Making the Most of Teacher Self-Captured Video*

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Recent advances in technology have resulted in an array of new digital tools for capturing classroom video, making it much easier for teachers to collect video from their own classrooms and share it with colleagues, both near and far. We view teacher self-captured video as a promising tool for improving mathematics teacher education. In this article, we discuss three issues that are essential for making the most of self-captured video: camera position, how much video to capture, and when to specify tasks for capturing, selecting, and using video. We propose that the act of deliberately participating in the self-capture process, as well as viewing and analyzing one's own video with colleagues, offers worthwhile opportunities for mathematics teacher learning.

Key words: Teacher professional development; Self-capture video; Video analysis

Video has been used extensively in mathematics teacher education for more than 2 decades, and its use continues to be widespread today. Video captures much of the complexity of teaching and allows teachers an opportunity to view and examine instruction with the guidance of mentors and colleagues. In the past, video-based professional development typically relied on researchers or teacher educators to videotape in teachers' classrooms. Such work led to the development of a range of published curriculum materials for mathematics teachers (e.g., Boaler & Humphreys, 2005; Goldsmith & Seago, 2012; Seago et al., in press; Seago, Mumme, & Branca, 2004), as well as programs in which researchers selected video from participants' own classrooms for participants to view with colleagues (e.g., Borko, Jacobs, Eiteljorg, & Pittman, 2008; Grant, Kline, & Van Zoest, 2001; Sherin & Han, 2004; van Es & Sherin, 2008). These approaches have provided teachers with valuable opportunities to examine student mathematical thinking, new visions of mathematics teaching, and classroom discourse.

Recent advances in technology support a new approach to video-based professional development in which video from teachers' classrooms is captured by the teachers themselves. Because teachers now have access to small, high-quality consumer cameras (including phones and tablets), they no longer need specialized equipment for videotaping in their classrooms. In addition, new online applications make it relatively easy to upload and share video with colleagues. So what does this mean for mathematics teacher education? What might self-captured video have to offer teachers and teacher educators?

First, self-captured video increases the ease with which teachers can engage in ongoing cycles of planning, teaching, and reflection as recommended by current research initiatives (Hiebert, Morris, & Glass, 2003; Koellner et al., 2007; McDonald, Kazemi, & Kavanagh, 2013). Second, having teachers capture video from their own classrooms reduces the burden on teacher educators, making video-based programs more feasible to implement at scale. Third, being able to share video of one's teaching with peers quickly and directly increases the potential for teacher involvement in new forms of professional learning communities, both local and at a distance (see Krammer et al., 2006; Lieberman & Pointer-Mace, 2009). Furthermore, we conjecture that the act of capturing video provides teachers with learning opportunities beyond those of reflecting on and analyzing video from one's classroom.

Given recent research and policy that advocate for mathematics teachers to attend closely to student thinking and engage in practices that are responsive to student ideas (e.g., Kazemi, Franke, & Lampert, 2009; National Council of Teachers of Mathematics, 2014; Sherin, Jacobs, & Philipp, 2011), we believe that teacher self-captured video is a particularly worthwhile tool for mathematics teacher education and professional development. Teachers can

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deliberately plan to both elicit student thinking during a lesson and capture those moments on video. Research finds that such purposeful planning for video capture, as well as actively capturing moments during instruction, can fundamentally shift the opportunities that teachers create for student mathematical thinking to emerge and the ways in which teachers take notice of these ideas during instruction (Sherin, Russ, & Colestock, 2011; Sherin, Russ, Sherin, & Colestock, 2008). Furthermore, although video of others (e.g., Boaler & Humphreys, 2005; Seago et al., 2004) has been used successfully to promote teacher attention to and interpretation of student thinking (Goldsmith & Seago, 2011), research has found value in mathematics teachers examining their own students' thinking through videos from their own classrooms (van Es & Sherin, 2010). Self-captured video extends this perspective by promoting teacher attention to student thinking during both the capture and the reflection periods (Dyer, 2013).

Although there is clearly great potential in using self-captured video for teacher learning, realizing this promise requires consideration of a variety of issues. Mathematics teacher educators need to give careful thought to how and why self-captured video is used: How can teacher educators help teachers collect video that is usable and substantive? What kinds of tasks are productive for teachers to engage in around self-captured video and when should these tasks be specified? What methods should be used to organize sharing and discussion of video? To what extent will professional development around the video be facilitated and by whom? In this article, we begin to address questions about self-captured video by examining the following three issues, each of which we believe is essential to making the most of self-captured video: (a) where to position equipment for optimal results, (b) how much video to capture and share with colleagues, and (c) when to specify tasks for using teacher-captured video.

Our Background With Teacher Self-Captured Video

Our experience using video with teachers is extensive, working with both preservice and in-service teachers and spanning more than 20 years. In terms of teacher self-captured video, our experience is quite diverse. Across the five authors of this article, we have used a range of camera types, including stationary, hand-held, and wearable cameras. In addition, we have asked teachers to capture different types of video, from whole lessons to shorter segments, and have provided varied degrees of structure and guidance for video capture and analysis tasks. Across these experiences is a shared interest in using teacher self-captured video to help teachers consider student mathematical thinking as it relates to the practice of teaching (see for example Dyer, 2013; Stockero, 2013, 2014) and to develop teachers' agency in their own professional development. For example, several of us work with preservice mathematics teachers, having them self-capture video in their field placement assignments to develop their attention to and interpretation of student thinking to inform planning and in-the-moment teacher actions. We have also worked with in-service mathematics teachers who capture videos of their own classrooms for various video-based programs, including National Board Certification. In all these contexts, teachers typically engage in collaborative analysis or discussions of their videos, facilitated by themselves, a teacher leader, or an outside facilitator. Throughout this article, we draw on data from our research with these teachers—including observations of professional development and teacher education courses, interviews with teachers, and teachers' written work—to illustrate and contextualize our claims.

As previously stated, our goal is to share some of our insights concerning the decisions that teacher educators need to make when planning to have mathematics teachers capture video of their own instruction. Regardless of whether the use of self-captured video is highly structured by an external facilitator or informally teacher-led, we think these are important issues to consider. In particular, we discuss the affordances and constraints of different choices related to camera positioning, how much video to capture, and when to specify tasks for capturing, selecting, and using the video. We recognize that issues related to equipment selection are also important. Although equipment selection is not a central focus of this article, we include details about various types of cameras and accessories, such as microphones and tripods, in **Appendix A.**

Three Issues in Teacher Self-Captured Video

Positioning of Equipment

When teachers videotape themselves, it is nearly impossible to obtain access to every element of the classroom environment. Instead teachers need to make choices about particular classroom features on which to focus. Although video is often believed to be objective—capturing activities from a neutral perspective—different positioning of equipment can cause various aspects of the same classroom lesson to appear more or less salient (Goldman, 2007; Roth, 2007). Therefore, how video equipment is positioned has important consequences for what can be seen in the video. Of particular interest to us are the ways in which video can provide access to the teacher

and the students in the classroom and, as a result, to the mathematics the class is exploring.

Access to teachers. In our work with both preservice and in-service mathematics teachers, we find that teachers often place the video camera at the back of the room when first videotaping. Their reasons for doing so seem related to the fact that teachers often associate videotaping with evaluating or analyzing the teacher. As one teacher explained,

> **When I think of colleagues taping themselves and sitting and discussing with each other, the first thing that I thought of was [that] we are going to look at me as a teacher and talk about what I'm doing as a teacher, not about what students are thinking.**

For these teachers, placing the camera at the back of the room can be seen as a strategic choice because that position provides the best access to the teacher throughout the lesson. Other positions are also possible, however, as shown in Table 1. For example, a stationary camera positioned at the front of the room typically provides better access to the teacher's interactions with individual or small groups of students, as long as the teacher is not standing too close to the front of the room. However, a camera positioned at the front of the room often will not capture the teacher when she is writing on the board or using a document camera or overhead projector. With regard to audio, positioning the camera at either the front or the back of the room can also make it difficult to hear the teacher's interactions with individual or small groups of students over the noise of the classroom.

Sometimes it may be useful to position a camera on a small group of students rather than on the class as a whole. A constraint of this position is that it provides access to the teacher only when the teacher approaches that group. An affordance is that it allows the viewer to make sense of the teacher-student interactions in light of conversations among the students before and after the teacher approached the group. As one teacher wrote, "[It] worked really well to tape the group. I liked that I could see what they did after I left."

Finally, wearable cameras provide no visual access to the teacher—the teacher is literally wearing the camera and is thus not seen in the video at all. Yet video taken from this perspective does provide a different kind of access to the teacher—access to what the teacher sees throughout the course of a lesson, as well as what a teacher hears as instruction takes place. One teacher commented, "It's like [a] whole new way to see myself teaching." In addition, a wearable camera provides excellent access to what the teacher says because the camera is so close to the teacher. To obtain similar auditory access to the teacher with other camera positions, some teachers choose to wear a wireless lapel microphone.

Table 1
Equipment Position and Access to Teachers

Camera or microphone position	Visual affordance	Visual limitation	Auditory affordance	Auditory limitation
Back-of-the-class stationary	Teacher visible throughout classroom	Limited access to teacher interactions with individual or small groups of students	Teacher usually audible	Teacher interactions with students at the front of the room may be difficult to hear
Front-of-the-class stationary	Teacher visible when working with individual or small groups of students	Limited access to teacher at the front of the room	Teacher usually audible	Teacher interactions with students at the back of the room may be difficult to hear
Small group stationary	Teacher interactions with small groups of students visible	Limited access to teacher	Teacher usually audible when speaking to small groups	Teacher interactions with other groups may be difficult to hear
Teacher wearable	Camera reveals what teacher sees and hears	Teacher not visible	Teacher always audible; access to what teacher hears	Access only to students whom the teacher hears

Access to students. Over time, we find that teachers generally become more open to various camera placements, particularly when the goal is to see and hear students (see Table 2). Teachers quickly discover that positioning a camera in the back of the classroom has numerous limitations in gaining access to students: "I was trying [to look] at the students, but I couldn't tell who was who. I heard what they said, but I couldn't match it [with their faces]." With a camera placed at the back of the room, it is difficult to recognize if students are engaged, to see their gestures, or to see their reactions to events taking place. As with cameras in the back of the room, the front-of-the-room position provides a general sense of what is taking place in the classroom, but a camera in the front provides better access to students' faces. A constraint of the front-of-room position is that it can be difficult to see work being done at the front of the classroom; teachers have been able to compensate for this by taking photographs of the board or using an interactive white board that can automatically save electronic copies of what is written on it.

In terms of audio, a microphone located at the front of the room, rather than at the back, provides much better access to what students say during whole-class formats because students often speak toward the front of the room. In both positions, however, the noise of the class as a whole can make it difficult to hear what students say as they work in small groups. In general, we have found that external microphones provide better quality audio and greater flexibility in microphone placement, particularly when placed near the students the teacher wishes to hear. A teacher explained, "I think the external microphone helped a lot with the audio. I never had any problems hearing the students talking, and my class got pretty loud at times. I also liked being able to put the camera at the back of the classroom and put the microphone on a table in the middle of the classroom to record whole class discussions." In general, we have found that the teacher typically can be heard from most positions, while students' voices are often difficult to hear, particularly when the microphone is placed at the back of the room.

A stationary camera positioned directly on a group of students offers a different perspective. In this setup, the viewer has extensive access to those students who appear in the camera's field of view, particularly in terms of facial expressions and gestures. The rest of the students in the class are not visible, however. When focusing on a small group, placing an external microphone in the center of a group can help capture what students say because the microphone on a camera is often insufficient for capturing individual voices over the general noise of the classroom during small group discussions. Moreover, when capturing video of a small group, it can be vital to have a copy of the students' work to make sense of what they are doing because students often reference their written work when sharing ideas with their classmates.

Wearable teacher cameras provide different access to students. When the teacher is interacting with the class as a whole and scanning the room, students throughout the classroom will likely be captured, and it will be students' faces that are visible. Teachers like to remind us that "[With the wearable] camera you have to look at students [in the video]. That's all that's there." In addition, when the teacher approaches an individual student, or a small group of students, a more intimate view of those students is offered, in line with how closely the teacher and students are interacting. In fact, with high-resolution cameras it is often

Table 2
Equipment Position and Access to Students

Camera or microphone position	Visual affordance	Visual limitation	Auditory affordance	Auditory limitation
Back-of-the-class stationary	Many students appear in video	Students' faces may not be visible	Hear students in back of room	Students in front of room often hard to hear
Front-of-the-class stationary	Many students' faces are visible	May not see students if they present at front of the room	Students usually audible during whole-class format	Students at back of room often hard to hear
Small group stationary	Sustained access to group of students	Few students appear in video	Easily hear students in the group	Hard to hear students not in the group
Teacher wearable	Students central focus of video	Access only to those students in teacher's field of view	Easily hear students close to teacher	Access only to students whom the teacher hears

possible to see the student written work that the teacher is examining. Finally, with the location of the microphone on the teacher, the sound quality is good, particularly for those students who are close to the teacher.

Determining the Amount of Video to Capture

A second issue that has become relevant in our work is deciding how much video to capture. This issue is important because it has implications for what teachers have access to view and analyze, as well as for when in the video capture process they have to devote the most time, energy, and careful thought. Teachers might capture an entire lesson, define selected excerpts to capture prior to a lesson, or, if using a wearable camera, capture events and interactions in an impromptu fashion during a lesson. We discuss the affordances and limitations of each approach, particularly as they relate to sharing and analyzing video with others.

Whole lesson. In our work with teachers, we find that capturing a whole lesson offers several affordances (see Table 3). First, it decreases the decisions teachers need to make about what to capture both before and during their teaching of the lesson being captured. Preservice teachers, in particular, are often challenged by selecting, designing, and organizing materials for use in the lesson and are also overwhelmed by all the decision points as they teach their lesson. Being able to set up a camera and press the record button at the start and end of a lesson requires less cognitive demand and allows teachers to focus on their teaching. Another affordance of capturing a whole lesson is that the context of the entire lesson is available. Teachers can see how a lesson begins, builds, transitions, and concludes, and can examine how these pieces fit together to support or constrain student learning. A third affordance is that colleagues can view an entire lesson from one another's classrooms. This is particularly worthwhile when teachers plan a full lesson together, as in a lesson study approach (Lewis, Perry, & Hurd, 2009). If they are unable to be present to watch the lesson in real time, they can later view their colleagues teaching the lesson and then collectively discuss strengths of the lesson and areas for improvement. Finally, with a whole lesson, teachers can decide what to share after they have an opportunity to view the lesson in its entirety and identify the most salient segments.

These affordances of a whole lesson also come with some constraints. Having more video means that it takes more time to watch and find noteworthy aspects of a lesson; the intellectual demand increases after collection because a larger amount of data must be analyzed. Some teachers comment that, after they capture a lesson, they often have ideas about what in the lesson is worthwhile and can focus their viewing on these segments. That approach, however, minimizes the affordances of capturing a whole lesson, as a careful viewing of the entire lesson may reveal noteworthy interactions that the teacher had not been aware of during instruction. A whole lesson also requires more space to store and share the video, although this is becoming less of an issue as storage devices become smaller and have increased capacity. However, if groups of teachers are sharing video, consideration needs to be given about where to store whole lessons so they are easily accessible and minimize challenges associated with Internet speed and data transfer. Finally, although recording an entire lesson captures all of its richness, it can also detract from focusing on specific features of classroom interactions. There is so much to see in a lesson that it can be overwhelming to focus on particular features of interest, requiring more time and attention to review and identify relevant segments. In reference to reviewing a whole class video, one teacher commented, "I spent more time watching the video early on because you're back and forth, back and forth, was that it? . . . I spent less time at the end because I knew what was going on."

Selected excerpts. An alternative to taping a whole lesson is to capture selected excerpts. As is the case with capturing whole lessons, capturing excerpts provides both

Table 3
Affordances and Limitations of Capturing a Whole Lesson

Issues	Affordance	Limitation
Collection	Minimal intellectual preparation	Requires more space on camera to capture
Analysis	Deciding what to attend to occurs after collection	Quantity of data to analyze can be overwhelming
Context	Context is more apparent, allowing for more nuanced analysis	Context can detract from the intended focus
Storing and sharing	Allows colleagues to see lessons from others' classrooms	Requires more space to store and is challenging to share quickly with others

affordances and constraints (see Table 4). One affordance is that defining the types of excerpts one wants to capture ahead of time drives the focus of video capture. In particular, it allows teachers to focus on something other than what they usually focus on while teaching, which can give them different perspectives on their practice. We have worked with teachers to identify particular types of interactions to capture, allowing them to hone in on specific areas of interest. For example, if the goal for video analysis is to attend to student thinking, then teachers can capture videos of groups of students working together or whole class discussions that feature students sharing their work at the board. By defining an area of focus, fewer distractions arise from having too much data. Another affordance of capturing particular interactions is that the storage and sharing demands decrease—the video takes up less space and takes less time to view. Finally, defining the focus prior to taping reduces the amount of work required to identify a segment to share.

Defining ahead of time what segments to capture has constraints as well. One is that this approach requires more planning and intellectual demand prior to video capture. Careful consideration needs to be given to what will be captured at particular points in the lesson, and the lesson needs to be designed and implemented to elicit and capture the issue of interest. For example, if the issue of interest is student mathematical interactions in small groups, decisions need to be made about how many and which small groups to capture. Moreover, by narrowing the focus of capture, the broader context of the lesson is lost, requiring the teacher to provide relevant contextual information and supplemental materials to support later viewing and analysis. In addition, the sense of being inside one's classroom can often get lost when teachers capture brief portions of a lesson. Though brief segments simplify the process of selecting clips to share, they also constrain what is available to be seen. This can be an affordance if the clips represent the issue of interest. However, if the issue of interest is not represented in the clips, then the limited scope of the segments restricts what is available for analysis.

Wearable cameras offer some unique affordances and constraints concerning the capture of selected excerpts of video. First, many wearable cameras offer selective archiving capability, which enables teachers to capture an event immediately after it occurs (see Sherin, Russ & Colestock, 2011, for further discussion). In addition, some allow teachers to mark moments while capturing an entire lesson, making it easier to return to selected segments. Choosing what to capture while teaching decreases the time needed to review an entire lesson at a later point. Moreover, selected clips are usually fairly brief, only a few minutes in length, requiring less time to review the clips and decide which segments to share. This also decreases the space needed to save, store, and share the video.

One constraint of wearable cameras, however, is the need to coordinate what a teacher wants to capture with the use of the technology—a teacher may find that he or she did not activate the camera at the right time to record a specific event. Another constraint for teachers using a wearable camera is that they need to monitor what they want to capture while they are also attending to the students, their learning, and the progression of the lesson, adding an additional challenge to the already cognitively complex work of teaching. We suspect that as teachers more frequently use this technology for self-capture and develop greater insight into the kinds of interactions that are worth capturing, these issues become of less concern. Finally, much of the classroom context can get lost capturing with this camera type; however, viewing several shorter segments from a lesson can allow viewers to seam them together to get a broad sense of the lesson and classroom as a whole.

Deciding When to Specify the Tasks

Although there are many issues associated with the specification of tasks around self-captured video—including

Table 4
Affordances and Limitations of Capturing Selected Excerpts

Issues	Affordance	Limitation
Collection	Focuses on specific areas of interest	Requires intellectual effort to decide what to collect
Analysis	Minimizes distractions	Narrowly focuses teacher noticing
Context	Fewer distractions	Risk of minimizing context
Storing & sharing	Requires limited space, can share clips easily, and takes less time to view	Lose feeling of being in someone else's classroom

the nature of the tasks themselves—we limit our focus to issues related to when tasks are specified for teachers. Tasks around self-captured video can be defined prior to capture, after capturing the video but prior to viewing and discussing the video in a group context, or when teachers come together to view self-captured video. Decisions about when tasks are assigned have implications for teachers' analyses of the videos and for facilitating discussion of the videos.

Teacher analysis and reflection. Variations in when the task is specified have important implications for how teachers use the video to reflect on and analyze their practice (see Table 5). One affordance of having a specified task prior to video collection is that teachers can plan a lesson to meet the specified criteria. They could, for example, be asked to plan a lesson that includes small group work or discussion around a rich mathematical task. Setting the task ahead of time increases the likelihood that the teacher will capture what is intended; however, it is no guarantee. As one teacher remarked, "Something I thought was going to lead to really meaningful class discussion, or something I thought would make a great video, didn't always happen." Capturing something specific may become even more challenging if it requires the teacher to make in-the-moment decisions about the selection of video excerpts, as previously described.

The task for using self-captured video can also be specified after capturing the video but prior to discussing it. At this stage of the process, teachers might be asked to select video excerpts to share with their colleagues, to submit for an assignment, or to analyze using a particular framework. One affordance is that as teachers engage in such tasks, they have adequate time for individual analysis and can replay a video multiple times to locate clips or make sense of what they are seeing. Another benefit of this approach is that it allows teachers to formulate their own ideas and impressions of what took place before hearing others' ideas. A teacher explained: "I think [discussing the video with others before analyzing it alone] would be really difficult. It would be really hard to discuss your deep thoughts on it. You wouldn't have had time to think about it, so it would be hard to bring . . . your ideas to the table." However, one constraint is that teachers may struggle with the task if they do not have a good understanding of the ideas they are studying or if they were unable to capture particular types of interactions in their video.

Specifying the task when a group comes together to view and analyze self-captured video typically involves teachers responding to a prompt immediately following the viewing. In this case, the group discussion emerges from the ideas that participants raise. An affordance of this approach is that the discussion is responsive to what teachers notice in the video and to their current thinking. This approach also allows teachers to work together to jointly make sense of the video, each contributing ideas to further elaborate the group's thinking.

However, this approach also has constraints. Teachers may take up unproductive ideas or issues that are peripheral to the issues of interest. Additionally, without sufficient time to analyze the video individually, some teachers may not be able to formulate their ideas fully, limiting the ideas that might otherwise be available for discussion. As one teacher explained, "If we were all to just analyze at the same time as a group, you probably wouldn't have gotten as much diversity, especially in the discussion."

Facilitation. When the task is specified also has implications for facilitation (see Table 6). Setting the task prior to capturing increases the likelihood that the video captured will allow the facilitator to work toward his or her goals for teacher learning. For example, if the facilitator wishes to focus on making sense of students' mathematical thinking, teachers might be asked to capture instances in which students share their mathematical ideas. This requires, however, that teachers have some level of

Table 5
Teacher Reflection and Analysis Related to When a Task Is Specified

When the task is specified	Affordances	Challenges
Prior to video collection	Lessons can be planned around ideas of interest	In-the-moment analysis/selection while teaching a lesson
Post-video collection/ pre-discussion	Time available for thoughtful individual analysis	Individual teachers may struggle to engage with the task
During discussion	Discussion is more responsive to what teachers notice	Provides limited time for teachers to formulate ideas fully and for group thinking to emerge

Table 6
Implications for Facilitation Related to When the Task Is Specified

When the task is specified	Affordances	Limitations
Prior to video collection	Video capture likely to be aligned with learning goals for teachers	Work must be done in advance to ensure teachers have some knowledge of key ideas
Post-video collection/ pre-discussion	Discussion likely to be focused on established learning goals for teachers	Inability to gauge teachers' initial reactions
During discussion	Access to teachers' initial reactions	Need to be responsive to emerging ideas

knowledge about the ideas under consideration; for instance, in the previous example, the facilitator must do enough advance work with teachers for them to know what counts as an example of student mathematical thinking (see, for example, Leatham, Peterson, Stockero, & Van Zoest, 2015). Setting the task early also provides the facilitator an opportunity to assess teachers' initial understanding of particular teaching practices and ideas about which they are learning.

Specifying the task after video capture but prior to the group discussion offers the facilitator the possibility of intentionally using teachers' analyses to guide the discussion. For example, a facilitator can set up the task where teachers capture a segment, view and provide initial analysis, and submit their initial ideas to the facilitator before the group comes together. In this way, the facilitator can see how teachers have analyzed a video on their own and then develop questions to elicit key issues during the group discussion. Alternatively, a facilitator might select key teacher-identified instances to discuss as a group. The facilitator might, for example, choose both teacher-identified examples and non-examples of an idea of interest to help teachers learn to differentiate among instances and thus develop a better understanding of the concept they are studying as it arises in practice. A constraint of such an approach is that the facilitator loses the ability to observe teachers' initial reactions to the video.

The task for self-capture and analysis may also be defined between capture and when a group shares and discusses the video, without requiring the teachers and facilitators to view the clips in advance of the group discussion. In this case, the group has an awareness of what they will focus on when they come together to discuss the clips (e.g., classroom discourse or student mathematical thinking) but there is less advance preparation. In addition, the group has a sense of what types of interactions and events to attend to when they get together to view the videos and can have more focused discussions, without demanding much of their time before coming together. Constraints include more work on the part of the facilitator to maintain a focus on the ideas of interest and greater difficulty ascertaining ideas that individual teachers have about the video.

Finally, a facilitator might specify the video analysis task when a group comes together to view the video for the first time. In this case, an affordance is that the facilitator can gain insight into teachers' initial reactions to the video and develop a good sense of what is most salient to them. A constraint of this approach is that it requires more in-the-moment facilitation, particularly if unexpected ideas surface or unproductive ideas take hold.

Discussion

Planning for and using self-captured video raises a variety of issues. We focused on three that we consider central to productive use of self-captured video for mathematics teacher education and professional development: where to position the camera, how much video to capture, and when to specify the task. We discussed these issues independently, but we recognize that in practice there is much balancing to do among them. For example, specifying the task has implications for camera placement and how much video to capture. In particular, asking teachers to capture short excerpts requires some degree of in-the-moment analysis to position and operate the camera, something that can be difficult for teachers to focus on while they are teaching. At the same time, asking teachers to capture a whole lesson requires less planning ahead of time but also has implications for identifying a clip to share and for facilitation. Having a clear sense of the purpose for using video, particularly with respect to supporting mathematics teacher learning, will help guide decisions on these three issues. Other issues, such as the nature of tasks for using self-captured video, strategies for sharing and discussing video, and orchestrating meaningful discussions with video that teachers capture and share with one another, are also important to consider but are beyond the scope of this article. In the next section, we offer some recommendations related to these issues based on our experiences.

Recommendations

From our work with teachers, we have identified several strategies for making the most of self-captured video. We offer the following recommendations.

Make the purpose explicit. We strongly recommend making the purpose of capturing and using video clear to teachers from the start. We have found that as teachers develop a deeper understanding of the specific purpose for capturing video, they also develop a more nuanced understanding of the benefits and limitations of different camera positions in reference to that purpose. One way we have made the purpose explicit is through the use of frameworks that specify what teachers will be looking for in the video (e.g., van Es, Cashen, & Auger, 2011). For example, in teacher education settings, we have provided detailed frameworks to provide criteria that teachers will identify in the classroom video when they occur, such as productive student thinking (e.g., Stockero, Peterson, Leatham, & Van Zoest, 2014) or evidence of maintaining high cognitive demand of student tasks (e.g., Stein & Smith, 2011). Providing teachers with such frameworks gives them a sense of the purpose for the video capture, allowing them to make informed decisions about which portions of the lesson to capture and how to position equipment to ensure they are capturing video that will allow them to apply the framework. One teacher we worked with explained,

> **[The goal] is something that needs to be made very clear from the get go and needs to be reminded every step of the way—that we aren't just looking to have conversations about teaching and learning. We are specifically looking to discuss student thinking.**

Provide multiple opportunities for video capture. A second recommendation is to allow teachers multiple opportunities to self-capture video. We recommend this for several reasons. First, positioning the camera and/or microphone can be difficult; teachers benefit from having some practice—trying out different placements, watching the video, and reflecting on the benefits and drawbacks of these placements. One teacher shared several issues and concerns that arose for her when she videotaped in her classroom, "What to tape and whether I would get anything good . . . where should I put [the camera], whether I should put it in the front of the class during a discussion or try to do a group . . . which group do I pick." Second, when capturing short video clips, we have found that it takes time for some teachers to remember to activate a camera while they are also teaching a lesson. Self-capturing video while teaching seems to become easier with experience. We find it particularly helpful to require teachers to first capture video where the stakes are low (i.e., when it is not imperative that the video be of high quality for the intended purpose) in order to become proficient with video capture before they do so under the pressure of needing to capture high-quality video for a specific purpose.

Support teachers in designing and enacting lessons that include events of interest. Finally, what is captured on video is what is available to be seen, analyzed, and discussed. If the purpose of video capture and analysis is to examine student thinking, for example, then attention needs to be given to eliciting student thinking during instruction. Likewise, if the goal is to capture student-to-student discourse, then the lesson needs to provide opportunities for students to communicate with one another. This may require supporting teachers in designing and learning to enact lessons that will afford opportunities for particular types of events and interactions to arise during instruction. Our experience has been that through multiple cycles of video capture and analysis, teachers come to see that particular types of interactions may not be occurring in their classrooms, and they then attempt to create such opportunities in future lessons. This further supports our prior recommendation for multiple opportunities to capture video. Not only do teachers develop routines and practices for capturing and selecting clips, but they also come to develop a better sense of the kinds of clips that lead to productive discussion and allow them to gain deeper insight into the complexities of teaching and learning.

Conclusion

We conclude by proposing that the act of self-capturing video in and of itself is a form of professional development. By taking on this role, teachers become more deliberate and intentional in two important and mutually supportive ways: (1) planning for and enacting particular types of interactions in their classrooms and (2) planning to capture these interactions for later viewing and analysis. As a result, teachers become authors of their own learning. Teachers' active participation in self-capture gives them more agency over what they capture and share with colleagues, how they analyze and reflect on their own and others' teaching, and how they collaborate with others to explore the particulars that arise in their instruction. We conjecture that it is this ability to place the learning in teachers' hands that makes self-captured video particularly promising for improving mathematics teacher education and professional development and, more important, mathematics teaching. Finally, we recognize that it can often seem daunting to capture video of one's own teaching and share

this video with others and to navigate the logistical and substantive issues related to using self-captured video. We hope, however, that we have provided some guidance in getting started using this tool by specifying several areas in which teachers and teacher educators can make deliberate choices about how to make the most of teacher self-captured video.

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Appendix A: Equipment for Teacher Self-Captured Video

A range of equipment is available for teachers to use to self-capture video of their teaching. When choosing equipment, we find it useful to consider how easy the camera is to use, how easy it is to upload video from the camera, and the quality of the video and audio produced. Teachers may prefer to use cameras with which they are already familiar, whether that means a traditional video camera or their personal smart phone. In any case, becoming familiar with the range of equipment that is available can help teachers get the most out of their recording experience. We also provide suggestions on cameras and accessories to get started.

Video Cameras

We have worked with teachers using four different types of cameras to self-capture video: conventional video cameras, pocket cameras, smartphones/tablets, and wearable cameras (see Table A). Conventional video cameras have been used to record classrooms for many years. Current versions are much smaller than their predecessors and offer digital recording options. Though these cameras can be held and carried around the classroom, teachers typically place them on a tripod and leave them stationary while videotaping. Conventional video cameras usually offer the best picture quality for the price, and offer optical zoom, which permits close-ups without degrading picture quality. Many of these cameras record to removable memory cards so teachers can select the amount of storage that is appropriate, although some models only come with built-in storage capabilities.

Pocket cameras are similar to conventional video cameras in their features, although they have reduced optical zoom capabilities, if any at all. Compared to conventional cameras, the quality of the image may not be as clear when using the zoom capability. However, these cameras are small enough that teachers easily carry them around the classroom and record selected aspects of a lesson. Their small size also allows them to be placed on desks with groups of students with minimal disruption.

Phones and tablets are a relatively new way to capture video that can be particularly convenient if teachers already own one of these devices. One benefit of smartphones and tablets over the pocket camera is that the screen tends to be larger, which improves the capture and re-viewing experience. Many of these devices also offer simple editing tools to create clips from longer video or make other adjustments. However, these devices often do not accept removable memory cards, so video recording is limited to the free disk space on the device. Additionally, using an external microphone typically requires purchasing specific kinds of adapters or microphones.

Another camera option is the wearable camera (e.g., Drift Ghost-S, GoPro). These are commonly used to videotape sports and action from the point of view of a person. Although not a common choice for videotaping classrooms, some teachers prefer the perspective they offer. Some models (e.g., Drift Ghost-S, Looxcie HD) offer *selective archiving*, the ability to select moments of video to save immediately after they occur, or *video tagging*, the ability to mark moments while capturing video. This can be of interest to teachers who want to decide in the moment of instruction what video to capture. In addition, these cameras typically come equipped with a wide-angle lens; thus, the entire classroom is visible in the field of view from many positions. This perspective is often impossible to achieve in any position with the other types of cameras. Last, some models of wearable cameras also have the capability to be placed in a stationary position using a tripod, offering additional flexibility in their use.

Table A highlights the features we find noteworthy for each type of camera that are particularly common of high-quality cameras in that category. In addition, we identify specific cameras for each category as a starting point for identifying products to get started with self-capturing video.

Accessories

Two accessories frequently used to capture video are tripods and microphones. Tripods provide a more stable video image that can be easier to watch than video collected by someone who is moving. In the past, teachers have typically used a traditional tripod that stands on the floor and adjusts to different heights, allowing them to position the camera to capture the video from the height of the students. More recent options include desktop and magnetic tripods. The benefit of these newer tripods is that they are smaller and can be moved around a classroom easily. Magnetic tripods, in particular, easily attach to many surfaces in the classroom, such as whiteboards and metal file cabinets.

Additionally, external microphones are often used to increase the audio quality and provide flexibility to capture sound from a variety of classroom locations.

Table A
Video Camera Options

Camera type	Noteworthy features	Example cameras
Conventional video camera	High image quality	Canon Vixia® HF R500
	Optical zoom	Sony Handycam® HDRCX240/B
Pocket camera	Small and lightweight	Kodak Playtouch®
	Low cost	Tascam® DR-V1HD
Smartphone/Tablet	Larger screen for capture, reviewing, and editing	iPod touch®
		iPhone®
	Easy to edit and upload/share	Android smartphone
Wearable camera	Wide-angle field of view	Drift Ghost-S (selective archiving)
	Selecting archiving or mark moments	GoPro® HERO4 (mark moments)

Table B
Additional Accessories for Video

Types of accessories		Example products
Tripods	Traditional tripod	Sunpak TravelSmart digital tripod
	Desktop tripod	Joby® GorillaPod Hybrid® tripod
	Magnetic tripod	Joby GorillaPod magnetic flexible tripod
	Phone/tablet tripod Mount	Joby GripTight Mount®
Audio and microphone	Wireless microphone	Sony® ECM-AW3 Wireless Bluetooth microphone
		Azden WMS-Pro wireless microphone
	External microphone	Sony® ECMCS3 stereo microphone
		Crown® Sound Grabber II
		PZM condenser microphone
	Audio extension cord	3.5mm male to 3.5mm female extension stereo audio cable

Microphones can be placed directly on the camera or they can also be placed in a different location than the camera by using an extension cord or a wireless microphone. To use an external microphone with a camera, the camera needs to have an external microphone jack, which may be a factor in a teacher's camera selection. Many wearable cameras and conventional cameras now come with external microphone jacks, but they are rarely found on pocket cameras.

Memory cards and storage devices may also be needed for self-captured video. Most cameras use either a memory card to store the video or have built-in storage. Memory cards that are 16 GB or larger are recommended because they hold up to 2 hours of 1080p HD video. If teachers will be capturing extensive amounts of video over time, we recommend purchasing an external hard drive to store and organize the teacher-captured videos. Alternatively, various web sites

(e.g., Dropbox®.com) exist for uploading, storing, and sharing video files.

Video Storage and Sharing

For most digital cameras, transferring video from a camera to storage has become fairly easy. In many cases, the camera can be connected directly to a computer and the files from the camera can be copied and pasted directly from the camera to a computer or external hard drive. When using removable memory cards, the card can either be inserted directly into the computer to download video and photos or an adapter can be plugged into the computer that allows users to upload images from memory cards. Smartphones and tablets, as well as some newer conventional and wearable cameras (e.g., GoPro Hero3), also have the option of sharing or uploading video directly from the camera over WiFi.

(**Return to page 7**)