Video as a Tool for Fostering Productive Discussions in Mathematics Professional Development

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Abstract

This article explores the use of classroom video as a tool for fostering productive discussions about teaching and learning. The setting for our research is a two-year mathematics professional development program, based on the Problem-Solving Cycle model. This model relies on video from the teachers’ own classrooms and emphasizes creating a community in which members feel comfortable learning from video. We describe our experiences carrying out the Problem-Solving Cycle model, focusing on our use of video, our efforts to promote a supportive and analytical environment, and the ways in which teachers’ conversations around video developed over a two-year period.
0. Introduction

“I think this [watching and discussing video clips] was the single most valuable part of the STAAR program. I have learned the most about my teaching by watching my teaching practice. Even better, though, was watching others teach a lesson that I also taught. My ideas have been sparked by others in this group. Having a safe place to watch ourselves and not feel like we were being criticized or evaluated was critical also.” (Ken, final Year 2 written reflection, May 2005; emphases by the teacher)

Teacher professional development programs, by and large, seek to increase teachers’ professional knowledge, improve classroom practices, and ultimately foster student learning and achievement gains (Fishman, Marx, Best, & Tal, 2003; Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). These ambitious goals are widely agreed upon, but we are only beginning to learn how to achieve them or how to measure them in reliable and valid ways (Desimone, Porter, Garet, Yoon, & Birman, 2002; Fishman, Marx, Best, & Tal, 2003). Moreover, although educational scholars generally agree that professional development should be an ongoing, long-term venture from which teachers can continue to benefit throughout their careers, there is much less agreement about what constitutes high-quality professional development or how to assess quality during initial stages of a professional development program (Feiman-Nemser, 2001).

How can we tell, in the initial stages of the formation and enactment of a professional development program, the degree to which it is (or is not) having an impact? How do we know whether the teachers, at least, are benefiting from engaging in the process? One common method of gathering data on this point is to ask teachers about their experience. Although helpful in some regards, particularly in modifying the design of a program, self-report data have obvious
limitations. Another approach is to systematically investigate critical elements of the professional development experience. What counts as “critical” depends on framework within which the program was designed. For example, in the professional development program described in this paper, the use of video to foster productive conversations is a central feature. Because we hypothesize that such conversations can promote new understandings about mathematics teaching and learning, a probe into their nature and evolution provides preliminary evidence regarding the effectiveness of the program.

In this article, we first discuss the theoretical grounding of our model of mathematics professional development. Next we describe the model in some detail, and then we focus in on our use of video to foster productive discussions about teaching and learning. Our aim is to investigate the nature of the conversations in which teachers engaged after viewing video excerpts from their own classrooms, and to explore the degree to which these conversations changed over the two-year duration of the program.

1. Professional development: A situative perspective

Our professional development program and research are grounded in a situative perspective on cognition and learning—specifically, that knowing and learning are constructed through participation in the discourse and practices of a particular community, and are situated in particular physical and social contexts (Greeno, 2003; Lave & Wenger, 1991). Although the research base on how to provide high-quality teacher professional development is limited, there is a growing consensus regarding the value both of creating opportunities for teachers to work together on improving their practice and of locating these learning opportunities in the everyday practice of teaching (Ball & Cohen, 1999; Putnam & Borko, 1997; Wilson & Berne, 1999).

1.1 The central role of community in teacher learning

Situative theorists draw our attention to the social nature of learning and the central role
that communities of practice play in determining what and how people learn (Greeno, 1997).
From a situative perspective, learning is both an individual process of coming to understand how to participate in the discourse and practices of a particular community, and a community process of refining norms and practices through the ideas and ways of thinking that individual members bring to the discourse (Lave & Wenger, 1991). In educational settings, a situative perspective suggests that strong professional learning communities can foster the enhancement of teachers’ professional knowledge and improvement of practice (Little, 2002).

1.2. Situated learning and artifacts of practice

Situative theorists also posit that the contexts and activities in which individuals learn are fundamental to what they learn (Greeno, Collins, & Resnick, 1996). A focus on the situated nature of knowing and learning suggests that teachers’ own classrooms are powerful contexts for their learning (Putnam & Borko, 2000). It does not imply, however, that professional development activities should occur only in K-12 classrooms. An alternative is to bring ideas and events from the classroom into the professional development setting through the use of tangible artifacts such as lesson plans, curricular materials, student work, and video of lessons.

2. Video as an artifact of practice in teacher professional development

Video has become increasingly popular as an artifact of practice in teacher professional development because of its unique ability to capture the richness and complexity of classrooms for later analysis (Brophy, 2004). As Sherin (2004) explained, “Video allows one to enter the world of the classroom without having to be in the position of teaching in-the-moment” (p. 13). Video records can highlight aspects of classroom life that a teacher might not notice in the midst of carrying out a lesson, and can capture the social fabric of a classroom (Clarke & Hollingsworth, 2000; LeFevre, 2004). Furthermore, with the aid of external microphones, it is possible to record small-group interactions and teachers’ conversations with individual students.
that are not typically available to an observer in the classroom.

Professional development leaders can select video excerpts to address particular features of teaching and learning that they want to examine; and the video can be stopped, replayed, or otherwise manipulated to focus conversations on those features. Used in these ways, video can support collaborative learning focused on reflection, analysis, and consideration of alternative pedagogical strategies in the context of a shared common experience (Brophy, 2004). Participants in these experiences have “the opportunity to develop a different kind of knowledge for teaching—knowledge not of ‘what to do next,’ but rather, knowledge of how to interpret and reflect on classroom practices” (Sherin, 2004, p. 14).

Brophy (2004) cautioned that teachers do not necessarily gain new insights about their practice from watching classroom video. To be an effective tool for teacher learning, video must be viewed with a clear purpose in mind. When used within a professional development program, clips should be purposefully selected to address specific program goals and be embedded within activities that are carefully planned to scaffold teachers’ progress toward those goals (Brophy, 2004; Seidel et al., 2005). As LeFevre (2004) reminded us, “Video is not a curriculum…. Video is rather a medium which can be developed into a resource and used in specific ways to enhance learning” (p. 235).

Despite the widespread enthusiasm for incorporating video into learning experiences for teachers, there has been relatively little systematic research on the feasibility or effectiveness of various types and uses of video in teacher professional development (Brophy, 2004). The research reported in this article is one attempt to address this limitation. We describe a professional development program in which video excerpts from teachers’ own classrooms were used to foster conversations about improving teaching and learning. We analyze the nature of discourse around video that evolved throughout the program and highlight features of our
approach that appear to be key to fostering rich and productive video-based conversations. We first review what others have learned from similar efforts.

2.1. Teachers watching video of their own classrooms

Professional development programs that incorporate video as an artifact of practice can generally be classified as programs in which teachers examine video from other teachers’ classrooms (i.e., from teachers not participating in the program) or programs in which they examine video from their own classrooms (i.e., from teachers participating in the program). Although any videotape of classroom instruction can situate professional development in a setting that is likely to prove meaningful for teachers, there are both empirical and theoretical arguments for using video from participants’ own classrooms. Seidel and colleagues (2005) reported on an experimental study in which they compared the experiences of teachers who watched video from their own classroom in a computer-based professional development environment with those of teachers who watched video from someone else’s classroom. Teachers whose professional development was organized around their own videos found the experience to be more stimulating and reported that the program had greater potential for supporting their learning and for promoting change in their instructional practices.

Empirical findings from the Seidel study provide support for the theoretical position that video from teachers’ own classrooms situates their exploration of teaching and learning in a more familiar, and potentially more motivating, environment in contrast to video from unknown teachers’ classrooms. As LeFevre (2004) pointed out, video makes teachers’ own classrooms accessible in a way that other mediums simply cannot, and therefore has the potential to be a powerful catalyst for change and improvement.

Two research projects that used video from participating teachers’ own classrooms as a centerpiece of their professional development, and have been reported in detail, had a strong
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impact on our thinking about how to create an effective professional development program.

Sherin and colleagues (Sherin, 2004, in press; Sherin & Han, 2004; Sherin & van Es, 2002) documented a year-long professional development program for four mathematics teachers at the same middle school. The teachers met regularly throughout the school year to view video excerpts from their own classrooms and discuss issues that appeared salient to them. Sherin and colleagues referred to the meetings as “video clubs.” A central purpose of these video clubs was to help the teachers develop “professional vision”—a specialized knowledge that would enable them to make sense of what was happening in their classrooms through selective attention and knowledge-based reasoning. Video was used as a resource to help teachers learn to critically notice and interpret classroom interactions. It provided an entry into the classroom without the need to act, which allowed the teachers to reflect on their classroom practices and activities at a more leisurely and thoughtful pace. The researchers found that over time, in the video clubs they studied, important changes occurred in both what the teachers discussed and how the topics were addressed. For example, discussions shifted from a primary focus on the teachers’ decisions and actions to increased attention on students and their mathematical ideas. In addition, the teachers engaged in increasingly detailed and complex analyses of student thinking, and they more closely connected their discussions of pedagogy with their analyses of student thinking.

The Video Case Studies in Scientific Sense Making Project was a four-year professional development program aimed at helping a group of 14 elementary and middle school teachers to better understand an inquiry approach to teaching and learning science (Rosebery & Puttick, 1998; Rosebery & Warren, 1998). Video clips from the participating teachers’ classrooms were an integral component and were used to help the group explore “questions about their students’ learning that arose in light of their classroom practice” (Rosebery & Warren, 1998, p. 7). The participants selected clips for the group to watch and eventually began to frame the presentation
of their clips with specific questions, such as “What did the students appear to understand or be confused about?” The conversations that took place as the group watched videos and engaged in various scientific explorations together helped them to learn that talk can play an important role in “sense-making” in their own classrooms. Rosebery and Puttick (1998) and Rosebery and Warren (1998) presented several detailed accounts of the experiences and knowledge gained by the participating teachers, as well as changes they made in their classroom practices.

These two research projects suggest that teachers can have meaningful discussions with their colleagues around video from their own classrooms. Participants in these multi-year professional development efforts increasingly explored the nuances of their students’ thinking, and considered the dynamic relationship between student thinking and their instructional practices. In both projects the conversations evolved in important ways over time, and studying this evolutionary process enabled the researchers to describe what and how the teachers learned from their participation.

2.2. The importance of a supportive community for video-based professional development

Several researchers who attempted to bring video into their professional development programs noted the importance of establishing a supportive community. Two of the teachers in the video clubs that Sherin and Han (2002) documented “were self-conscious about being videotaped” (p. 166). Although the original intention was to view and discuss video excerpts from all four classrooms, only two participants were willing to be filmed and to share the footage from their classrooms during the video club meetings. Sherin and Han argued that the video clubs were a productive learning experience for all four teachers, however, because they shared enough aspects of practice such as common curricular materials that they were able to work together as a community and “participate equally within the group” (p. 180).

Grossman, Wineburg, and Woolworth (2001) experienced a similar problem in their
Community of Teacher Learners project. This project brought together English and history teachers from an urban high school with university-based educators to read books, discuss teaching and learning, and design an interdisciplinary humanities project. The proposal for the project included plans for a video club. However, as the researchers explained, “We had only a single meeting of the video club because the majority of the teachers in the project decided not to continue with it” (p. 1002). Grossman and colleagues hypothesized that some of the difficulties in their professional development efforts might have been attributable to the fact that the teachers worked together in the same two departments in the same school. The teachers did not have a “collegial culture,” and long-standing tensions often surfaced during their meetings. Ultimately, a book club worked better for these teachers than a video club, perhaps because professional development centered on videos more readily exposes actual teaching practices and therefore requires a higher level of trust and respect.

Establishing a collegial learning community is a critical aspect of most professional development endeavors (Little, 2002; Putnam & Borko, 2000). A strong community is particularly important when teachers are asked not only to discuss teaching and learning but also to share video clips from their classrooms with their colleagues. Sharing classroom video is likely to seem more threatening to teachers than sharing other artifacts such as student work and lesson plans. To be willing to take such a risk, teachers must feel part of a safe and supportive professional environment. They also should feel confident that showing their videos will provide learning opportunities for themselves and their colleagues, and that the atmosphere will be one of productive discourse.

3. What are productive discussions and how can they be fostered in professional development?

Cook and Brown (1999) pointed out that John Dewey was a strong proponent of what he
called “productive inquiry,” or the deliberate and active pursuit into a provocative question or troublesome situation. They explained Dewey’s philosophy in the following way: “One end result of engaging in the (situated, dynamic) activity of productive inquiry is the production of (abstract, static) knowledge, which then can be used as a tool for further knowing” (p. 388).

Extending this idea into the realm of teacher professional development, researchers have begun to argue that inquiry into meaningful topics must be a central feature of professional development programs (Wilson & Berne, 1999). Too often, however, school cultures discourage teachers from critiquing and challenging each other’s professional ideas. Thus, “there is no basis for comparing or choosing among alternatives, no basis for real and helpful debate. This lack impedes the capacity to grow” (Ball, 1994, p. 16).

Merging the ideas of productive inquiry and learning within a professional community, we argue that professional development programs should seek to foster productive conversations in which teachers discuss issues directly related to their own teaching and their students’ learning. McLaughlin and Talbert (1993) put forth a similar argument that for teachers to be successful in changing their practice, they need opportunities to participate “in a professional community that discusses new teacher materials and strategies and that supports the risk taking and struggle entailed in transforming practice” (p. 15). Conversations in these communities should promote a critical examination of teaching; they should enable teachers to collectively explore ways of improving their teaching and support one another as they work to transform their practice. To foster such conversations, professional development leaders should help teachers to establish trust, develop communication norms that enable challenging discussions about teaching and learning, and maintain a balance between respecting individual community members and critically analyzing issues in their teaching (Frykholm, 1998; Seago, 2004).

Artifacts of teaching and learning have the potential to play a central role in fostering
productive conversations by focusing teachers’ attention on specific instances of classroom practice (Ball, Ben-Peretz, & Cohen, 2001). For example, artifacts can support the close examination of student thinking and learning, instructional strategies, and enactment of curricular tasks (Ball & Cohen, 1999). As we have argued, video from teachers’ own classroom lessons are likely to be a motivating source for discussions around these issues.

4. The STAAR professional development program

Our reading of the theoretical and empirical scholarship on developing teacher learning communities, using video as an artifact of practice, and fostering productive discussions, informed the design of our professional development model. Through the Supporting the Transition from Arithmetic to Algebraic Reasoning (STAAR) Project we worked with middle school mathematics teachers for two years, developing and refining this model. We used video from the teachers’ classrooms, together with other artifacts such as their lesson plans and students’ work, to situate the professional development firmly within the participants’ own practice. One of our main emphases throughout the project was on creating and maintaining a learning community, in which group members felt comfortable watching, discussing, and learning from video.

4.1. The Problem-Solving Cycle

At the core of the STAAR professional development program is the Problem-Solving Cycle (PSC), a series of three interconnected professional development workshops in which teachers share a common mathematical and pedagogical experience. The PSC model is designed to help teachers enhance their understanding of foundational mathematical concepts while also closely examining pedagogical practices and student thinking (see Figure 1). The three workshops that comprise one iteration of a Problem-Solving Cycle center around a single, rich mathematical task. Throughout the workshops, teachers delve deeply into issues involving
mathematical content, pedagogy, and student thinking, as they pertain to the selected task. The PSC model is intended to be an iterative, long-term approach to professional development. Each cycle focuses on a unique mathematical task and highlights specific topics related to teaching and learning. As they participate in multiple cycles, over time, teachers are provided with new learning opportunities and can continually broaden their professional knowledge base (Koellner et al., in press).

During Workshop 1 of the Problem-Solving Cycle, teachers collaboratively solve a mathematical task and develop plans for teaching it to their own students. The main goal of this workshop is to help teachers develop the content knowledge necessary for planning and implementing the problem. Thus, the mathematical task should be one that will support the development of algebraic reasoning for both the participating teachers and their middle school students.

After Workshop 1, each participant teaches the problem in one of his or her classes, and the lessons are videotaped. In the STAAR program we used two cameras to film each lesson. One camera followed the teacher throughout the lesson, and a second camera captured one group of students as they worked during small-group activities.

Workshops 2 and 3 of the Problem-Solving Cycle focus on teachers’ experiences implementing the problem. To situate teachers’ explorations in their classroom practice and anchor the discussions, these workshops rely heavily on clips from the videotaped lessons. Teachers watch and discuss video excerpts selected by the workshop facilitators in both small-group and whole-group contexts. Facilitators frame the viewing of these excerpts to focus
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teachers’ attention on particular features of instruction (Workshop 2) or on student thinking about the mathematics (Workshop 3). Workshop 2 typically begins with teachers reflecting on and sharing their experiences teaching the problem. The major focus of this workshop is exploring the teacher’s role; topics might include using rich mathematical tasks and orchestrating classroom discourse. The selected video clips might show how teachers introduced the task or questions they posed to students as they worked on the task. Activities in Workshop 3 center on a critical examination of students’ mathematical thinking. The selected video clips might show unusual or unexpected methods students used or interesting conversations they had with one another about the problem.

All three workshops include opportunities for the teachers to talk in small groups as well as a full group. During small-group time, the facilitators listen to portions of each group’s conversation in order to get a sense of the important ideas. They then encourage the teachers to share their thoughts in the full-group setting, ensuring that the majority of ideas are vetted by the entire group. In this paper we focus on full-group discussions, with the expectation that those discussions provide a relatively complete portrayal of the ideas generated during the workshops.

4.2. Research problem and questions

This paper describes our use of video in the STAAR professional development program, our efforts to foster a supportive and analytical environment, and the ways in which teachers’ conversations and interactions around video developed over a period of two years. The analyses we present examine conversations in the Problem-Solving Cycle workshops that revolved around excerpts from videotaped mathematics lessons. We concentrate on the first and third iterations of the Problem-Solving Cycle in order to provide a detailed analysis of changes in discourse patterns over time. PSC 1 and PSC 3 took place one year apart, in spring 2004 and spring 2005, respectively. Because our focus is on video-based conversations, we look in depth at Workshops
2 and 3 in both of these PSCs. Our two main research questions are: (1) What was the nature of the full-group discussions around video, and (2) How did these discussions change over time?

5. Method

The STAAR professional development program began in summer 2003 with a two-week algebra institute. (For more information on the summer institute, see Borko et al., 2005). Over the next two academic years we held monthly, full-day professional development workshops. During each year there were seven workshops. In the majority of these workshops, the group spent a substantial portion of the day watching and discussing video excerpts from selected mathematics lessons.

In spring 2004 we conducted the first iteration of the Problem-Solving Cycle. We conducted two more iterations during the 2004–2005 academic year. Each iteration was built around a different mathematical task and focused on different aspects of the teacher’s role and students’ mathematical reasoning. In the first PSC we used the “Painted Cubes” task; in the third we used the “Skyscraper Windows” task. Both problems were adapted from Fostering Algebraic Thinking: A Guide for Teachers, Grades 6-10 (Driscoll, 1999). Appendix A provides the text of the two tasks, to which we refer throughout the paper.

5.1. Participants and the STAAR Project team

Sixteen teachers enrolled in the STAAR summer algebra institute. Eight of the 16 participants attended the monthly professional development workshops held during the 2003–2004 academic year. All eight were middle school mathematics teachers, with classroom experience ranging from 1 to 27 years. They represented six different schools in three school districts within the state. In 2004–2005, seven of the teachers continued working with us and three additional middle school mathematics teachers joined the program. Each new teacher was a

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1 The final workshop at the end of each academic year functioned primarily as an opportunity for reflection and celebration. The teachers reflected in writing and orally, individually and as a group, on their experiences in the STAAR professional development program and celebrated their progress.
colleague of one of the current participants.

The STAAR Project team that developed and conducted the professional development program included two university professors, two postdoctoral research associates, and five graduate students pursuing doctoral degrees in education. The summer algebra institute and all monthly workshops were co-facilitated by two of the graduate students (the students shifted roles at several points throughout the project).

The entire STAAR Project team participated in planning and debriefing the summer institute and each monthly workshop. A majority of the team members attended the summer institute and the workshops, videotaping and keeping detailed field notes. We used multiple cameras to film whole-group and small-group interactions, and we collected all of the teachers’ written work completed during the professional development program. The facilitators were interviewed after each workshop in order to document their goals, intentions, and reactions.

5.2 Workshops prior to the development of the PSC model

We conducted the summer algebra institute (in July 2003) and first three professional development workshops (in fall 2003) prior to the first iteration of the Problem-Solving Cycle. The algebra institute focused heavily on establishing a professional learning community as the teachers engaged in the study of algebraic content central to the middle school curriculum. The institute facilitators strove to develop and model norms for productive mathematical discourse. When a subset of these teachers agreed to participate in the monthly professional development workshops, they had already formed a cohesive group that was relatively comfortable engaging in critical dialogue and reflection (Borko et al., 2005; Clark, Jacobs, Pittman, & Borko, 2005).

A primary goal of the three workshops that preceded the Problem-Solving Cycle was to develop norms for viewing and analyzing classroom video. During the first workshop the facilitators played video footage from the summer algebra institute. By showing this video, they
were able to expose themselves as “teachers” for the group’s review. In addition, the facilitators used this footage to introduce the idea of considering videotaped events through a specific analytical frame, in this case “classroom discourse.” As the group discussed video from the institute, they talked at length about what the word “discourse” means and the types of discourse they saw. Next the group watched video footage from a Japanese teacher’s lesson (National Research Council, 2002), again through the lens of discourse. Here the intent was to introduce the practice of watching video from an actual middle school mathematics classroom. One of the facilitators, Craig, explained that this video was part of a “lesson study” endeavor and noted, “The point is that they are not analyzing the teacher. They’re analyzing just the lesson.”

The facilitators also distributed a copy of the article “The New Heroes of the Teaching Profession” (Hiebert, Gallimore, & Stigler, 2003) to all of the participating teachers. The premise of the article is that teachers who are willing to have their classrooms videotaped and subjected to critique are providing an invaluable learning opportunity for their colleagues. In one workshop, when several teachers began to harshly criticize an unfamiliar teacher’s mathematics lesson, the facilitators reminded them about the “heroes article” and the group immediately began talking more respectfully. In fact, in response to a participant’s suggestion that they commend the videotaped teacher for allowing her lesson to be publicly accessible (via the Internet), the entire group broke into applause.

After receiving enthusiastic feedback from the teachers regarding their experiences analyzing video excerpts, the facilitators showed clips from one participant’s eighth-grade mathematics lesson. At this point in the STAAR program all of the participants had been videotaped teaching in their mathematics classrooms, although they had not yet engaged in the Problem-Solving Cycle. One teacher had used a mathematics task from the summer institute in

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2 Actual names are used for the STAAR Project facilitators; pseudonyms are used for the teachers and students.
her videotaped lesson, and the project team agreed this would be meaningful video for the group to consider because they would easily be able to follow the mathematical ideas. Prior to viewing the clip, the facilitators introduced a new analytic frame—reasoning and proof—and provided several discussion questions. Initiating a pattern that became common throughout the PSC workshops, the videotaped teacher, Kristen, offered the most criticism of her own instruction while the others in the group primarily offered support and suggestions.

By the conclusion of the fall 2003 workshops, the teachers appeared ready and willing to open up their own classrooms for review, and they had established a community in which they could talk respectfully while engaging in critical analyses of teaching and learning. In interviews conducted in January 2004, shortly after the first workshop of the first Problem-Solving Cycle, two of the facilitators discussed why they felt this professional development model would be beneficial for the teachers. Craig explained, “I think it becomes more meaningful when [the teachers] start looking at video because they’re not just watching some stranger’s video… [or] one of their colleague’s videos. It’s a common experience they’ve had as well.” Mary added, “I think community needed to be there. I think if we had walked in the first day and said, ‘Okay, do this problem now [and then] go teach it,’… they would have been less comfortable sharing their videotapes [and] opening themselves up.”

5.3. Data analysis

We drew upon multiple data sources and used various analytic techniques to address our research questions about the nature of full-group discussions around video during the Problem-Solving Cycle, and how these discussions changed over time. One of our first steps was to create a catalogue detailing the activities and discussions that took place during each professional development workshop. This catalogue enabled us to identify all full-group discussions around video. We then conducted both a quantitative analysis based on coding of these discussions and a
5.3.1. Coding of discussions

We coded all full-group discussions from the first and third Problem-Solving Cycles in two-minute intervals. We found two minutes to be a reasonable coding unit because it carried a meaningful amount of conversation and did not cause a cognitive overload. We excluded time spans of two minutes or more during which teachers watched video without commenting. However, we did code times when the teachers briefly paused the video to comment, or talked while the video was playing. To develop meaningful coding categories, we used an iterative process that involved considering the relevant literature (especially Sherin, in press, and Sherin & Han, 2002) and exploring our own data. Ultimately we developed four main categories, each with several subcategories.

(1) When the conversation took place.

Subcategories: (a) before, (b) during, (c) after watching video.

(2) Who participated in the conversation.

Subcategories: (a) facilitator, (b) videotaped teacher, (c) other teachers.

(3) What type of conversation took place.

Subcategories: (a) setting up the discussion about the video, (b) describing (not evaluating) events in the video, (c) critiquing events in the video, (d) giving suggestions for how events in the video could be improved, (e) asking questions about events in the video, (f) identifying with events in the video.

(4) Content of the conversation.

Subcategories: (a) teacher’s thinking, (b) students’ thinking, (c) pedagogy, (d) mathematics.

For all four main categories, the subcategories were not mutually exclusive; thus, a segment of a conversation could be coded in as many subcategories as were relevant. For
example, a given two-minute segment could span the period of time before the video started and while it was being shown; the speakers could include the facilitator and the videotaped teacher; the talk could involve setting up the discussion and asking questions about events in the video; and the conversation could reference both the teacher’s thinking and the students’ thinking.

To be coded in the “what” category, the conversation in some portion of the two-minute segment had to be directly linked to videotaped events or student thinking evidenced in the video. In cases where none of the talk in the segment was directly linked to events or thinking displayed in the video (but the conversation was still related to the video), the “what” category was not marked. The “content” category was defined more broadly; although the segment had to contain talk that was in some way related to the video, speakers did not have to specifically reference events or thinking displayed in the video. For example, the teachers could comment on their own knowledge, their own experience with students, pedagogical strategies they were familiar with, or mathematical content beyond what was captured on the video.

Each of the authors independently coded the data using video from the workshops together with written transcripts of the group’s conversations. The authors then met to compare coding, clarify or revise the coding definitions, and recode when necessary. We came to a consensus for all coding decisions, frequently rewatching portions of the videotaped conversations together and discussing segments until agreement was reached.

5.3.2. Vignette analysis

To provide a more thorough response to our research questions, we also conducted a vignette analysis that incorporated the videotaped footage as well as related data gathered from each professional development workshop (such as field notes and written teacher reflections),

\[3\] This kind of talk (i.e., talk that was related to the video but did not reference events or thinking displayed in the video) most often took place when the teachers delved deeply into an exploration of the mathematical content; for example, when they reworked the focal problem in order to better understand a conversation that took place in the video. We provide an extended look at such an occurrence in section 6.4.2.
transcribed interviews with the facilitators (conducted after each workshop), transcribed interviews with the teachers (conducted at the conclusion of the project), and written notes from our project team meetings. The vignette analysis enabled us to explore more deeply the substantive characteristics of the discussions that were associated with patterns in the coded data, and to examine participants’ reactions to those discussions.

We created four vignettes to depict the nature and evolution of whole-group discussions around video. Two vignettes portray conversations with a focus on the teacher’s role in PSC 1 and PSC 3, and two portray conversations with a focus on student thinking in the two cycles. Our aim in these vignettes is to illustrate specific features of the conversations and related activities in detail, while at the same time preserving the complexity and richness of the context from which they were drawn (Miles & Huberman, 1994). Within each vignette we note how the discussion around the selected video clip began and ended, and we capture the main ideas that emerged. The vignettes are “normative depictions” or “realist tales”; that is, they are short descriptions intended to reconstruct and authentically represent the events, people, and activities under consideration (Erickson, 1986; LeCompte & Schensul, 1999; Van Maanen, 1988).

6. Results and discussion

6.1. Overview of results

The results section is organized to address our two research questions. First we document, broadly, the discourse trends in the first and third Problem-Solving Cycles, and we consider how these trends changed over time. Then we look in greater depth at the discussions that were specific to the teacher’s role and students’ thinking in these two Problem-Solving Cycles. Recall that in the design of the Problem-Solving Cycle model, Workshop 2 focuses on the teacher’s role and Workshop 3 focuses on students’ thinking. In keeping with these distinctions, we have separated the conversations along these two dimensions.
For the more in-depth examinations of the four sets of discussions, we consider patterns from the coded data along with illustrative vignettes. Following each vignette, we provide a brief analysis that connects to the relevant coding categories and highlights key features of the discussions. Summary analyses that draw from both the coding and vignette analyses are provided at the end of the results section. There we identify and interpret patterns along two dimensions: (1) the two iterations of the PSC and (2) discussions focused on either the teacher’s role or students’ thinking (within each PSC).

6.2. Nature of the discourse around video in PSC 1 and PSC 3

Table 1 presents the results of coding all full-group discussions around video during the first and third Problem-Solving Cycles. Several important similarities can be noted. In both iterations of the PSC, the facilitators and non-videotaped teachers talked in the vast majority of two-minute segments. The conversations tended to be inclusive, frequently involving several teachers including the videotaped teacher. From the onset, the teachers critiqued events in the video (both positively and negatively), asked questions, and made remarks indicating that they identified with the videotaped teacher. This type of discourse continued in the third PSC. With respect to content, the group focused on teachers’ thinking and pedagogy to a similar extent in the two PSCs.

Perhaps more striking are the differences between the Problem-Solving Cycles. One clear distinction is the amount of time the teachers spent talking about video as a full group. In the first PSC we coded 37 segments (approximately 74 minutes), and in the third PSC we coded 77 segments (approximately 154 minutes). Not only did the group spend about twice as much time
discussing video in PSC 3, they devoted less time to setting up the discussion prior to watching the video, and more of their conversations took place after watching the video. Taken together, these findings suggest that as the group gained experience analyzing video clips, they were able to have more extended conversations about the selected excerpt with less lead-in time.

Many of the subcategories identifying the types of conversation that took place are coded less frequently in PSC 3 than in PSC 1. This pattern can be explained, in part, by the fact that the “what” category was not coded if the discourse moved away from the videotaped events. As we further discuss later in the paper, conversations that extended from viewing video but did not directly reference the videotaped events occurred more frequently in PSC 3 than in PSC 1.

An examination of the “content” category within the first PSC reveals that comments about students dominated the discussions. In the third PSC, the conversation topics were more evenly divided among the four subcategories (teacher’s thinking, students, pedagogy, and mathematics). In contrast to PSC 1, where relatively little time was devoted to actively exploring mathematical content, in PSC 3 the discussions most frequently involved mathematical content.

6.3. Discussions about the teacher’s role

In the first iteration of the Problem-Solving Cycle, the STAAR team elected to focus on the teacher’s role in introducing and concluding the Painted Cubes task. In keeping with this focus, we selected two sets of video clips: the first set showed a teacher’s introduction to the problem, and the second set showed a (different) teacher’s conclusion. Full-group discussions around these clips were relatively brief, totaling approximately 22 minutes (see Table 2). The majority of the conversations took place prior to watching the clips or during the time that the video was playing (or briefly paused). Almost three-quarters of the coded segments included comments that set up the discussion or describe events in the video clips. About half contained critiques, both positive (mostly by the facilitator) and negative (mostly by the two videotaped
teachers, about themselves). The participants sometimes asked questions or made comments identifying with the situation in the video. Consistent with the intended focus of the workshop, much of the content of the discussion related to pedagogy, but a number of comments were also about students.

During the third iteration of the PSC, the analytic focus was on three aspects of the teacher’s role: introducing the Skyscraper Windows task, posing questions, and listening to students’ reasoning. Correspondingly, the facilitators showed three sets of video clips. The discussions around these clips were much longer than the comparable discussions in PSC 1 (see Table 2). Furthermore, in PSC 3 the majority of the conversations took place after the teachers had watched the clips, and the participants spent less time setting up the discussion or describing the events they saw. They offered critiques, asked questions, and identified with the teacher with approximately the same frequency as in PSC 1; however, they gave suggestions more often. With respect to content, conversations in PSC 3 were similar to PSC 1 in their strong focus on pedagogy. Other topics, particularly about students, also came up frequently.

6.3.1. The teacher’s role in PSC 1

The vignette that follows is from PSC 1 and depicts the group’s interactions as they watched and discussed the first set of video clips from the Painted Cubes task. The video is from Pam’s lesson and shows how she introduced the problem to her eighth-grade students. One of the primary reasons the STAAR Project team selected this footage is that Pam modified the problem in a unique way. Specifically she presented her students with “color-coded” cubes in an attempt to highlight the visual nature of patterns that can be identified within cubes. The facilitators
pointed out this modification, but overall their framing of the clip was rather general and they did not provide written discussion questions.

After the teachers informally share stories of the trials and tribulations in their efforts to teach the Painted Cubes task, there is an air of nervousness in the room as the facilitators prepare to show the first video excerpts. Mary briefly explains the parameters for the discussion, telling the group:

Think about how you set the problem up. And even prior to setting the problem up, all that planning that you guys did…. It’s not about standing back and just letting things happen…. For things to happen and happen well, we as teachers are really important. But what does that look like? What does that mean? What kinds of questions are we asking?

The teachers nod along to suggest they follow what Mary is saying. There is some laughter from the group as Mary jokes about her poor videotaping skills. Audio from the clip is heard briefly and Pam makes fun of her voice, which triggers more laughter from the group. The first of three short video clips from Pam’s lesson plays, showing Pam’s exhortation to her students that they stay focused and work hard on today’s problem. Before the next clip begins, Pam responds briefly to a question from another teacher asking her to clarify how she modified the task.

The group quietly watches the second clip, in which Pam describes the task in more detail. Prior to the third clip, Mary explains that Pam created a worksheet for her students to fill in as they solved the problem. Mary and Pam joke that students often begin completing worksheets as soon as they are handed out, before they are given instructions. The teachers then watch as Pam goes over the worksheet with her class.

When the last video clip ends, Mary calls Pam’s introduction “interesting.” She notes
that Pam’s students, similar to many of the other teachers’ students, had difficulty with some of the vocabulary involved in the Painted Cubes task. Mary asks Pam, “Do you want to talk about that, or do you want me to?” Pam takes the opportunity to acknowledge that she had not anticipated the range of problems her eighth-grade algebra students would have with terms such as “corners” or worksheet prompts such as “give a definition.” Mary prods the rest of the group, searching to hear who else shared in this unexpected problem. Kristen offers, “I debated about it and we went over the vocabulary ahead of time.” Celia notes that even when teachers attempt to anticipate students’ prior knowledge they still may be thrown off by unanticipated questions, as was the case for her when a student asked, “How many angles are on this cube?” That remark ends the discussion and Mary transitions to video from another teacher’s lesson.

This relatively brief discussion around the teacher’s role in introducing the task is typical of the discussions during the first Problem-Solving Cycle. For example, much of the time was spent by various teachers describing events that took place in their own classrooms and comparing them to the events in the video clips. For the most part, the teachers empathized with one another, and while they sometimes criticized their own lessons (or students in general) they were rarely critical of their colleagues. In addition, as this vignette illustrates, the facilitator took an active role in both setting up and moderating the discussion, describing what the teachers should look for in the video clip and helping them to make sense of the classroom events. The group sometimes made connections between specific pedagogical moves and concerns about students. For example, Pam and Celia mentioned unanticipated difficulties their students had understanding various aspects of the problem, and Kristen shared a strategy that she found helpful.

6.3.2. The teacher’s role in PSC 3

By the third iteration of the PSC, the group became more analytical and vocal. Their
interactions are depicted in the vignette that follows, which is based on a discussion about video from Peter’s Skyscraper Windows lesson. The STAAR team intended for this video clip to provide a foray into the central theme of the workshop: teacher questioning. The facilitators prepared guiding questions in order to focus the group’s attention on Peter’s line of questioning when he asked a student to explain her thinking.

The group has just finished watching and discussing one member’s introduction to the Skyscraper Windows task, and now the focus shifts to considering the role of teacher questioning. In preparation for watching and discussing a video clip from Peter’s lesson, the facilitators distribute a handout with two guiding questions. Craig explains that they are going to watch Peter interact with a small group of students. In the clip, Peter studies the solution method written on (student) Kaitlin’s paper, and he poses a number of questions to Kaitlin and her teammates. Craig reads the guiding questions aloud: “How did Peter’s questions help him understand how Kaitlin derived her expression? What additional questions would you ask Kaitlin to further understand her mathematical thinking?”

The teachers view the clip twice and then divide into small groups to consider the discussion questions. After about 12 minutes, the facilitators ask the teachers to share their thoughts with the full group. Although Peter quips that their reactions might cause him to be “in tears,” his colleagues immediately point out questioning techniques that they especially liked. For example, several teachers note that one of Peter’s questions helped Kaitlin to “articulate and explain what those numbers mean” and to “connect the variables back to their origin.” Peter’s colleagues also liked that he asked Kaitlin if she would be willing to show her solution method to the rest of the class, noting that this technique gives Kaitlin “a choice” and helps to “solidify her learning.” Far from the negative comments Peter was expecting, his colleagues point out numerous strategies that they are impressed by and make negative comments only
about the fact that they don’t use Peter’s techniques in their own classrooms.

The conversation then shifts to focus more on the mathematical aspects of Kaitlin’s solution strategy, as several teachers wonder whether Kaitlin is reasoning correctly about how to solve the problem. Most of the teachers, and their students, solved the problem by using the expression $19n + 57$. However, Kaitlin works from the expression $19n + (3\cdot19)$. The teachers acknowledge that her expression is accurate, but are not sure if it is just a lucky guess. They suggest questions that a teacher could ask to probe Kaitlin’s thinking and to determine if she really understands the problem. The group decides to rewatch a portion of the clip two more times, hoping to better understand how Kaitlin is thinking. Gradually the teachers come to agree that Kaitlin’s method of counting by 19s is a reasonable, middle step in the solution process. Kristen exclaims, “I almost think it’s more elegant....It has more meaning.”

As the conversation winds down, Peter becomes reflective about his role in this teaching episode and considers what he could have done to better aid Kaitlin. He says, critically, “I was trying to force her down toward that bottom thing [i.e., $19n + 57$]. And the more you guys have talked about how Kaitlin was thinking, I kind of wish I had processed that a little bit more. Or actually I kind of wish I had stopped talking for about 5 seconds and looked at it.”

Before Peter goes too far with his self-critique, Kristen notes that they had to watch the video numerous times to understand Kaitlin’s mathematical reasoning; she says empathically, “I would not have caught that myself.” Other teachers add that it can be challenging to figure out “what’s in the head” of each individual student. Peter seems comforted by these comments and adds, “You look stupid as a teacher if you don’t have the answer right away. So you just talk. I think that’s probably what I was doing.” He suggests that a better approach might have been to ask the other students in his class to consider how Kaitlin came up with her expression. The facilitators and other teachers agree such an approach could be a very powerful learning tool.
Throughout the discussion of Peter’s video clip, as the group considered the effectiveness of his questions, Peter related powerful insights about some aspects of his teaching that he believed could be improved. In contrast to PSC 1, the facilitators provided more structured discussion questions and intentionally prodded the group to take a more critical look at the teacher’s role. Carefully studying the clip afforded an opportunity to closely examine Kaitlin’s reasoning, and ultimately led Peter and the other teachers to new insights about better ways of asking questions to uncover student thinking. At the same time that they were providing suggestions, the teachers continually offered support and encouragement to Peter and maintained an upbeat and positive tone. The group pointed out Peter’s many strengths as an educator and identified with the difficulty of following a student’s thinking in the heat of the moment. The content of their discussion was multifaceted, as the group considered pedagogical moves in relation to the teacher’s thinking, the student’s thinking, and the mathematics of the Skyscraper Windows problem.

6.4. Discussions about students’ thinking

In the first iteration of the Problem-Solving Cycle, as the group watched video and considered issues related to student thinking in the Painted Cubes task, their analytic focus was on understanding the nature of specific instances of student thinking and looking for evidence that individual students were learning. In contrast to discussions involving the teacher’s role in implementing the Painted Cubes task, discussions involving student thinking required less setup time, and mainly took place after watching the video (see Table 3).

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Insert Table 3 here

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The facilitators and other teachers talked in nearly all of the coded segments, and the
videotaped teacher talked in roughly half of them. A majority of the segments contained description as well as questions. There were a number of critiques (largely positive) and statements in which the teachers identified with the situation based on their own experiences teaching the Painted Cubes task. With respect to content, in keeping with the facilitators’ intentions, most of the talk fell into the “students” category. The group also discussed some of the pedagogical strategies they saw in the clip and, to a lesser degree, the teacher’s thinking.

During the third iteration of the Problem-Solving Cycle, video from one teacher’s Skyscraper Windows lesson was used to anchor the conversation about students’ thinking. The analytic focus was on understanding and extending the students’ approach to solving the problem. As Table 3 indicates, in PSC 3 most of the full-group discussion took place after the teachers had watched the video. The facilitators and other teachers talked in a majority of the segments, and the videotaped teacher talked in about half the segments.

As the vignette portrays, it was not unusual for teachers’ conversations in PSC 3 to move beyond the specific videotaped events. Therefore, the “what” category frequently was not marked. In fact, of the 39 coded segments for students’ thinking, only 18 referred to a videotaped event and were coded in the “what” category. As codes in the “content” category indicate, much of the talk was focused on the mathematics entailed in examining and extending the students’ solution methods. A full three-fourths of the segments included talk about the mathematics content, much more than for any of the other clips analyzed. Secondarily, the talk related to the students and the teacher, and occasionally the conversation included references to pedagogy.

6.4.1. Students’ thinking in PSC 1

The following vignette from PSC 1 portrays the group’s conversation as they considered footage from Celia’s Painted Cubes lesson. The video clip showed Celia interacting with one of her students while he explained his strategy for counting cubes. The STAAR team selected this
clip to highlight an unanticipated but accurate strategy students might use, and to consider the learning that this strategy engenders. Although the facilitators did not provide the teachers with written discussion questions, they did encourage the group to focus on the videotaped student’s thinking and learning processes.

The facilitators, Mary and Craig, introduce the teachers to the idea of considering video excerpts through the lens of student thinking. Prior to showing a video clip selected from Celia’s Painted Cubes lesson, Craig asks the group to consider the following questions: “What evidence of student learning can you see in this clip? Can you try to get inside the kid’s head?” Then, after they have watched the clip, Mary reiterates, “What’s the learning? What’s going on here? Think about where the kid is in this process. Where is he headed? How would you help him?”

The video consists of a period of small-group work in which Celia talks to one student, Nick, about his solution method. Nick explains to Celia that in order to determine the number of blocks with two sides painted in a 4x4x4 cube he multiplied 8 times 3 and got 24 blocks. Although Nick’s answer is correct, his method of counting is unusual and the teachers are unsure whether it would work for a cube of any size.

The teachers watch the video carefully two times before they engage in a discussion. After the second viewing they talk briefly about the mathematical strategy that Nick had in mind. For example, Pam says, “He’s proving it by showing you the sides and saying, ‘Look, look. Three, and eight times three is 24.’ And he was really sure of that…. He sees the entire middle of whatever-sized cube as one layer.” Sensing, however, that most of the group does not completely understand Nick’s method or Pam’s explanation, Mary asks them to talk further in small groups.

When they come back together to have a whole-group conversation, the teachers are able to describe Nick’s thinking with greater clarity and in much more detail. Kristen notes, “It’s not
really eight. It's two, four times.... That's the top layer. And two, four times on the bottom layer. And two, four times on the center layer." The group discusses how Nick’s strategy differs from other, more commonly used counting strategies, and agree that it is correct and appropriate.

The facilitators are conscious of the fact that Celia might be embarrassed by this video, especially when she acknowledges that she did not understand Nick’s strategy when he was explaining it to her. Celia admits, “I was uncomfortable not knowing whether really, to be honest, Nick was right or wrong.” Mary tells her, “Feel really okay about that, because it took six of you 20 minutes [to figure out the mathematics].” Craig adds: “And if you have a classroom environment ... where students can point out something and know that you’re open to hearing that idea, that you’re willing to learn from them, that’s a nice thing. Look at all the mathematics that comes out of it....That’s really powerful for kids.”

This first discussion around students’ thinking helped to set the tone for how to critically analyze unusual or unexpected student reasoning on the selected mathematics task, while at the same time encouraging a supportive environment. Because the lens for viewing this video clip was student thinking and not teacher role, the group focused mainly on Nick and paid less attention to the way in which Celia interacted with him. Unlike the discussion around the Peter and Kaitlin video clip (portrayed in the previous vignette), in which the group dissected Kaitlin’s strategy in the interest of suggesting improvements to Peter’s questions, their discussion of this video clip focused squarely on the student’s strategy and his associated mathematical reasoning. Furthermore, the insight shared by Craig similarly highlighted the powerful learning opportunities for both teachers and students when they study and share alternative solution strategies.

6.4.2. Students’ thinking in PSC 3

The following vignette portrays the discussion in PSC 3 around video of a small group of
students in Laura’s class engaged in the Skyscraper Windows task. Specifically, when one student explained his reasoning to three of his peers, the other students took his approach seriously and worked diligently to solve the problem using a method unanticipated by any of the teachers (or the facilitators). This 5½-minute video clip engaged the teachers for the majority of the professional development workshop. They spent about 1½ hours talking about it as a full group and a similar amount of time in small-group discussions. The STAAR team selected this clip because it involves a creative use of the distributive property. The facilitators prepared discussion questions that focused the group’s attention primarily on the mathematical ideas evident in the video.

**Near the beginning of the third workshop of PSC 3, Craig says with a smile, “The Skyscraper Window problem. Remember this one?”** The teachers laugh, and he hands everyone a printed copy of the problem. Craig tells the group that they will watch a clip from Laura’s lesson and notes that Laura modified the problem slightly for her students, using an 8-story building rather than a 12-story building. Laura explains, “I just thought 12 stories would scare them too much. Those double digits they seem to get scared over.”

Craig also distributes a handout with three questions for the teachers to consider as they watch the video: (1) What are the students doing mathematically? (2) What mathematical background do the students appear to draw on? (3) What new ideas does this clip give you about teaching this problem? Craig reads the questions aloud. As the video begins to play, the teachers laugh at a student’s shirt that reads “Hot Stuff,” but they soon become quiet and concentrate on the clip. After it is over, they move into three small groups, eager to talk about the interactions they just watched.

Craig encourages the teachers to work out the mathematics for themselves, acknowledging, “That’s certainly what I needed to do.” The small groups all have laptop...
computers so they can view the clip, or selected portions, as many times as they want. Laura distributes copies of the written work she collected from the videotaped students.

Noticing that many of the small groups have written out complex mathematical statements, Craig asks that a representative from each group write their ideas on the white board at the front of the room in preparation for a full-group conversation. He then initiates the discussion by saying, “So this was what the Kristen, Laura, and Pam group wrote here. Do you want to walk us through it a little bit?”

Laura begins explaining, with input from her colleagues, how the students used the distributive property and “factored out the 38.” They calculated the cost of one window per floor and then multiplied that sum by 38. Pam notes that although she and her colleagues were impressed by this unexpected solution method and it does lead to the correct answer, it is somewhat inefficient. She explains, “We were first thinking, ‘Wow. This is cool.’ But they were still stuck at that numeric level because they didn’t have a formula that sums the cost of one window per floor for the entire building. So if we would have asked them, ‘What about a 50 story building?’ They would have to add $2, $2.50, $3, $3.50 all the way to the 50th floor.”

The other teachers agree that the videotaped students approached the Skyscraper Windows task in this numeric manner, and they begin expanding on the approach in order to come up with a generalized expression. Their exploration of the mathematics enters more complex territory, and the teachers eventually arrive at a quadratic expression that they agree works for buildings of all sizes, based on the student work they were examining. The group notes that they have gone far beyond what the students were able to do with this problem, and that engaging in this mathematical exercise has expanded their understanding of the task and its underlying mathematical concepts. Eventually, lunch time approaches and the conversation winds down, although many teachers continue mulling the ideas over as they eat.
This long conversation around an unusual and complex student-generated solution method helped the teachers to reconsider their conceptual understanding of the task and to advance their algebraic content knowledge. Whereas in PSC 1 the teachers ended their conversation once they understood the students’ solution method and agreed that it was correct, in PSC 3 the facilitators encouraged the teachers to continuing probing into the nuances surrounding the students’ mathematical ideas. In particular, the group investigated several different ways of finding the sum of a large string of numbers. The teachers not only were able to identify the creative application of the distributive property in the students’ numerical calculations but they also extended the students’ reasoning to develop a direct formula for the cost of an entire building. Using the videotaped students’ work as a springboard, the teachers devised and shared multiple strategies and formulas that represented increasingly sophisticated mathematical thinking.

7. Summary and possible interpretations of results

Our data suggest that throughout the two years the teachers participated in the STAAR professional development program, their full-group conversations around video became more “productive;” that is, the teachers talked in a more focused, in-depth, and analytical manner about specific issues related to teaching and learning the selected mathematical problems. Possible reasons for these changes include the ongoing development of a strong professional community, the establishment of discourse norms, an expanding ability and willingness to learn by analyzing and sharing ideas about classroom video, and increasingly focused and challenging facilitation. In this section we briefly consider similarities and differences in the group’s discussions around video held in the first and third iterations of the Problem-Solving Cycle and offer possible interpretations of these patterns. We draw on the coding and vignette analyses, and also provide illustrative quotes from interviews with the teachers and facilitators to help
characterize the learning that took place.

During the first Problem-Solving Cycle, as they discussed video of their implementation of the Painted Cubes task through the lens of the teacher’s role, the participants appeared to be cautious and hesitant to explore pedagogical issues in great depth. One possible explanation is that many teachers felt their first implementation of a PSC task did not go as well as they had hoped and were disappointed by what they saw on their videotapes. Therefore, they spent much of their time decompressing and sharing stories. Rather than pondering the merits of one teacher’s approach to introducing the task, the group instead focused on difficulties students often have with seemingly simple vocabulary words. Turning the spotlight onto the students and providing empathy in this regard may have helped the group to further develop their supportive and protective community, while sidestepping a more critical discussion of pedagogical strategies.

The conversations around student thinking in PSC 1 might be considered more productive than those around the teachers role because the group was willing to engage in an in-depth analysis of the mathematical ideas that were represented in the video clips. This more focused and lengthy exploration may be explained, in part, by the fact that the teachers needed considerable time to recognize the mathematical validity of the unanticipated student-generated solution method. These discussions, initiated by the use of video clips together with an analytic focus on the student’s mathematical reasoning, appeared to encourage the teachers to more deeply appreciate their own students’ unique approaches to the problem. As Mary explained in an interview, “This was the first time that we spent any substantial amount [of time] really trying to figure out what the kid was saying and what that meant…. That’s a first for us, and I think they did a good job [working] as a community to solve this together” (facilitator interview, February 2004). Craig added, “At the time, in Celia’s class, it probably just seemed like a small
thought the kid was having. But it had such an impact on our teachers to try and figure out what the kid was saying” (facilitator interview, February 2004).

By the third Problem-Solving Cycle, and the end of their second year participating in the STAAR professional development program, the group engaged in discussions involving the Skyscraper Windows problem that were longer and, we would argue, more productive than comparable discussions involving the Painted Cubes problem. Capitalizing on the supportive climate, and on the teachers’ expanding analytical skills and eagerness to improve their instruction, the facilitators provided more specific guidance for the discussions around video and encouraged the teachers to take a more critical stance. Craig foreshadowed this shift in facilitation strategies when he reflected in PSC 1: “We pretty much gave them the freedom to talk about whatever they wanted. We gave them some general themes or topics to think about. So maybe after [reviewing this workshop with the STAAR Project team] we’ll figure out that we need to have a more specific direction” (facilitator interview, February 2004).

Also in comparison to PSC 1, in PSC 3 concerns about embarrassment were mitigated by an interest in tackling more challenging issues and a sense that the community was strong enough to dive into murkier territory. For example, by selecting a clip from Peter’s lesson that depicted a student’s unique solution strategy and asking the group to carefully examine Peter’s questioning techniques, the facilitators highlighted the complex interplay among the teacher’s role, the students’ thinking, and the mathematics. The group did not shy away from a critical examination of questioning strategies. And, in a written reflection Peter noted, “The most valuable part of this year [was] watching the mistakes I made in forcing students toward a conclusion on the videotape. I have actively monitored myself since to not repeat this” (final Year 2 written reflection, May 2005).
In their discussion of student thinking in the third workshop of PSC 3, the facilitators prompted the teachers not only to consider a complex student solution method (from Laura’s lesson), but also to extend the mathematical ideas presented by the videotaped students. The teachers embarked on a lengthy inquiry into sophisticated mathematical ideas that involved some of the richest exploration of student thinking and mathematical content of the professional development program. Specifically, the teachers worked hard to understand the videotaped students’ solution strategy of adding a large string of numbers to find the cost of washing all the windows in the building, which differed from the various strategies they had developed in Workshop 1. A thorough investigation in the mathematical nuances behind these different strategies prompted the teachers not only to verify the students’ calculations but to better understand the students’ emerging strategies for developing generalized formulas.

Furthermore, in PSC 3 the teachers appeared to feel more comfortable addressing limitations in their understanding of the mathematics content, without continually making reference to their students or otherwise couching the conversation. All of these factors lead us to conclude that the discussions in PSC 3 were more productive than those in PSC 1. Such discussions would likely not have occurred unless all of the necessary elements were in place: specifically, a tightly knit professional community eager to learn, a common mathematical and pedagogical experience, and the use of video to situate the teachers’ conversation in a meaningful context.

Near the end of Workshop 3 in PSC 3, a facilitator, Kim, discussed the learning that appeared to take place within this iteration of the Problem-Solving Cycle, and the key role that video played: “What we see is this full circle happening. Teachers initially work the math problem in Workshop 1.... With this many different people, we saw a lot of different solution [strategies] that first time. Then we gave the problem to a bunch of kids, and we got more
[solution methods]. If we hadn’t sat down and studied that video clip and their work, I know I never would have thought of this [method].” The videotaped teacher, Laura, agreed: “Today was the first day that really solidified my understanding of this problem. We’ve looked at it for three days and I’m finally like, ‘Oh gosh. Now I get it.’ I think having that knowledge will help me to understand where the kids are going, and to understand their thinking a little bit better.”

8. Conclusion

I think the most helpful thing was the videotaping, to watch myself on videotape.

Sometimes painfully so. Wanting to say, “Shut up, shut up. Why do you keep going on with that?” It’s so helpful to see how you come across to kids and how they are or are not responding … and to think about what I might have changed in that lesson … or how I could have connected with kids better. (Celia, final Year 2 interview, May 2005)

When I watched other teachers’ videos, it wasn’t critiquing. It was seeing what they do in their classroom and realizing that a lot of what’s going on in their classroom is what’s happening in mine. Or… this person really does a great job at opening a lesson. Maybe I could try something they’re doing. (Linda, final Year 2 interview, June 2005)

All of the teachers who participated in the STAAR professional development program were interviewed at the end of the third iteration of the Problem-Solving Cycle. One of the topics we asked about was the impact of watching and analyzing video from their own lessons and their colleagues’ lessons. The teachers overwhelmingly expressed the positive nature of this experience; for many viewing and discussing video was the most valuable aspect of their participation in the program. Viewing footage from their own classrooms allowed the teachers to see what they were doing well and to identify areas for improvement. Observing their colleagues
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in action helped the participants learn new pedagogical strategies, better appreciate their students’ capacity for mathematical reasoning, and realize that they all struggle with similar issues. Participating in conversations focused on carefully selected video clips, and with a specific analytic focus in mind, seemed to foster learning about topics that were meaningful and important to these teachers, and motivated them to want to continue to learn, improve their teaching skills, and better serve their students. In this regard, their reactions were similar to those of teachers in the video clubs conducted by Sherin and colleagues (e.g., Sherin & Han, 2002).

Many of the teachers told us that they were eager to promote a similar style of professional development in their own schools. For example, teachers at four of the six schools represented in the STAAR program hoped to spearhead new professional development efforts within their schools that would contain some or all components of the PSC model. Teachers at several schools intended to observe and videotape one another and then meet to watch and discuss these videotapes. When asked about their reasons for initiating and pursuing these types of professional development activities, the teachers explained that they felt empowered by their experiences in the STAAR program and wanted to share what they had learned.

The STAAR program builds on and extends the work of others in the field of teacher professional development, particularly those who incorporate video as an artifact of practice. As suggested by Brophy (2004) and LeFevre (2004), we used video in structured ways, to address particular goals within our professional development workshops. In particular, the Problem-Solving Cycle model of professional development relies on video to foster productive conversations in which teachers inquire into and deeply investigate issues around teaching and learning a specific mathematics problem. Within this model, video is used to help teachers learn important mathematical content, investigate their own instructional practices, and study their students’ work. Our experiences carrying out the PSC model are also similar to those detailed by
Lewis, Perry, and Murata (2006) in their description of lesson study. A key difference is that lesson study is focused on designing, carrying out, and reflecting on a specific lesson, whereas the PSC is focused on solving, teaching, and learning from a specific mathematics problem.

Furthermore, we took seriously the lessons learned by other researchers regarding the importance of a strong professional learning community (Grossman, Wineburg, & Woolworth, 2001; Sherin & Han, 2002). The flexibility of the Problem-Solving Cycle model, enabled us to continually assess and respond to the ongoing needs and interests of the teachers who worked with us. For example, in advance of each workshop we considered what topics the teachers were struggling with or were particularly interested in discussing (including issues related to mathematics content, pedagogy, and students), and what aspects of the community needed to be addressed (such as what to do when a few teachers were dominating the conversations). With each successive iteration of the Problem-Solving Cycle, we capitalized on advances the teachers had made in the development of their analytical skills and the increasing strength of their bond as a community, to help them more deeply pursue relevant ideas and skills.

One way in which the Problem-Solving Cycle differs from some other models of professional development that involve discussing video from teachers’ own lessons is that the facilitators take a lead role in determining the analytic focus of the workshop, selecting the clips, and framing the conversations. In the PSC model, the facilitators make these decisions by taking into consideration the goals of the professional development program as well as the interests of the participating teachers. The team considers questions such as: What focus would capture the teachers’ attention and stimulate discussion? What video clips would help make particular points, without causing stifling discomfort for the group members or disempowering them as professionals? How should multiple clips (from a variety of lessons) be sequenced to best provide opportunities for learning? Over the two-year period that we carried out the STAAR
professional development program, we became even more strongly convinced of the value of this planning process and the benefit of providing structured guidance during the workshops. Empirical work by Seidel and colleagues (2005) supports the notion that professional development using video from teachers’ own lessons can be enhanced by using structured analysis tasks.

The results presented in this paper suggest that the participants in our program engaged in increasingly reflective and productive full-group conversations around video from one another’s classrooms. At the same time, they formed a supportive community and continually maintained respect for the videotaped teacher and his or her students. We recognize that such an experience may have been an anomaly; perhaps we had a very unique group of teachers or a particularly talented team of facilitators. Nonetheless, we consider this experience to be “an image of the possible” (Shulman, 1983). Our findings should signal optimism regarding the learning potential of this type of professional development, and may encourage those who have otherwise been wary of using video with teachers.
9. References


10. Appendix A: Tasks used in Problem-Solving Cycles 1 and 3

10.1. Painted Cubes (Problem-Solving Cycle 1)

A cube with edges of length 2 centimeters is built from centimeter cubes. If you paint the faces of this cube and then break it into centimeter cubes, how many cubes will be painted on three faces? How many will be painted on two faces? On one face? How many will be unpainted? What if the edge has a length different from 2? What if the length of the large cube is 3 cm? 50 cm? \( n \) cm? (Driscoll, 1999, p. 108)

10.2. Skyscraper Windows (Problem-Solving Cycle 3)

A building is 12 stories high and is covered entirely by windows on all four sides. Each floor has 38 windows. Once a year, all the windows are washed. The cost for washing the windows is $2.00 for each first-floor window, $2.50 for each second-floor window, $3.00 for each third-floor window, and so on. How much will it cost to wash the windows of this building? What if the building is 30 stories tall? \( n \) stories tall? (paraphrased from Driscoll, 1999, p. 70)
Table 1. Percentage of segments coded for each category during full-group discussions around video in PSC 1 and PSC 3.

<table>
<thead>
<tr>
<th>Code</th>
<th>Percentage of segments</th>
<th>PSC 1 (N = 37)</th>
<th>PSC 3 (N = 77)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>When</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before watching video</td>
<td>38</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>During video</td>
<td>38</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>After watching video</td>
<td>73</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td><strong>Who</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facilitator</td>
<td>97</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>Teacher in video</td>
<td>62</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Other teacher (not in video)</td>
<td>89</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td><strong>What</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set up the discussion</td>
<td>52</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Describe video</td>
<td>65</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Critique video</td>
<td>44</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Give suggestions</td>
<td>11</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Ask questions</td>
<td>57</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Identify with teacher</td>
<td>33</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher’s thinking</td>
<td>19</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Students</td>
<td>70</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Pedagogy</td>
<td>49</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Math</td>
<td>11</td>
<td>44</td>
<td></td>
</tr>
</tbody>
</table>

1Note: N is the number of 2-minute segments that were coded. Within each of the four main categories, the subcategories are not mutually exclusive.
Table 2. Percentage of segments coded for each category during “teacher role” discussions in PSC 1 and PSC 3.

<table>
<thead>
<tr>
<th>Code</th>
<th>Percentage of segments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PSC 1 ((N = 11))^1</td>
</tr>
<tr>
<td><strong>When</strong></td>
<td></td>
</tr>
<tr>
<td>Before watching video</td>
<td>64</td>
</tr>
<tr>
<td>During video</td>
<td>64</td>
</tr>
<tr>
<td>After watching video</td>
<td>45</td>
</tr>
<tr>
<td><strong>Who</strong></td>
<td></td>
</tr>
<tr>
<td>Facilitator</td>
<td>91</td>
</tr>
<tr>
<td>Teacher in video</td>
<td>91</td>
</tr>
<tr>
<td>Other teacher (not in video)</td>
<td>82</td>
</tr>
<tr>
<td><strong>What</strong></td>
<td></td>
</tr>
<tr>
<td>Set up the discussion</td>
<td>73</td>
</tr>
<tr>
<td>Describe video</td>
<td>73</td>
</tr>
<tr>
<td>Critique video</td>
<td>55</td>
</tr>
<tr>
<td>Give suggestions</td>
<td>0</td>
</tr>
<tr>
<td>Ask questions</td>
<td>45</td>
</tr>
<tr>
<td>Identify with teacher</td>
<td>36</td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td></td>
</tr>
<tr>
<td>Teacher’s thinking</td>
<td>18</td>
</tr>
<tr>
<td>Students</td>
<td>45</td>
</tr>
<tr>
<td>Pedagogy</td>
<td>73</td>
</tr>
<tr>
<td>Math</td>
<td>9</td>
</tr>
</tbody>
</table>

^1Note: \(N\) is the number of 2-minute segments that were coded. Within each of the four main categories, the subcategories are not mutually exclusive.
Table 3. Percentage of segments coded for each category during “student thinking” discussions in PSC 1 and PSC 3.

<table>
<thead>
<tr>
<th>Code</th>
<th>Percentage of segments</th>
<th>PSC 1 (N = 26) (^1)</th>
<th>PSC 3 (N = 39) (^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>When</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before watching video</td>
<td>27</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>During video</td>
<td>27</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>After watching video</td>
<td>85</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td>Who</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facilitator</td>
<td>100</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>Teacher in video</td>
<td>50</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>Other teacher (not in video)</td>
<td>92</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>What</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set up the discussion</td>
<td>42</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Describe video</td>
<td>62</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Critique video</td>
<td>38</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Give suggestions</td>
<td>15</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ask questions</td>
<td>61</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Identify with teacher</td>
<td>31</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Content</td>
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<tr>
<td>Teacher’s thinking</td>
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<tr>
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<tr>
<td>Pedagogy</td>
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</tr>
<tr>
<td>Math</td>
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<td>74</td>
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</tbody>
</table>

\(^1\)Note: \(N\) is the number of 2-minute segments that were coded. Within each of the four main categories, the subcategories are not mutually exclusive.
Figure 1. The Problem-Solving Cycle model of professional development