	VC 10
Actor										
Student			(4) 80	(4) 80	(4) 57	(5) 56	(7) 78	(9) 100	(4) 50	(5) 83
Teacher			(0) 0	(0) 0	(3) 43	(1) 11	(1) 11	(0) 0	(2) 25	(1) 17
Self			(1) 20	(1) 20	(0) 0	(3) 33	(1) 11	(0) 0	(1) 12.5	(0) 0
Curriculum developers			(0) 0	(0) 0	(0) 0	(0) 0	(0) 0	(0) 0	(1) 12.5	(0) 0
			Narrow	Narrow	Narrow	Narrow	Narrow	Narrow	Broad	Narrow
Topic										
Math thinking			(4) 80	(3) 60	(6) 86	(5) 56	(6) 67	(8) 89	(5) 63	(5) 83
Pedagogy			(1) 20	(1) 20	(1) 14	(3) 33	(2) 22	(0) 0	(3) 37	(1) 17
Climate			(0) 0	(1) 20	(0) 0	(1) 11	(1) 11	(0) 0	(0) 0	(0) 0
Management			(0) 0	(0) 0	(0) 0	(0) 0	(0) 0	(1) 11	(0) 0	(0) 0
			Narrow	Narrow	Narrow	Narrow	Narrow	Narrow	Narrow	Narrow
Stance										
Describe			(1) 20	(2) 40	(1) 14	(3) 33	(2) 22	(1) 11	(0) 0	(1) 17
Evaluate			(0) 0	(1) 20	(3) 43	(2) 22	(2) 22	(1) 11	(3) 37	(1) 17
Interpret			(4) 80	(2) 40	(3) 43	(4) 45	(5) 56	(7) 78	(5) 63	(4) 66
			Narrow	Broad	Broad	Broad	Narrow	Narrow	Narrow	Narrow
Specificity										
General			(4) 80	(2) 40	(3) 43	(1) 11	(4) 45	(4) 45	(4) 50	(0) 0
Specific			(1) 20	(3) 60	(4) 57	(8) 89	(5) 55	(5) 55	(4) 50	(6) 100
			Narrow	Narrow	Narrow	Narrow	Broad	Broad	Broad	Narrow
Video-focus										
Video-based			(4) 80	(3) 60	(3) 43	(5) 55	(5) 55	(8) 89	(5) 63	(5) 83
Non-video based			(1) 20	(2) 40	(4) 57	(4) 45	(4) 45	(1) 11	(3) 37	(1) 17
			Narrow	Narrow	Narrow	Broad	Broad	Narrow	Narrow	Narrow
Overall vision			Narrow	Narrow	Narrow	Narrow	Narrow	Narrow	Narrow	Narrow

Note: Values in parentheses indicate the number of comments made in a particular category. The percentages follow.

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