Using Digital Video to Investigate Teachers' In-the-Moment Noticing

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Abstract: Understanding teacher cognition – and in particular teacher noticing - poses significant challenges to researchers because of the ongoing nature of teaching. To overcome those challenges learning science researchers have used a variety of methods to help them understand how teachers reason and make decisions while teaching. In this symposium we describe a new digital technology that allows teachers to capture short video clips of classroom activity as they are teaching. The three papers explore different aspects of what we have learned about teacher noticing using this new technology. The first paper describes the potential of the camera to serve as a window into teachers' in-the-moment noticing. The second examines teacher noticing of their students' thinking. The third paper investigates our efforts to use clips captured using this methodology as the basis for video clubs in which teachers watch and discuss excerpts of one another's classrooms.

Introduction

Learning science researchers have, for many years, had a strong interest in teacher cognition. In particular, we would like to understand how teachers reason and make decisions in the act of teaching. Yet studying teacher thinking during instruction poses challenges for researchers. Because of the ongoing nature of teaching, it is not feasible to interrupt and ask teachers what they are thinking, what decisions they are considering, or what questions they have at the moment. Instead, researchers generally use other, less intrusive, approaches. For example, some researchers draw on observations of teaching to make inferences about a teacher's thinking (e.g., Schoenfeld, 1998). In this approach, researchers may try to construct a plausible chain of reasoning events that aligns with the teacher's actions and utterances during a lesson. Another approach involves asking teachers to reflect, after-the-fact, on their teaching. Using retrospective interviews, for instance, researchers may ask teachers to recall how they came to a particular decision or what alternatives they were considering at the time (Peterson & Clark, 1978). A third approach is to try to simulate teaching in some manner, for example, by showing teachers videos of instruction and asking them to comment (e.g., Copeland et al., 1994).

Each of these approaches, however, has limitations. Some of what a teacher thinks may not be visible in a teacher's actions or words, making it difficult to infer how a teacher is thinking simply by watching them. Also, in retrospective interviews, there is a risk that teachers will construct new interpretations of what took place during the interview, rather than recall their thinking during instruction. Similarly, even if simulations are carefully constructed to present teachers with situations that closely resemble instruction, teachers will lack the kind of detailed background information they use to make sense of real-world situations while teaching. It seems possible then that simulations will provoke a different kind of reasoning than takes place during instruction.

Whether or not these approaches suffice will depend in part on what aspect of teacher cognition the researcher is interested in. In our work, we are particularly interested in teacher noticing — in how teachers attend to and make sense of significant interactions during instruction. The classroom is a complex environment with many things happening at once. How does a teacher decide where to focus his or her attention? This issue is particularly important in light of efforts to reform mathematics and science education in the U.S. today. Teachers are called upon to continually assess the ongoing nature of lessons and to base their instruction, at least in part, on the ideas that students raise in class. In this context, how teachers direct their attention in the act of teaching is a critical area for researchers to investigate.

Given our interest in teacher noticing, the three approaches outlined above pose methodological challenges. First, it may be particularly difficult to observe a teacher "noticing;" noticing may not align with specific utterances or actions on the part of the teacher. In addition, because noticing is likely to take place in a fleeting manner it may

be hard to capture retrospectively. Furthermore, during simulations noticing may operate in a manner that is quite different than how it operates during instruction. How then, can we effectively study teacher noticing?

The purpose of this symposium is to discuss a new technology that we are using to study teacher noticing during the act of instruction. Our claim is not that this new technology should replace the methods discussed above. Rather, we believe that this new technology has the potential to add an additional, complementary, window into teacher thinking in action.

Exploring New Technology

Recently, a new class of video cameras have been introduced, cameras that are small enough to be mounted on a hat or a pair of eyeglasses. Of particular interest are cameras that offer "selective archiving" capabilities. Selective archiving allows the user to select moments of video to capture immediately after they occur.

Two cameras were used in the studies we present here: the Deja View CamWear 100 (Reich, Goldberg, & Hudek, 2004) and the POV 1.5 (V.I.O., 2009). Both cameras include two components: a small wearable camera approximately one inch long, and a recording module about the size of a cell phone that can be attached to a belt. The cameras record in a loop mode, and record over themselves after a short time. Pressing the "save" button on the recording module interrupts this process and saves the previous "loop" of video in a digital file — 30 seconds in the case of the Camwear 100 and 3 minutes in the case of the POV 1.5. In both cameras, the digital files are stored on a video card that is housed in the recording module. The files can easily be downloaded and viewed on a computer.

We developed the following two-part methodology to support our use of the new cameras. First teachers were asked to wear the camera during instruction and to press the record button "when something interesting happens." Occasionally we used variations of this prompt, but in general we asked teachers to focus on events that they found "interesting." In order to capture a complete record of the lesson taught, we also videotaped the classroom from the back of the room using a single stand-alone video camera. Second, on the same day, a researcher met with the teacher to review the set of clips that had been captured. To do so, we developed a process intended to increase the possibility of teachers drawing on their thinking during instruction, rather than creating retrospective accounts of their noticing. Specifically, a still image of the start of the captured clip was shown to the teacher. If the teacher could recall, just from the still image, why he or she captured the clip, then the video clip was not reviewed further and the teacher explained at that point why the clip had been captured. If the teacher could not recall why the clip was captured, then the clip was played but only until the point at which the teacher was able to recall his or her reason for capturing the clip. Teachers were also asked to generally describe their experiences using the camera that day, and whether the clips represent the events that the teachers had intended to capture. All interviews were videotaped and later summarized and partially transcribed.

The three papers presented in this symposium explore different aspects of what we have learned about teacher noticing thus far using this new technology. The first paper describes what we have found about the potential of the camera to serve as a window into teacher noticing during the instruction. The second paper looks closely at those clips teachers describe as being about student thinking. The third paper investigates our efforts to use clips captured using this methodology as the basis for video clubs in which teachers watch and discuss excerpts of each others' classrooms. While all three papers share methodology for studying teacher noticing, the specific data examined are somewhat different across the papers.

The format of the symposium will be as follows. We will begin with a brief introduction of the goals of our project as well as a demonstration of the wearable video camera and illustration of the kinds of data that were collected. Following this, there will be three 12-minute presentations of the papers. Next our discussant, Rogers Hall, of Vanderbilt University will provide comments on the papers. Dr. Hall's research explores the relationship between one's perception of events and how one participates in such events in a number of contexts including teaching. Finally, we will have 30 minutes for questions and discussion with the audience.

Freezing Time: What Mathematics and Science Teachers "See" While Teaching

Bruce L. Sherin, Miriam Gamoran Sherin

Our methodology was designed to tap directly into teachers' in-the-moment noticing in a way that has not been possible before. Specifically, the idea is that the clips themselves have the potential to reveal the kinds of events that teachers pay attention to during instruction. In addition, the hope is that teachers' comments in the interviews will provide valuable information concerning the ways in which noticing acts during instruction, for example, the extent to which noticing is a conscious process and the reasons behind teachers' attention to various kinds of

events. The goal of this presentation is to summarize and illustrate the data we have collected thus far, and then discuss the ways in which the methodology achieved its potential as well as problems we faced in the process.

Over the past two years, we have worked with 12 high school mathematics and science teachers who volunteered to use one of the cameras during instruction. The teachers taught in three different school districts in the Midwestern United States, all of which have diverse student populations. Most teachers used the cameras on three separate occasions; in all we conducted 39 interviews lasting approximately 45 minutes each. Each of these interviews was conducted after a teacher had worn a camera for one class session.

Overall, we found that teachers were able to use the camera to capture moments of instruction during teaching. About one-half of the teachers initially faced logistical problems using the camera — pressing the wrong button, or not pressing the button correctly, or other malfunctions of the camera. After one or two attempts at taping, however, these issues were generally resolved. The clips themselves illustrated a range of types of classroom events — whole group discussions, small group work, individual seatwork, and student presentations. Teachers reported to us that using the camera was not overly disruptive, either for themselves or for their students. This is also evident in the fact that teachers typically captured clips throughout a lesson; thus it was not the case that teachers captured clips only during the first 10 or 15 minutes of class at which point the demands of instruction took priority and camera use fell off.

On average, teachers captured 9 clips per 50 minute class period. We see this moderate number as suggesting that teachers were somewhat selective in capturing moments of instruction. Furthermore, the distribution of clips was not evenly spaced throughout a lesson. Teachers did not simply press the button every five minutes or so without regard to the specifics of the moment. Instead, teachers seemed to be sufficiently conscious of what they viewed as interesting to be able to push the button when an event stood out to them. Mason (1998) writes of the need for teachers to be "aware of their awareness." It is this kind of conscious awareness that we believe we have accessed with this methodology. Along the same lines, in many cases, teachers were able to recall what they had captured and why from looking only at the still image or a few seconds of video. Specifically, issues of student thinking, pedagogical techniques, and organizational issues were reported to have captured the teachers' attention.

Our methodology was not without problems, however. At times, teachers stated that they did not remember why a particular moment was captured. "I don't know why I pushed the button there, but I know I actively did because I can see myself [look down to press the button.]" In such cases, our methodology failed to tap into teachers' in-the-moment thinking about the noticed moment. Another concern is that there is some evidence that the act of wearing the camera and capturing moments may alter the very noticing that we intended to access. In particular, a few teachers suggested that using the camera heightened their sensitivity to noticing events that took place during instruction. "[Using the camera] made me more aware of what I thought was important." Thus while our efforts to access teachers' in-the-moment noticing appears to have been somewhat successful, there is reason to also be cautious as we move forward with the new technology.

Science and Mathematics Teachers' In-The-Moment Noticing: Attending to Student Thinking Within a Lesson and Beyond

Adam A. Colestock, Rosemary S. Russ

Recent reform efforts in science and mathematics education call for teachers to carefully attend and respond to their students' thinking in the classroom (Schifter, 2001; Hammer & Van Zee, 2006). To help teachers achieve this goal we must first understand their existing practices for attending to student thinking (Sherin, 2001; Levin, Hammer & Coffey, 2009). In this paper we investigate how the teachers in our sample attend to student thinking in the moments of instruction. In particular we draw on data collected with our new methodology to explore the question: "Why do particular moments of student thinking stand out as interesting to a teacher?"

For our analysis, we relied heavily on the teachers' reflections in the interviews. In particular, we used this data to explore teachers' ideas about the moments of student thinking they captured with the camera. First we reviewed the videotaped interviews and created descriptive summaries of what a teacher found interesting in each captured moment. Second, from those descriptions we identified and selected for analysis only those summaries in which the teacher discussed students' thinking as an important aspect of the reason they captured that moment. Of the 266 clip summaries we created, we identified 48% as relating to student thinking. We then looked across these summaries for evidence of why particular moments of student thinking stood out to the teacher. The four themes that emerged from the data suggest that a teacher's predictions and expectations for a particular lesson and their knowledge of their students' prior and future learning strongly influence the student thinking moments to which

they attend. Below we describe these four themes, highlight how they relate to the work of teaching, and provide illustrative examples from the data.

Theme 1: Attending to unanticipated moments of student thinking. In planning for a lesson, teachers use their prior teaching experience, their knowledge of typical student thinking, and their understanding of this particular group of students to anticipate students' reactions to different parts of the lesson, including what students might find routine or easy and what they might find challenging or puzzling (Schoenfeld,1998). Thus teachers may have a set of expectations about what student thinking will emerge in the lesson. In our data we found that teachers often described the moments they captured as being surprising or unexpected. For example teachers sometimes focused their discussion of a moment on a particular student question or insight that they had not anticipated, but were nonetheless pleased with encountering. For example, one teacher captured a moment because a student was able to solve algebraic equations involving absolute value signs, something they had not yet learned as a class. At other times teachers described moments when students had trouble with aspects of the lesson that they had assumed would be straightforward. For example, a science teacher captured a moment in which a student has difficulty answering what she considered to be a straightforward question. In describing the moment, she explained, "I asked what the function of the cell membrane, which we've spent the last 15-20 minutes talking about… It is literally written on the slide. We've said it like ten times. And I call on Jess and she has no clue."

Theme 2: Attending to the progress of the lesson. Another aspect of lesson planning involves considering the pace of a lesson, the sequence of ideas, and the location of important conceptual checkpoints within the lesson (Leinhardt, 1993). When discussing why they captured particular moments of student thinking our teachers sometimes discussed the ways in which a student's idea related to the progress of the lesson. Some teachers reported specifically waiting for students to express certain ideas and capturing them because they were important benchmarks for monitoring lesson progress. For example, one science teacher captured several different moments in which her students were accomplishing her instructional goal of making the connection between the pattern recognition activity that they were engaged in and the organization of the periodic table of elements. In describing one interaction with a student she explains, "He said, 'Oh, this is just like the periodic table!' and I was like 'Ding, Ding, Ding! Yes, that is exactly what you were supposed to [figure out].'" In contrast, other teachers captured moments when the lesson was not progressing as they had hoped, such as when students struggled with a crucial part of the lesson. For example, a mathematics teacher captured a moment in which a number of students were having difficulty understanding why it wasn't necessary to write the variable *t* as part of the answer when finding the rate of change of a parametric linear equation. She took this as evidence that she should think about doing more work to help students understand slopes and rates of change.

Theme 3: Attending to students' prior knowledge. In planning a lesson, teachers make assumptions about the relevant prior knowledge students possess, either from the everyday world or from previous formal teaching. In our data teachers frequently described moments as being interesting for what they revealed about a student's prior knowledge. For example, during a lecture about membrane structure one science teacher captured a moment in which a student asked what a solute was and another student provided a poor explanation. This moment of student thinking stood out to her because she was surprised that despite their previous coursework the students were unable to accurately describe a solute, "It was mind-boggling to me that they do not know what a solute is because these are kids who have come through two years of honors chemistry and physics…so I have to think about assumptions that I make about what they have learned in the past." In addition to capturing moments in which student prior knowledge was lacking or problematic, our teachers also captured moments in which students productively drew on prior knowledge by making connections with previously learned material. For example, the same science teacher captured another moment because a student applied his understanding of protein structures that he had learned in class a month and a half ago to a new context in a class research presentation about a particular disease.

Theme 4: Attending to opportunities for future learning. Often teachers plan to leverage the understandings that students develop in one day's lesson as starting points for future lessons in the curriculum. As a result, teachers may draw on their awareness of how ideas will be used in the future to be alert for opportunities to foreshadow or motivate future learning. Several teachers in our sample discussed the student thinking they captured in terms of its importance for future lessons. For example, one Calculus teacher captured a student question and subsequent discussion about how a particular integration technique might be similar to other methods they would encounter later in the week. He was pleased because the discussion allowed him to foreshadow upcoming lessons; he said, "it was an interesting question because we've just started talking about these solids of revolution today…but eventually we will get to what Eric was talking about." The teacher also indicated that he decided to bring the conversation to a certain point and then stop it because they would be returning to these ideas later, "If we were working on cross sections we could have spent more time with Derrick's response but as it was I thought Dylan answered the question sufficiently for today."

In this work we have examined why teachers may attend to particular aspects of student thinking in the moments of instruction and not others. In particular we discussed how their attention to events is influenced by (1) the student responses they anticipate (2) the conceptual checkpoints that help them determine when to proceed (3) the relationship of the current lesson to students' prior knowledge and (4) the opportunity of the thinking to foreshadow future learning. Furthermore, the methodology we employed to access that teacher thinking allowed us to see teachers in their own teaching situations — situations in which they have rich knowledge of the curriculum, the students' learning history, and the possible paths along which the lesson will progress. Our analysis suggested that this detailed knowledge creates expectations and predictions that substantially influence which moments stand out to teachers. Thus we suspect that other methodologies that do not allow teachers to draw on this rich set of knowledge – either because teachers are reflecting on classrooms that are not their own or because they are too far removed from the in-the-moment use of that knowledge in their own classroom – may be unable to access the kind of thinking about student thinking we describe here. In our future work we plan to continue to use this methodology to explore how teachers attend to their students' thinking during instruction and the role that this noticing plays in shaping their teaching practice.

Supporting Video Club Conversations Using Teacher-Selected Video Clips

Melissa J. Luna, Martha Mulligan, Miriam Gamoran Sherin, Janet Walkoe

The other papers in this symposium report on the kinds of classroom moments teachers captured using wearable cameras and the reasons teachers give for capturing such moments. In this paper, we take a different approach. Specifically, we investigate using these captured moments to support conversations among teachers around their students' ideas in science and mathematics.

This work takes place in a particular context we call video clubs. A video club is a type of professional development experience in which a group of teachers watch and discuss classroom video excerpts of their instruction with a particular focus or framework in mind (Frederiksen, Sipusic, Sherin, & Wolfe, 1998). For example, discussions in a video club context can be intentionally focused on a range of issues such as discourse, student thinking, or management (Tochon, 1999). The use of video is central to the work of a video club. Video is able to capture the complexity of a classroom and meaningfully reduce that complexity by providing a record of interactions (Borko, Jacobs, Eiteljorg, & Pittman, 2008). With video, teachers do not have to respond immediately as they do when they are teaching. Therefore, watching and discussing video opens up rich opportunities for teachers to reflect upon and analyze events that occur during teaching.

Prior research on the use of video clubs demonstrated that this is an effective context for helping teachers notice and respond to students' ideas in mathematics (e.g. van Es & Sherin, 2008). This paper extends such work to include science teachers. Furthermore, the use of a new video technology—the wearable camera—inspired a slightly different video club design. Other video clubs typically ask teachers to reflect on and discuss video that researchers have created of teachers' classrooms from footage from the back or side of the classroom (i.e., video from a researcher's point of view) (Sherin & Han, 2004). Here we instead asked teachers to reflect on and discuss classroom moments that the teachers themselves captured while wearing the Deja View or POV 1.5 camera. In doing so we had two main goals. First, we wanted to explore the ways in which clips from the wearable camera would support conversation around students' ideas. Would the fact that the video clips are exclusively from the teachers' point of view—and thus teachers are not visible—prompt consistent discussion of students' thinking? Second, we wanted to take a first step towards testing the feasibility and viability of making video clubs self-sufficient rather than relying heavily on a research team. In our experience, teachers do not usually have time to select excerpts from video of an entire class session. The wearable camera allows teachers to select the moments while they are teaching, thus removing this barrier. While we were still heavily involved in the logistics of the video clubs discussed here, we view this study as a valuable first step toward understanding what it would take for teachers to sustain a video club on their own.

The data in this study draw from our work with three separate video clubs. All video club meetings were videotaped.

(1) *High School Mathematics Video Club.* This video club consists of two experienced high school math teachers and a researcher-facilitator. Both teachers had previously participated in other video clubs to examine their students' mathematical thinking using classroom video. However, both were new users of the Deja View, which required them to capture classroom moments from their point of view for the video club discussion. Video club conversations focused on students' mathematical thinking.

(2) *Middle and High School Mathematics Video Club.* This video club consists of seven teachers with varying levels of teaching experience and a researcher-facilitator. Both the video club context and the POV 1.5 were novel for this group. At the start of the year the researcher videotaped the classroom and selected video clips for the video club discussions. Then later in the year, teacher-captured clips were used as the focus of

discussion in the video club. Video club conversations focused on classroom discourse around mathematics.

(3) *Elementary School Science Video Club.* This video club consists of four 3-5th grade teachers with varying levels of teaching experience and a researcher-facilitator. The video club context and the POV 1.5 were new for this group as well. However, this video club was different from the others in that it only used teacher-captured video clips for discussion. Video club conversations focused on students' ideas in science.

While the three video clubs reported here differed in important ways, they were similar in that they all included the use of a small wearable camera by teachers. We argue that because of its capability to capture classroom moments as they happen, this tool helped support interesting conversations in the video club as teachers reflected on and analyzed those moments. In our analysis of the video club discussions, three issues stand out as noteworthy.

First, the short time length of the videos appeared to influence the teachers' initial conversations around the video clips. Video club discussions in general focus on 5 to 10 minutes of video footage from a participating teacher's classroom. The Deja View and POV 1.5, however, capture short episodes of classroom events ranging from 30 seconds to 3 minutes. In using these shorter clips as a basis for discussion, we found that this placed greater burden on the teacher whose clip was being discussed. Essentially, these shorter clips strip away contextual details and thus require the presenting teacher to provide sufficient context in order to reconstruct the event for others. In addition, the other teachers had to articulate a range of questions as they made sense of the event. For example, after watching a 30-second clip of students from Richard's class, Richard and Nancy conversed back and forth until they arrived at a shared understanding of the moment. In the video students were discussing how they expanded the binomial $(x+5)^3$.

Nancy:	[So] her question was, how do you multiply all three binomials at once?
Richard:	Yeah that['s]… right.
Nancy:	She was like… "How do you multiply three times three times three?" …
Richard:	Right. Times three…
Nancy:	So I think she wanted an easier way…to expand that binomial, but you haven't gotten to that. …But I don't really understand what the presenter said…
Richard:	Well, …the first girl, her question was, … "How do you know? If you do the first and the second…or the second or the third first, which do you do?" And so what the girl in front said is that it doesn't matter because it is multiplication.

Together these two teachers carefully scrutinized the short captured clip in order to understand both what the student was asking and what the student was thinking about expanding binomials. This level of scrutiny required close attention to a classroom event on the part of both teachers.

Second, when teacher-captured clips were shown in the video club, presenting teachers had already "noticed" these moments during instruction. Thus, they typically came into the video club with an established interpretation of what had taken place in the captured moment. Perhaps using the camera during instruction heightened their noticing somewhat as well as deepened their interpretations in the moment. Interestingly, however, we found that teachers remained open to considering alternative interpretations of the events when viewed with colleagues in the video club. In fact, these new interpretations often built on the ideas the presenting teachers brought to the group. For example, upon capturing a classroom moment Nancy initially thought her students had understood the classroom talk around the equation $2x + 3$:

> I think I captured it because they [the students] *did* correct it [the problem]. …the girl did say "No wouldn't that be plus 3x?" But then I think something else happened after that. I think the presenter was convinced that she didn't need to say per week, … and she did change her mind.

However, while discussing her clip in the video club she realized something different:

> Well, ...now I noticed, as I think about this a little bit more, I'm thinking how she [the student] described her situation. I think it might have been just sort of tangled in semantics. [So] is *x* the total amount of money she saved, or is *x* the amount of money she saved that week? So, right now I don't know what it was…But I think that distinction matters and so this whole conversation, I don't know that anybody was clear on that.

This differs from other video clubs because teachers in those clubs did not capture the video clips themselves, and therefore, the first explicit interpretation of the event occurred in the context of the video club. We found that having teachers bring their in-the-moment interpretations into the video club discussion, as well as their willingness to consider other interpretations, added a level of depth to unpacking the classroom event captured.

Third, at times we noted a topic of discussion that was new for video clubs. Specifically, teachers occasionally mentioned and asked each other about the reasons why they had captured particular moments with the wearable cameras. For example, in the above example, the conversation later turned to why Richard captured the clip to begin with and he responded by explaining his thinking.

> Well, it's just really about multiplying, because I was thinking…a lot of times they don't quite understand a parenthetic expression is like, you can treat it like a number. And so, in terms of applying properties, she was saying it is just multiplication, it just doesn't really matter. So I think that is probably why.

We suspect this kind of talk occurred because we asked teachers to capture specific kinds of classroom events (e.g. "Capture students' algebraic thinking." or "Capture student ideas about magnets.") while wearing the Deja View or POV 1.5. Since all teachers from one video club had the same prompt, it is not surprising they were curious of each others' reasons for capturing a particular classroom moment, and thus turned the video club discussion towards unpacking the teachers' thinking and reasoning behind the moment of capture. While we want video club discussion to focus on what students are saying and doing, we recognize that unpacking teacher thinking can be a productive focus for a video club conversation helping teachers understand their own thinking in this process.

In conclusion, video clubs that utilize clips captured by teachers in the moments of instruction do support sustainable conversations in the video club context. We have found that such conversations involve teachers in collaborative sense making often elaborating on contextual detail not apparent in the clips, being open to alternative interpretations when viewing practice, and focusing on their own thinking about why they identified a particular classroom moment as worthy of capture.

Implications of this Methodology

Our purpose in presenting these papers as a set is to give the reader a sense of the potential of a new digital video technology – selective archiving – for the study of teacher noticing. For us, the power of these cameras lies in that they allow teachers to record particular moments of classroom interaction as the interactions unfold and without interrupting the on-going instruction. Although the full breadth of our research program with these cameras is still emerging, our use of this technology so far has provided a window into the kinds of data we might collect when working with teachers, the kinds of questions that data will allow us to answer, and the kinds of theoretical issues that data will inform.

In terms of the data we can reasonably expect to obtain with this methodology, we have seen that teachers can implement this selective archiving technology to collect moments that are meaningful to them, and that those moments can ground both personal reflections and discussions with colleagues. This process then provides us with data about the range of things that teachers notice during instruction, their own thinking about what they notice, and their colleagues' interpretations of that noticing. In terms of the questions this data can address, we see that this data may be useful for examining both population- and individual-level questions. For example, aggregating data across multiple teachers will allow us to answer questions about trends and patterns in teachers' in-the-moment noticing. In contrast, identifying moment-to-moment relationships between a single teacher's noticing as captured with the camera and that teacher's instruction may allow us to better understand the how's and why's of a successful teacher's noticing. The answers to both kinds of questions will be crucial for understanding and impacting teacher noticing. Finally, in terms of the theoretical issues our data might inform, we have found that just the possibility of capturing teachers' in-the-moment noticing has forced us to examine our underlying conceptualization of teacher noticing. For example, the methodology raises questions about whether the noticing that is conscious - and thus captured with this data - and more tacit noticing are the result of similar or distinct cognitive processes. In addition, data from teacher reflections suggests that we as researchers may need to explore the possibility that noticing is not isolated to a single event in time but is rather distributed across multiple episodes. While we do not yet have definitive answers to all these questions, our preliminary analysis of the data suggests that this new technology will allow us to make substantial contributions to the study of teacher noticing – both methodologically and theoretically - in the near future.

References

Ball, D. L. (1997). What do students know? Facing challenges of distance, context and desire in trying to hear children. In B. J. Biddle, T. L. Good, & I. F. Goodson (Eds.), *International handbook of teachers and teaching* (Vol. II, pp. 769-818). Dordrecht: Kluwer.

Borko, H., Jacobs, J., Eiteljorg, E., Pittman, M.E. (2008). Video as a tool for fostering productive discussions in mathematics professional development. *Teaching & Teacher Education, 24*(2), 417-436.

Copeland, W. D., Birmingham, C., DeMeulle, L., D'Emidio-Caston, M., & Natal, D. (1994). Making meaning in classrooms: An investigation of cognitive processes in aspiring teachers, experienced teachers, and their peers. *American Educational Research Journal*, *31*(1), 166-196.

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

Hammer, D. & van Zee, E. (2006). *Seeing the Science in Children's Thinking.* Portsmouth, NH: Heinemann.

Leinhardt, G. (1993) On teaching. In R. Glaser (Ed.), *Advances in Instructional psychology* (Volume 4, pp. 1-54). Hillsdale, NJ: Erlbaum.

Levin, D. M., Hammer, D., & Coffey, J. E. (2009). Novice teachers' attention to student thinking. *Journal of Teacher Education, 60(2),* 142-154.

Mason, J. (1998). Enabling teachers to be real teachers: Necessary levels of awareness and structure of attention. *Journal of Mathematics Teacher Education. Vol 1(3) 1998, 243-267.*

Peterson, P. L. & Clark, C. M. (1978). Teachers' reports of their cognitive processes during teaching. *American Educational Research Journal, 15*(4), 555-565.

Reich, S., Goldberg, L., & Hudek, S. (October, 2004). *Deja View Camewear Model 100*. Paper presented at the First ACM workshop on Continuous Archival and Retrieval of Personal Experiences. New York.

Schifter, D. (2001). Learning to see the invisible: What skills and knowledge are needed to engage with students' mathematical ideas? In T. Wood, B. S. Nelson, & J. Warfield (Eds.), *Beyond classical pedagogy: Teaching elementary school mathematics* (pp. 109-134).Mahwah, NJ: Lawrence Erlbaum Associates.

Schoenfeld, A. H. (1998). Toward a theory of teaching-in-context. *Issues in Education, 4*(1), 1-94.

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

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

Tochon, F. V. (1999). *Video study groups for education, professional development and change*. Madison, WI: Atwood Publishing.

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

V.I.O., Inc. (2009). POV. 1.5. Retrieved September 21, 2009 from http://www.vio-pov.com.