

Professional Vision in Action:
An Exploratory Study

**Miriam Gamoran Sherin, Rosemary S. Russ,
Bruce L. Sherin, & Adam Colestock**
Northwestern University

For the past two decades, much of mathematics teacher education and professional development has focused on helping teachers develop their subject matter knowledge and pedagogical content knowledge (Shulman, 1987). The idea has been that teachers need a deep understanding of mathematics, and one that is pedagogical in nature. More recently, researchers and teacher educators have begun to consider how teachers apply this knowledge in planning for and carrying out instruction (Franke, Carpenter, Levi, & Fennema, 2001; Lampert, 2001). Of particular concern are the ways in which teachers employ knowledge in the very moments of instruction, when they are leading discussions or interacting one-on-one with students.

Given the current context of reform in the U.S, the in-the-moment demands that mathematics teachers encounter have become increasingly great. Rather than carefully follow a pre-planned lesson, mathematics teaching today calls for a great deal of on-the-fly decision making (Smith, 1996; Wallach & Even; 2005). Teachers must be able to quickly diagnose students' thinking, decide whether or not to pursue an unexpected tangent, and continually assess the progress of an on-going lesson. Other researchers have also noted the importance of this kind of expertise both

Miriam Gamoran Sherin and Bruce L. Sherin are associate professors, Rosemary S. Russ is a post-doctoral fellow, and Adam Colestock is a graduate student, all with the School of Education and Social Policy at Northwestern University, Evanston, Illinois.

for teaching in general (e.g. Berliner, 1994; Rodgers, 2002), and more specifically for the teaching of mathematics today (Ball, & Cohen, 1999; Chamberlin, 2005).

Many kinds of knowledge must be brought to bear by teachers during the moments of instruction. In prior work we have focused on one aspect of this knowledge that we call *professional vision*. Goodwin (1994) coined the term professional vision to characterize the specialized way that members of a professional group look at the phenomena of interest of them. Thus, a detective's professional vision allows him to make sense of a crime scene, and an architect's professional vision allows the architect to recognize key features in the design of buildings. A teacher's professional vision, on the other hand, is concerned with the phenomena of classroom interactions. More specifically, teachers' professional vision involves the ability to notice and interpret significant interactions in a classroom (Sherin, 2001, 2007).

The study of teachers' professional vision poses some unique challenges. The application of professional vision happens in a manner that is fleeting, and that is distributed through the moments of instruction. Because of the ongoing nature of instruction, it is not realistic to expect that one could "pause" instruction momentarily, ask a teacher what he or she is attending to at that moment, and then continue uninterrupted. To address this problem, we have relied extensively on video as a tool for studying professional vision. We asked teachers to look, retrospectively, at short excerpts of video that we had collected of their own teaching, or the teaching of others.

In this article, we report on our attempts to employ a new technological solution to study professional vision in action. We have recently begun to explore the use of a new kind of tiny wearable video camera that can be worn by teachers in order to capture classroom events from their own perspective. Our purpose here is to, first, draw some initial conclusions about the viability of this new technological solution as a means through which to study professional vision, and to perhaps enhance it. Second, we will report on some of our first attempts to use the camera to answer basic questions about the nature of teachers' professional vision as it is applied in action. Working with one high school mathematics teacher we ask: (a) What kinds of events stand out to the teacher during instruction? and (b) To what extent can the teacher articulate why those events are significant?

Using Video To Study and Enhance Professional Vision

Several attributes of video indicate that it might be a valuable media

for exploring teachers' professional vision. First, video appears to capture much of the complexity of classroom interactions. While the perspective of the videographer certainly influences what aspects of classroom interactions are portrayed (Goldman-Segall, 1998), video has the potential to richly represent classroom environments and the multiple actions that take place simultaneously. Second, video provides a permanent record that can be viewed repeatedly. Thus unlike a live moment of teaching that is over in an instant, video allows one to preserve an interaction for later consideration. And rather than having one's memory—which can vary—serve as the record, video documents what took place in an unwavering format (McAdams, 1993). Third, when viewing video, teachers do not need to respond with the immediacy that is typically required during instruction. Instead watching video can be a time for teachers to engage in extended reflection on what is taking place in a lesson and why.

Given these attributes, we hypothesized that video has the potential to provide both a means of studying professional vision and of developing teachers' professional vision. In particular, in prior research, we explored the possibility of using *video clubs* as a context in which to study and attempt to enhance professional vision. In video clubs, groups of teachers watch and discuss excerpts of video from their classrooms. We speculated that, by reflecting on video outside the demands of instruction, teachers might establish new ways of noticing and interpreting classroom interactions.

Much of our research has involved organizing year-long video clubs focused on mathematics teaching and learning. Moreover, several of the video clubs we studied were designed with the goal of helping teachers learn to closely attend to students' mathematical thinking. Towards this end, a researcher would typically videotape one of the participating teacher's classrooms and then select a 5-7 minute excerpt to show at the next meeting. While we often solicited teachers' help in choosing clips for the video club, the overwhelming response was that it was simply too time-consuming for teachers to review a videotape prior to the video club meeting. Also noteworthy is that a facilitator typically attended each video club meeting and prompted the teachers to discuss what stood out to them in the video and to look closely at the mathematical ideas raised by students in the video clips.

Analysis of teachers' discussions in the video clubs have been reported elsewhere (Sherin, 2007; Sherin & Han, 2004; van Es & Sherin, 2008). Of particular interest is that, over time, teachers came to pay increased attention to students' thinking in the video clips. Thus, for example, Sherin and Han (2004) reported that teachers initially commented on pedagogical issues that were apparent in the video clips,

describing what the teacher in the video was doing or saying. Later on, however, teachers' attention became more focused on the mathematical ideas raised by students in the video. At the same time, the teachers developed a number of strategies for interpreting students' thinking including discussing the reasoning behind students' methods, comparing different students' ideas, and looking across a lesson at the development of a particular concept. In related work, van Es & Sherin (2008) found that it was common for teachers in a video club to initially evaluate what they viewed, or to simply list key events they identified. Over the course of the year, however, teachers began to more often interpret the events that they noticed, and increasingly used video as a source of detailed evidence for making sense of these events.

Issues in the Study of Teachers' Professional Vision

While this research has yielded valuable information about the character of teachers' professional vision, a number of key issues remained. First, our typical approach to videotaping in a classroom involved setting up a camera in the back of the room, viewing whole-class interactions from a fairly wide angle, and occasionally zooming in to capture writing on the board, an explanation from the teacher, or a question from a student. While this approach allowed us to capture much of the activity taking place in a lesson, it represented a somewhat distorted view of what a teacher sees during instruction. On the video we see mainly the back of students' heads (depending on the arrangement of desks in the room) while the teacher's face is shown from a frontal view. To truly study teachers' professional vision, it seemed that we might instead need to show teachers video that represented classroom interactions from their perspective.

Second, as mentioned above, the teachers with whom we worked found it difficult to find the time to select video clips to show their colleagues. This resulted in a critical part of the video club design—selecting clips—remaining under the control of the researchers. And while it might be the case that as researchers we have the expertise to select clips that will likely stimulate discussion among teachers (Linsenmeier & Sherin, 2007), the clips nevertheless represented what the researchers found interesting, rather than the teachers. We wondered if there might be a way to shift this responsibility, and to put the video in the hands of the teachers in a way that was manageable for them.

Third, in studying professional vision in video clubs, we recognized that we were investigating a particular aspect of teachers' professional vision—the way that teachers notice and interpret classroom interactions after the fact, for example, as they appear on video. And as discussed

above, while we believe that video provides a useful representation of classroom events, we recognized that professional vision as it is used by teachers in the moment of instruction, what we are calling “professional vision in-action,” might be somewhat different. Because video affords the luxury of time, the way that teachers attend to classroom events via video might be quite different from the sort of instantaneous reaction they have during class.

Research Design

In early 2007, we came across a technological innovation that we believed would allow us to extend our previous research on teachers’ professional vision. Using a new video camera, we attempted to videotape from the teacher’s point of view, to put the selection of clips in the hands of the teacher, and at the same time, to study the nature of professional vision in-action. In order to investigate the viability of this approach, rather than work with a group of teachers in a video club format, we decided to embark on a trial with one teacher. While working with one teacher obviously limits the extent to which we can generalize, we believe that it is an essential first step as we seek to understand whether this new technology is usable by teachers, and whether it has promise as a new tool for examining teachers’ professional vision.

The Camwear 100

A wide range of technological advances have taken place in the last decade, many of which have influenced the ease with which researchers and teacher educators can use video with teachers. Of particular interest to us was the development of the Camwear 100 by Dejaview (Reich, Goldberg, & Hudek, 2004). The Camwear 100 consists of a small digital video camera, approximately one-inch long, and a separate recording module, that is about the size of a cellular phone, and that can be worn on a belt. Because of the camera’s small size it is “wearable,” and can easily be affixed to one’s glasses or to the bill of a hat. In addition, the Camwear 100 features “after-the-fact” technology, which allows one to capture the previous 30 seconds. Essentially, the record feature of the camera works nonstop, but the camera continually records over itself after a short period of time. Pressing the “save” button, in contrast, stores the most recent 30 seconds of action in a digital video file on the memory card housed in the recording module. The number of clips that can be recorded depends on the size of the card inserted in the recording module. The card we used could hold up to forty-eight 30 second clips. The stored clips can be downloaded onto a computer and viewed.

Piloting the Camwear 100

To explore how these features of the camera might permit us to investigate teachers' professional vision in a new way, we recruited one high school mathematics teacher to test the camera in his classroom. The teacher, Ray Bryant,¹ was in his fifth year of teaching at an urban public high school in a large Midwestern city. Mr. Bryant taught Years 2 and 3 of the Interactive Mathematics Program (Fendel, Resek, Alper & Fraser, 2000) which covers a range of topics from algebra, geometry, and statistics. Class periods at the school were organized into blocks of 90 minutes, with each class meeting three times a week. In the class Mr. Bryant selected for this study, students were arranged in six groups of five students. Typical lessons involved students working in their groups to prepare presentations on the previous nights' homework or in-class problems and then presenting those solutions to the class. The presentations were followed by whole-class discussion of the problems as well as the introduction of concepts and methods by Mr. Bryant.

Prior to this study, Mr. Bryant had used video to reflect on his teaching. In particular, during the previous school year, Mr. Bryant applied for (and received) National Board certification. As part of the process, Mr. Bryant needed to select video excerpts from his classroom and prepare narrative analyses of the excerpts. In addition, Mr. Bryant participated in weekly meetings with other mathematics teachers who were preparing National Board portfolios. In many of these meetings, the teachers shared excerpts of video from each others' classrooms and discussed how the excerpts illustrated National Board criteria for effective teaching.

As part of this study, Mr. Bryant volunteered to use the Camwear 100 in one of his classes on three separate days in May 2007. Prior to each class, Mr. Bryant met briefly with a researcher to describe the day's lesson. The researcher then affixed the camera to a hat that Mr. Bryant would wear. (Since hats were not permitted at the school, Mr. Bryant explained the research study to his students and specifically, his reason for wearing a hat in class.) Our instructions to Mr. Bryant were fairly simple: we asked him to capture "interesting moments" by pressing the "save" button on the camera. No instructions were given concerning the number of clips to save or the content of the clips. Prior to the third test date, Mr. Bryant asked for a more specific prompt from the researcher. In response the researcher offered Mr. Bryant a number of choices from which the teacher selected "moments of confusion—yours and your students" and "moments in which you changed your planned instruction." A researcher also observed and videotaped each of the three class sessions. The videotaping took place from the back of the room as we had done previously and was intended to pro-

vide a complete record of the lesson to complement any clips that Mr. Bryant would save (Figure 1).

Following each of the three test classes, Mr. Bryant participated in an interview with the researcher. Each interview lasted approximately 30 minutes and was videotaped. Prior to the interview, the clips that Mr. Bryant had saved that day were downloaded onto a computer. As the researcher and Mr. Bryant watched each clip, Mr. Bryant was asked to explain why he decided to capture that moment during class. In addition, the researcher asked Mr. Bryant to discuss his experience using the Camwear 100 thus far. A copy of the interview protocol can be found in Appendix I.

Figure 1

(a) The Camwear 100 attached to the teacher's hat, and (b) a view from the camera.

(a)



(b)



Methods of Analysis

Analysis of the data proceeded in three phases. Initially, a researcher reviewed the teacher's lesson plan and any accompanying handouts, the individual 30-second clips Mr. Bryant selected with the camera, and the researcher-directed videotape of the entire class period. By coordinating these records of the class, the researcher outlined the context of the lesson surrounding each clip. These outlines included a description of the mathematics on which the class was working, who had been speaking prior to the clip, and what ideas had recently been raised in class. The descriptions helped the researcher make sense of what happened during the clips that the teacher selected. The researcher also created a summary of each 30-second clip indicating the time at which each clip was captured during the 90-minute lesson, as well as the type of classroom activity represented within the clip. In addition, the researcher analyzed the interview data and created a summary of Mr. Bryant's comments after watching each clip. Though neither the clips nor the interviews were transcribed in their entirety, relevant and exemplary quotes were noted.

In the second phase of analysis, two researchers reviewed the work of the previous researcher and attempted to classify the teacher's stated reason(s) for capturing each clip. To start, a subset of the teacher's reflections from each of the three dates were considered and a set of preliminary reasons was identified. Next, the teacher's reflections on all of the clips were reviewed and categorized in terms of these reasons. This analysis took place in a cyclical process in which the set of reasons was refined as needed. This process continued until Mr. Bryant's reasons for selecting each clip were coded within a set of stable categories. Analysis also noted whether Mr. Bryant indicated a single reason for selecting a particular clip or whether multiple reasons were cited.

The third and final phase of analysis focused on the interviews and investigated comments Mr. Bryant made concerning the videotaping process and review of clips. Thus, rather than examine the nature of the clips themselves, or Mr. Bryant's reactions to the clips, here our goal was to identify other issues and concerns raised by Mr. Bryant in discussion with the researcher. To do so, the three interviews were reviewed, and segments of discussion not about specific video clips were noted. We then looked across these comments and identified three main themes: (a) the practicality of the Camwear 100, (b) the usefulness of the camera perspective, and (c) the influence of the process on Mr. Bryant's teaching.

Results

In what follows we discuss the nature of the clips that Mr. Bryant

identified as “interesting” as well as the ways in which he discussed these clips in the interviews. We then discuss how Mr. Bryant characterized the influence of the videotaping process on his instruction.

Collected Clips

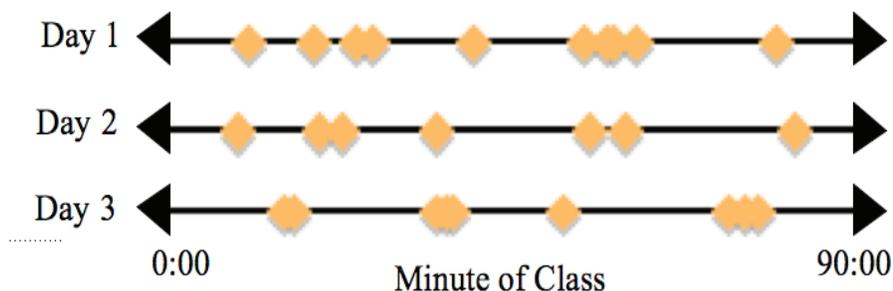
To start, we describe the clips Mr. Bryant selected in order to give the reader a sense of the kinds of things that Mr. Bryant notices in his classroom. We discuss how frequently he collected the clips, the kinds of activity displayed in the clips, and the role of the participants in the clips.

Number and frequency of the clips. On the first day of using the Cam-wear 100, Mr. Bryant saved ten clips during the 90-minute lesson. On the second day, he selected seven clips, and on the last day a total of nine clips were saved. In all cases, he captured moments spread throughout the 90-minute period. Sometimes he chose moments very close to one another (within two or three minutes) and at other times the clips were much farther apart (around ten minutes). Figure 2 illustrates this time distribution of the clips for each class day.

The fact that Mr. Bryant collected between seven and ten clips shows a willingness on his part to engage with the technology and integrate it into his teaching. Since he captured nearly as many clips on the last day as he did on the first, we speculate that his willingness did not waver over the course of this short intervention. In addition, his collection suggests that using the camera was not so intrusive on his teaching as to stop him from collecting clips. Mr. Bryant confirmed this in his interview saying “it was no big deal” to capture the moments. The moderate number of clips captured also suggests that Mr. Bryant was being somewhat selective in the moments he chose. In contrast, we can imagine a different teacher

Figure 2

Distribution of clip selection for the three days of class.



who might save a clip every time a student answers a question, which would result in a much larger number of clips.

This distribution rules out two problems we might imagine occurring when a teacher uses the camera. First, the fact that the clips are spread throughout the class period suggests that the teacher does not stop using the camera as he gets further into instruction. Were the clips “clumped” at the beginning of the lesson we might imagine the teacher was attentive to interesting moments at first but either forgot about it, lost interest, or did not have enough time in the midst of instruction to capture clips. Second, the fact that the clips are *unevenly* distributed suggests that Mr. Bryant was not just hitting the button after a given interval of time had passed. It appears that he was always on the lookout for interesting moments, whether they happened immediately after one another or with long stretches between them.

Classroom activities represented in the video clips. Mr. Bryant selected a variety of types of classroom activity using the camera (see Table 1). He captured *whole class discussions* that he moderated from the front or side of the room. He also chose moments when students were working in *small groups* as he circulated to answer questions or check progress. Student *presentations*, which are common in his classroom and involve a group of students using whiteboards to report their problem solutions to the whole class, were also selected a number of times. Finally, Mr. Bryant captured what we characterize as predominantly *teacher talk*. In characterizing these clips as such we do not mean that the students are silent, but only that the teacher provides most of the substantive conceptual ideas.

Table 1
Distribution of classroom activities in the clips.

<i>Classroom Activity</i>	<i>Number of Clips</i>	<i>Percent of Total Clips</i>
Whole class discussion		
Single contributor	6	23.1 %
Multiple contributors	4	15.4 %
Small group work		
Single contributor	2	7.7 %
Multiple contributors	4	15.4 %
Student presentations		
Single contributor	2	7.7 %
Multiple contributors	3	11.5 %
Teacher talk	5	19.2 %

These four types of clips are fairly well representative of how Mr. Bryant's classroom operated on the days we observed. The students sat with their desks in small groups and worked on or reviewed problems together. A few groups prepared presentations of their work and presented to the class, which then discussed the methods and ideas of the presenting group. Thus, as is suggested above by the fact that Mr. Bryant captured moments spaced in time throughout the class period, his choice of clips was well distributed over the different activity structures that characterize his classroom.

Given that the camera was located on Mr. Bryant's person, he was obviously present during all the clips he captured. However, his presence does not mean he was always participating vocally. Aside from the clips coded as "teacher talk," approximately half were comments or ideas voiced by one student (with possibly a non-substantive utterance by another student or teacher). The other half were exchanges among multiple participants—either only students or students and the teacher together. This analysis suggests that Mr. Bryant does not need to be actively involved to find a conversation interesting. For Mr. Bryant, the students can, largely on their own, create moments worthy of notice.

The first three types of classroom activity account for 80% of the clips Mr. Bryant selected. They all involved some part of a discussion of mathematical ideas, be it one turn of the discussion or multiple turns. Selecting clips during discussions is not surprising for this teacher. In discussing his class, Mr. Bryant explained that the class is more interesting when "good conversations happen" than when the material is too straight-forward to lend itself to discussions. For example, Mr. Bryant says "This couple of lessons didn't really lend itself to as in-depth a conversation or discussion as the previous class" as an explanation for why he captured fewer clips on one day than another. Thus the clips he captures on-the-fly using the camera are at least partially consistent with his overall impressions of the class.

Teacher's Reflections on Clips Collected

Mr. Bryant's reflections on his clips provide additional information concerning what he notices in the classroom. We first describe the varied reasons Mr. Bryant offered for choosing these particular clips as interesting. Next we discuss the form that his reflections took, that is, the approaches Mr. Bryant used to discuss the saved clips.

Reasons offered for selecting clips. Mr. Bryant's reflections in the interview provide further evidence that he attends to a variety of kinds of events in the classroom. We identified in his reflections a range of reasons for selecting the particular clips he captured including: (a) student

thinking, (b) discourse, (c) teacher moves, (d) teacher strategies, and (e) student engagement. We characterized Mr. Bryant as selecting a clip because of students' thinking when his reflection focused on the substance of the ideas raised by students. For discourse, we looked for a focus on how the teacher and students communicated with one another, or on the process by which ideas were articulated and discussed. A teacher move reflection focused on in-the-moment teacher actions or decisions such as a change in instruction in response to something unanticipated. In

Table 2
Teacher's reasons for selecting clips.

<i>Reason for Selection</i>	<i>Sample Explanation given by the Teacher</i>	<i>Percent of Clips*</i>
Student Thinking	"The reason I captured that was because Tracy ... she had a compelling argument.... [It was] not just that everyone had done it this way. [And] her argument was fairly logical."	37.5%
Discourse	"When Anita started to contradict Greg... it was this little battle back and forth, which I like in a classroom... And it seemed very respectful and non-confrontational and I was trying to capture that."	20.0%
Teacher Moves	"This was one of those critical moments, where ... I had just planned on brushing right through that and not spending anymore time. But that's where I made a decision to stop and see where is this going to go."	17.5%
Teacher Strategies	"Alex tells me the question, and I just answered it... which is not cool. [I thought], 'Should I have just answered that question, or... [was] there a line of questioning I could have led him down that would have helped Alex... come to [his] own answer?'"	17.5%
Student Engagement	"What I thought was interesting in this was that all five of [the students in the small group]... they're all working on the project... but nobody's writing anything down... I think that's a particular problem we have in this school."	7.5%

*This column adds up to more than 100% because some clips were coded as being selected for multiple reasons.

contrast, a teacher strategy reflection identified a class of instructional routines that the teacher commonly used. Finally, we characterized Mr. Bryant as selecting a clip because of student engagement when his reflection focused on the quality or amount of student participation in a given moment. We should be clear that Mr. Bryant did not explicitly use these terms; the categories are our researcher characterizations of his reflections. Table 2 lists each of the reasons we identified and a corresponding quote from Mr. Bryant.

Form of reflection: Identification of singular event versus narrative.

We now turn to a discussion of the form of Mr. Bryant's reflections, that is, the ways in which he discussed these reasons. In particular, we found that Mr. Bryant's reflections took on two distinct forms, each of which may indicate different aspects of his professional vision. For 11 out of the 26 clips, Mr. Bryant identified a singular event within the 30 seconds that he found noteworthy. In these "focused reflections," Mr. Bryant usually discussed particular moments in the class when he was struck by something—either students' thinking, his own thinking, or his teaching. For example, in one reflection Mr. Bryant said that he captured the clip because he was pleasantly surprised by one student's articulation of a difficult concept. Though the camera caught an exchange involving multiple participants, Mr. Bryant's reflection focused on the single moment when he realized how well the student had summed up the idea.

In contrast, for 15 out of the 26 clips Mr. Bryant provided a more comprehensive narrative of the 30 seconds that may have also included a discussion of the time leading up to and following the clip. In these "extended reflections," he often told a story about the classroom activity that described the action itself, the mathematical content, the students' comments and questions, any artifacts or representations, the teacher's responses, and the teacher's thinking. For example, Mr. Bryant described one clip in which students were having difficulty answering a homework problem. In doing so, he talked about the problem itself, its relation to previous problems, the students' methods, the correct method, his intervention, the students' response, and the typical behavior of one of the students in the clip.

Impressions of the Process of Capturing Clips

Finally, we report on three general themes that Mr. Bryant raised in discussing his experiences piloting the Camwear 100. These include the feasibility of using the camera during instruction, the usefulness, for the teacher, of the camera perspective, and finally, Mr. Bryant's impression that using the camera may have influenced his teaching in positive ways.

Using the Camwear 100. It seemed likely to us that asking a teacher to wear a camera and deliberately select moments from the class to record would be more intrusive on his teaching than merely allowing a researcher to tape the class from the back of the room. Yet overall, Mr. Bryant did not find the camera overly distracting. Furthermore, he reported that the process of pushing the button was quite straightforward and did not interfere with the ongoing nature of his teaching. As he explained, “[It] was a little strange but it didn’t, I don’t think, really get in the way of anything.”

Mr. Bryant also commented explicitly on the influence of the camera on the students. He reported that initially the camera was somewhat distracting to students. “[On the first day] it was on their minds quite a bit... It’s different than when you have the camera in the back of the room where I think they do forget about it... I think in this case they were always thinking about whether, it wasn’t like, I don’t think they were performing or anything, but they were clearly aware they were being recorded.” By the second day of taping however, the situation eased up as Mr. Bryant explained “[Today] I was ... able to capture moments without people noticing quite as much.” Thus, from a practical perspective, using the Camwear 100 seems quite feasible. Of course, the fact that Mr. Bryant had previous experience being videotaped may have influenced his ease with the Camwear 100. Nonetheless, using a Camwear 100 was, in several respects, a substantial departure from Mr. Bryant’s prior experience. Most importantly, wearing the camera, and selecting moments to record as he taught were new requirements. And it is precisely these unique requirements—and affordances—of the Camwear 100 that we wish to understand in this preliminary study.

Usefulness of the camera perspective. Mr. Bryant stated that he found the perspective of the camera, from the teachers’ point-of-view quite interesting. In contrast to his prior experiences with videotaping, in which a camera was in the back of his room, the Camwear 100 provided a different outlook, one that he found beneficial.

I like [the view from the camera]. It has good vision....[With a camera in] the back of the room you could probably see a little bit more, but, you’re not seeing, you’re seeing a lot of back of the heads from the back of the class. Here, you know, for the most part the kids are facing, looking at you more. So you get facial reactions. I think that’s a big advantage.

In fact, this ability to capture students’ faces prompted Mr. Bryant to use the camera to watch for nuance in his students’ reactions. In talking with the researcher he explained that, at times, he tried to keep a

student's face in his line of vision, in order to later evaluate the impact of a particular teaching move.

Mr. Bryant: I [tried to] keep the camera over long enough to kind of gauge his reaction... I kind of wanted to see how ... my making those little comments got him.

Researcher: So you were trying to make that comment and then... keep him in your gaze afterwards.

Mr. Bryant: Yeah.

The camera's perspective also seemed valuable when Mr. Bryant was asked to discuss the saved clips in the interviews. Specifically, when viewing the clips with the researcher, Mr. Bryant saw the interaction exactly as he did in the moment of instruction.

Influence on teaching. When reflecting on using the camera for the first time, Mr. Bryant indicated that he changed his teaching to create more moments to capture. He compared how he conducted the class while using the camera to his original plan for the class.

I think I did change things a little bit... I think the discussions, particularly the large class discussions that we had probably went on longer than I would have done normally. Because I was trying to find something to work with... Actually it was a good thing... because I would have ploughed through that real quick and not spent as much time discussing it... So I definitely modified things a bit based on [the camera].

Thus, rather than finding the camera an annoyance, Mr. Bryant thought "actually it was a good thing." He allowed the discussion to continue in the hopes that interesting moments would come out of it, or as he said, in the hopes of "finding something to work with." That something as simple, and potentially intrusive, as asking a teacher to capture interesting moments could cause a teacher to foster moments where students' thinking is made public is extremely exciting. It suggests that professional development encouraging teacher attention to various aspects of the classroom may do more than hone teachers' professional vision, it may also persuade teachers to craft classroom activity so as to allow more of those moments to happen.

While we are encouraged with this reported shift in Mr. Bryant's teaching, we do not imagine that this attempt to create interesting moments would be permanent or even long lasting. We suspect that as the camera became more commonplace for the teacher, his attempts to foster interesting clips would decrease.

Discussion

What have we learned about the viability of this new tool as a means to study and enhance professional vision? Can we begin to draw any new conclusions about the nature of professional vision? With respect to viability, the results of this first, very preliminary trial were generally positive. Many of our most serious concerns failed to materialize. The teacher and students did not find the use of the camera to be overly disruptive. Furthermore, the fact that the teacher collected a moderate number of clips, distributed throughout many parts of the classroom session, is suggestive of the tool's viability. It suggests, for example, that it might be reasonable for a teacher, working without the aid of researchers, to collect clips to use for discussions with colleagues. Such clips could be shared in a variety of contexts including department or grade level meetings to illustrate particular lessons, materials, or pedagogical approaches. In addition, the camera's capabilities have the potential to support virtual teacher communities that explore issues of teaching and learning over the internet.

In addition, the number and distribution of clips suggests that the tool might be useful for the purposes of research. At least in this case, the teacher was not collecting clips haphazardly. Instead, it seemed to be possible for him to collect clips in a thoughtful and deliberate manner. This suggests that through the use of this tool we might be able to tap into important parts of a teacher's online thinking.

What have we learned about professional vision from this brief trial? We believe that caution is required in drawing conclusion about professional vision from data of this sort. It seems clear that the clips collected tell us *something* about Mr. Bryant's professional vision, but it is not clear precisely what they tell us. Similarly, his reflections on why he selected clips seem to be relevant data about professional vision. But we cannot assume that the reasons that he gave bear any simple relationship to his thinking at the time he actually selected the clip. These problems are amplified by the nature of professional vision. We believe that professional vision typically acts in a rapid and relatively unconscious manner, often like simple recognition. This means that much of professional vision will not be easily accessible (or easy to verbalize) by teachers.

Nonetheless, we believe that the data do allow us to draw some tentative conclusions about teachers' professional vision. First, we believe it is reasonable to assume that the moments Mr. Bryant selected were moments at which his professional vision was hard at work, even if we cannot be certain exactly what work it was doing. If Mr. Bryant was not paying attention and thinking hard about what was going on at a given

moment—and thus not employing his professional vision—it seems unlikely that he would have decided to store a clip at that time. Thus, at the least, it seems reasonable to take the distribution of stored clips as indicative of times when his professional vision was active. In this regard, note that the interesting moments selected by Mr. Bryant were spread throughout the lesson and across different kinds of activities. This might suggest that the real challenges of professional vision are not localized to any particular sub-type of activity. Across all activities, the teacher was actively parsing and processing classroom events. This was even the case when the teacher was just watching students, and not intervening.

In addition, recall that we noted that Mr. Bryant's reflections took two forms, singular and narrative. This could perhaps be suggestive of some fundamentally different modes in which his professional vision operates. For example, in some cases, the "event" that is perceived might be very short in duration, such as a single utterance. In other cases, he might be parsing and making sense of events that span a significant fraction of a classroom session.

Finally, despite the caveats outlined above, we do believe that the reasons given by Mr. Bryant for selecting clips provide insight into his professional vision and into the kind of activity that stands out to him during instruction. Indeed, Mr. Bryant was at times quite articulate about his reasons for capturing a clip. In fact, when asked outside the context of the classroom, he reported a list of the kinds of events he typically finds interesting; "There's the content... then there's ... communication, engaging the students, equity issues." Thus he seemed well aware of the potential reasons why a classroom interaction might be noteworthy. Yet sometimes Mr. Bryant's noticing appeared to take a more tacit form. Specifically, he explained that, at times, he simply had an implicit sense that something was interesting. He described this sort of noticing by saying "It might have just been like, 'Oh, there's a moment,' without really thinking about what it is." This observation that Mr. Bryant's professional vision has tacit and explicit elements is important both because of the care that will be needed in drawing conclusions from his stated reasons for selecting a clip, and also because of what it suggests about the nature of teachers' professional vision.

Our preliminary analysis suggests that this new video technology can inform our understanding of teachers' professional vision. As such, we plan to extend this work in several ways. First, by increasing the number of teachers using the Camwear 100, we will be able to investigate how typical Mr. Bryant's experiences were—both in terms of the camera's usability and in terms of what we can learn about professional vision

from its use. Second, we intend to organize video clubs in which teachers will show clips they saved using this technology. This will provide useful information on the viability of scaling up teacher-led video clubs. Third, we plan to explore several technological modifications in the camera, including increasing the length of the saved clips to one or two minutes and creating software that will allow teachers to easily annotate and categorize their clips. Fourth, while the focus of this study was a mathematics teacher's professional vision, it is not clear to us that our findings are unique to mathematics teachers. Thus, we plan to extend this work to other subject areas in an effort to specify the subject-specific nature of professional vision. We expect these extensions to be valuable both for studying professional vision and for developing meaningful ways to enhance teachers' professional vision.

Notes

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¹ All teacher and student names are pseudonyms.

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Appendix I

Interview protocol for post-class reflection interview.

Before viewing clips:

How was it to use the camera while teaching?

- a. Did you notice the camera on your person?
- b. Did you notice whether your students behaved differently?
- c. Did you feel like having to make a decision about capturing a moment impacted your teaching in any way?
- d. Considering the 30 second limit, did you use any particular strategy in deciding when to save a moment?
- e. How did the design of the device work for you, was it hard to tell if you had successfully pushed the capture button?

For each clip:

- (1) Why did you capture this part? What did you think was going on that was interesting?
- (2) Are you noticing anything in this clip that you didn't see in the moment?

(3) Were you aware of other things in the moment that aren't visible in the clips?

After all clips have been viewed:

- (1) Overall, did you capture what you had anticipated?
- (2) Were you using any particular pre-formed criteria about the kind of clips that you intended to capture? Did other criteria develop as you were teaching?
- (3) Are these the kinds of clips that would be good for a video club? Would you capture different clips if you knew it were for a video club?
- (4) What do you think you might want to do differently with this camera next time?