Using Contrasting Video Cases of the Enactment of Cognitively Demanding Science Tasks in Professional Development

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Abstract: Prior research indicated the challenges of getting students to think at high levels as they work on cognitively demanding tasks. Teachers often unwittingly lower the cognitive demands of tasks during their enactment. We argue that teachers should be provided with opportunities that can support them to make sense of the ways in which teachers' actions can be consequential for the level and type of thinking in which students engage. In this paper, we examined how the use of contrasting video cases can support participants' learning to identify the ways in which teachers' actions shape students' opportunities to think and reason during their engagement with cognitively complex instructional tasks. Qualitative analysis of two sequential professional development sessions revealed that contrasting video cases supported participants' productive discussions about teacher's pedagogical actions and the ways that these actions shaped how students work on cognitively demanding tasks.

Introduction

The new rigorous standards for science education in the United States set the stage for students' thinking and reasoning about disciplinary ideas and their engagement in scientific practices (Next Generation Science Standards, 2013). For these standards to be realized, however, the nature of the classroom work needs to become more cognitively demanding; teachers need to select and effectively implement high-level instructional tasks that will position students as active agents in generating ideas, developing explanations, and designing models and investigations. However many studies in science and mathematics demonstrate the challenges of getting students to think and reason at a high level as they work on such cognitively demanding tasks (Blumenfeld et al., 1991; Blumenfeld & Meece, 1988; Doyle 1983; Stein, Grover, & Henningsen, 1996).

Prior research indicates that even when cognitively demanding tasks are selected, the level and type of student thinking that they require often declines during their enactment (Doyle 1983; Henningsen & Stein, 1997; Sanford, 1987; Stein et al., 1996). Teachers often *unwittingly* lower the cognitive demands of tasks by focusing on the correctness and completeness of procedures and answers rather than how students are thinking about the task and/or "taking over" the thinking and actually doing the work for the students (Doyle 1983; Henningsen & Stein, 1997; Stein et al., 1996). During the enactment of project-based activities in science classrooms—activities that are often complex and ambiguous (Blumenfeld et al., 1991)— teachers encounter many challenges that may lead to reducing high-level student thinking such as reluctance to provide autonomy to their students, allocating enough time for in-depth exploration of ideas, and being able to provide appropriate amount of scaffolding (Blumenfeld et al., 1991; Marx, Blumenfeld, Krajcik, & Soloway, 1997; Marx et al., 1994). All of these suggest that the way teachers facilitate students' engagement in cognitively demanding tasks shapes the way students are positioned to think and reason about the disciplinary ideas and engage in the practices of the discipline in the classroom.

Given the critical role teachers play in shaping students' opportunities for learning, we claim that teachers should be provided with opportunities that can support them to think about and make sense of the ways in which teachers' actions could be consequential for the level and type of student thinking that occurs as students engage with challenging tasks. It is particularly important to help them realize that selecting high-level tasks does not always guarantee high-level student thinking in their classrooms. This study focuses on high-school biology teachers' learning within a video-based professional development (PD) about the role of teachers' pedagogical actions in facilitating students' learning during the enactment of cognitively demanding science tasks.

Video use has increased in studies designed to support teachers' learning within the last decade (e.g., Star & Strickland, 2008; van Es & Sherin, 2006). When used as a tool for supporting teachers' learning, the structures and tasks designed around the video should be considered carefully to get the most benefit from what the video can offer (Le Fevre, 2003; van Es & Sherin, 2009). As part of our PD intervention, we made careful design choices about the activities in which we asked teachers, who participated in PD sessions, to engage surrounding the video cases. Drawing on prior research about contrasting cases (e.g. Bransford & Schwartz, 1999; Garner, 1974), we used *contrasting video cases* of enactment of the same high-level task to help PD-participants recognize finer distinctions in teachers' pedagogical actions between classrooms in which the cognitive demand of high-level tasks was maintained versus declined: One of the contrasting video cases represented high-level student thinking, the other one illustrated low-level student thinking during the enactment of the *same* cognitively demanding science task in two different high-school biology classrooms.

Even though video cases of instruction have been widely used to support teachers' learning, no study has yet used contrasting video cases to support science teachers' learning within a professional development setting. We argue that contrasting video cases could be a productive tool in professional development for helping participants to identify specific details in teacher's pedagogical actions and the role that these actions play in students' thinking. Thus, in this study we examined the differences in the nature of PD participants' pedagogy related comments between two sequential PD sessions: one involving participants' discussion about a *single* video case and the other one about *two contrasting* video cases. Our study findings address the following research question: How, if at all, do contrasting video cases in a PD support participants' learning to identify teacher's pedagogical actions and the role they play shaping the level and type of student thinking?

Theoretical Framework

Why Focus on the Enactment of Cognitively Demanding Tasks?

Prior research shows that interactions between the teacher and students play an important role in shaping whether the cognitive demand of tasks is maintained or declines as students work on the task (Doyle, 1988; Henningsen & Stein, 1997). As underscored by Doyle (1988), teacher's role is critical in shaping the level and kind of opportunities that students have for thinking in the classroom; he stated, "teachers affect tasks, and thus students' learning, by defining and structuring the work students do" (p.169). Teacher-related factors, which were identified in prior research as associated with declining cognitive demand, include teacher's "taking over" difficult pieces of the task and telling students how to do the task, and shifting focus from understanding to completeness or accuracy of answers. Teacher-related factors associated with maintaining high-level student thinking, on the other hand, includes scaffolding of student thinking, sufficient time for exploration, providing students with means of monitoring their own progress, and sustained press for meaning through teacher questioning and comments (Stein, Smith, Henningsen, & Silver, 2000).

Why Video Cases?

Using classroom-based artifacts in PD sessions such as copies of students' work, videotapes of classroom lessons, and curriculum materials helps to situate PD in the context of teaching (Ball & Cohen, 1999; Borko and Koelner, 2008). Prior research indicates that videos are powerful in capturing the richness and complexity of classroom instruction; they provide a more realistic picture of the learning environment by capturing the voices, body language, and interactions of classrooms (Borko, Jacobs, Eiteljorg, & Pittman, 2008; Colestock & Sherin, 2009; Koc, Peker, and Osmanoglu, 2009; Le Fevre, 2003; Miller & Zhou, 2007). Moreover, viewing videos of instruction can help teachers to notice problems in their own teaching and become more willing to accept that certain aspects of their teaching need to change (Tripp & Rich, 2012). Given these benefits of videos, we used *contrasting video cases* to support teachers' learning about the enactment of cognitively demanding tasks.

We used Task Analysis Guide in Science (TAGS) (see Figure 1) to identify the cognitively demanding tasks whose enactments were shown in the video cases as well as to determine the level and type of student thinking in these video cases. The TAGS is a two-dimensional (i.e. cognitive demand and integration) framework involving nine categories each of which represents different levels of student thinking demanded by science tasks (i.e. cognitive demand) that focus on either science content or scientific practices or the integration of the two. Science tasks require different cognitive demand levels by making students to reproduce previously provided knowledge or follow scripted procedures meaninglessly to get to a right answer, or by guiding them to make sense of the scientific ideas and/or practices, or requiring them to think like a scientist (For details, please see Tekkumru Kisa, Stein & Schunn, under review).

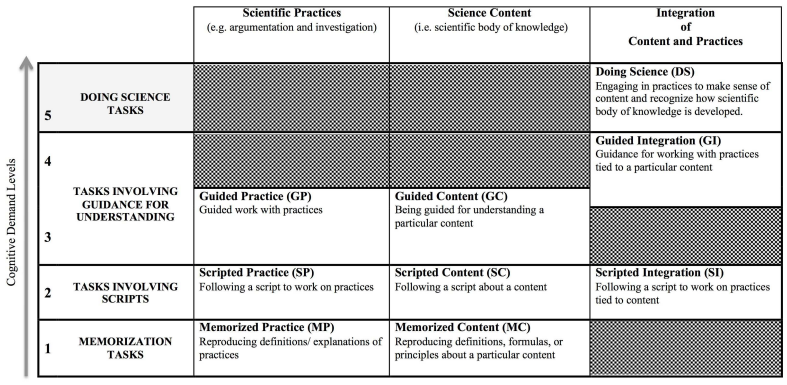

Figure 1. The Task Analysis Guide in Science (Tekkumru Kisa et al., under review).

Why Contrasting Video Cases?

Prior research suggests that contrasting cases help to make particular aspects and dimensions of cases become more salient and differentiated from others. Emphasizing the role of contrasting cases, Garner (1974) claimed:

> The single stimulus has no meaning except in a context of alternatives. When somebody uses the term circle, they infer that it could have been some other form, such as square or triangle. When somebody says there are two circles, or that the circle has two lines, they inferred the alternative of fewer or more lines. Each descriptive term used defines what the alternatives are, by defining what the stimulus is not (p. 185).

Others have also emphasized the importance of contrasts in allowing people to notice distinctive features that they may miss in the absence of a contrast set (Bransford et al.,1989; Bransford & Schwartz, 1999) Drawing on this body of research, we used contrasting video cases of task enactment. We examine the claim that contrasting video cases can be used to surface how different forms of teacher facilitation can be consequential for differences in the level and type of student thinking during students' work on the same high-level task.

Research Design

This study was situated within a larger NSF-funded project that focused on the development and implementation of design-based STEM units that aim to teach big ideas in biology tied to mathematics. It took place during the implementation of one of these units named, "Modeling Genetics: The Gecko Breeder Challenge". All the video clips that were discussed in the PD were selected from the video-records of classrooms during an earlier implementation of this unit. Teachers who participated in the study agreed to implement the four-week long unit, attend two project-related meetings and seven PD sessions, which were specifically designed for this study. In this paper, we focused on two of these seven PD sessions.

Intervention: Video-Based Professional Development

The PD sessions took place once or twice a week from the first week of February 2012 to the first week of March 2012 for a total of seven sessions (each was about 3 hours in duration), about half of which was allocated to viewing and discussing the video cases. In the first session, PD participants were introduced to the TAGS. In the next two sessions, they analyzed a video case that illustrated low-level student thinking (in session-3) and high-level student thinking (in session-4) during the enactment of two different cognitively demanding biology tasks. The fourth and the fifth PD sessions involved the use of contrasting video cases. Finally, in the last two sessions, participants analyzed video cases from their own classrooms.

Because the purpose of this article is to understand the role of contrasting video cases, we focused on two sequential PD sessions, which involved discussion about a single video case (session-3) and contrasting video cases (session-4) (see Table 1 for details about the sessions). **Session-3** involved the first video case in the entire PD in which participants viewed high-level student thinking during the enactment of a cognitively demanding biology task. In this task, students were provided with the PCR results that showed the variation in DNA for the same gene. PCR results showed two separate crosses of a male and a female gecko and their offspring. The task required students to generate the rules of inheritance (i.e. how the genetic information is transferred from parent to offspring) by analyzing the PCR results. In the video case, students in small groups were sharing their observations and interpretations of the PCR results with the teacher. The level of student thinking was at level-4, guided integration based on the TAGS.

Table 1: PD sessions 3 and 4: Activities and design rationales.

PD Session-3 Activities: 1. Analyzing a science task (as it appeared in print materials) based on its potential cognitive demand 2. Viewing and discussing "set-up" video showing how above task was introduced to students 3. *Viewing and discussing "enactment" video showing high-level student thinking & identifying the level and type of student thinking in the video case* Design Rationale: * Providing opportunity for PD participants to identify the level and type of student thinking in all three phases (print materials, set up, and enactment)
PD Session-4 Activities: 1. Analyzing print-based tasks based on their potential cognitive demand 2. Summarizing participants' analysis of print-based tasks and video cases in PD sessions 2 and 3 Presenting the change in cognitive demand across the phases of print-based materials, set up and enactment 3. Viewing the first video case showing low-level student thinking during the enactment of a high-level task 4. Viewing the second video case (contrast) showing high-level thinking during the enactment of the same task

Discussing (a) similarities and differences between the video cases and (b) identifying the level and type of student thinking in the video cases
Design Rationales:
* Providing opportunity for PD participants to see that cognitive demand of a task can be maintained or decline
* Using contrasting cases to learn to distinguish levels of student thinking as represented in the TAGS
* Using contrasting cases to support judgments of maintenance or decline
* Using contrasting cases to reveal pedagogical factors associated with maintenance or decline of the cognitive demand of the task

As seen in Table 1, in **session-4** before viewing the video cases, participants were first introduced to the key idea that tasks can change in their level of cognitive demand as they pass from print materials to how they are set up by the teacher in the classroom to how they are actually enacted or carried out by the students (Stein et al., 1996). This presentation helped to frame participants' viewing of and discussing *together* the contrasting video cases. The cognitively demanding task showed in the contrasting cases was about modeling how genetic information is inherited. In this task, students were guided through designing a paper-based simulation of gecko breeding that helped them to understand how the offspring gets one allele per gene from each parent and parental alleles are "packaged" inside eggs and sperm. In both video cases, students worked in small groups with the simulation materials and the teacher walked around and helped students. Video cases were designed to show that students were required to engage in scientific practices (e.g. modeling) in both of the classrooms but only in the second classroom they were required to make sense of the scientific ideas (e.g. how alleles are packaged into gametes) while designing the simulation. Therefore, how students were positioned to engage in this simulation task was very different in these classrooms. In the first video case, student thinking was at level-2, scripted integration according to the TAGS. Students followed the procedures of the simulation without really understanding the underlying content, and they engaged in a set of actions needed to complete the simulation because they were told to do so, mostly by the teacher. The opposite was the case in the second video in which student thinking was at level-4, guided integration based on the TAGS. Students were challenged to make sense of inheritance patterns explained in the simulation. They were asked to justify the simulation procedures by using what they learned about Mendelian Inheritance.

Participants of the Study

Five high school biology teachers from several different school districts participated in the PD. These teachers, who voluntarily participated in the study, were paid for their participation. Linda and Susan were the two most experienced teachers in the PD with 16 and 13 years of teaching experience. Linda was the only teacher in the PD who had prior experience in implementing the Genetics unit mentioned above. Barbara and Nancy were from two different schools operating under the same charter school organization, which focused on the use of project-based practices in the classroom. They both had three years of teaching experience. Lastly, Carol, with five years of teaching experience, was from a private school. Like Linda, Carol had experience in working with the project team, but on a different science unit.

Data Sources and Analysis

In our analysis, we focused on the parts of the PD transcripts during which teachers discussed the video case(s) and interpreted the level and type of student thinking. The unit of analysis was a segment of transcript in which one or more PD participants commented on a particular pedagogical action in the video. Therefore, each unit was separated from the next one in terms of the pedagogical action that was discussed. For example, while in one unit participants' comments were about the nature of questions used by the teacher in the video case, the next unit involved comments about how the teacher focused students' attention on the procedures of the task. For each unit, we 1) paraphrased the pedagogical action discussed by the participants, identified: 2) whether pedagogical action was grounded in students' thinking about the task, 3) whether any reference was made to the level and type of student thinking, and 4) whether the discussion was influenced by the facilitator's prompting.

Results

Our findings revealed interesting differences in the nature of PD participants' pedagogy-related comments between session-3 and session-4. Overall, in session-3, unless prompted by the facilitator, participants made general observations about the teacher's pedagogical actions. Their overall conclusion regarding the level of student thinking was that students were positioned to *do the thinking* in the classroom. In session-4, in contrast, participants —independent of the facilitator— began to make pedagogical remarks, which, were grounded in students' thinking about the task. Their comments involved characterization of how students were positioned to *think and reason at different levels of cognitive demand* (as defined in the TAGS) in the two different classrooms that used the same biology task.

These overall differences between the sessions were as we expected because a single video case presents a particular level of student thinking, which can be categorized based on the TAGS as Guided Integration (focusing on the integration of science content and scientific practices and at a cognitive demand level-4). Noticing the *salient* features about the teacher's pedagogical actions and their association with the level and kind of student thinking depicted in that single video case depends on the expertise of the PD participant that analyzes the video case. Contrasting video cases, on the other hand, presents *variations* in the level and kind of student thinking across two classrooms, which helps participants to notice more easily and precisely the differences between how students were positioned to think at different levels in these two classrooms as a result of the differences in the teachers' pedagogical actions. In what follows, we will discuss in more detail the nature of participants' discussions about the teacher's pedagogical actions and the role that these actions play in how students were positioned to think in the two classrooms.

The Nature of Discussion in Session-3: A Single Video Case

A little more than half of participants' pedagogy-related comments in session-3 (57%) were at a general level. With that we mean participants were talking about the teacher's actions without a clear reference to students' work on the task (e.g. what students think about the concepts covered in the task and how the teacher's pedagogical moves were influenced by what students do or say surrounding the task). For example, the following conversation illustrates describing the nature of teaching at a very general level:

> Carol: And she [the teacher] didn't tell them anything.
> …
> Carol: Everything was a statement.
> …
> Nancy: Yeah. She [the teacher] didn't guide them. It was all questions.

As demonstrated in this conversation, such general comments were only about what the teacher did (or did not do) and they were independent of what students seemed to be doing at that time.

Some of the pedagogical actions that were discussed by the participants at a general level in session-3 include "teacher did not tell what was right or wrong"; "teacher did not transmit knowledge" and "teacher did not lead students to any conclusion". For example, the following exchange between Carol and Susan illustrates their observation about the teacher's pedagogical actions in the video case:

> Carol: When they [students] say something, she'll [the teacher] say, "Oh, why?" like [line] 121 [in the transcript] "Oh, so why are you saying this band is thick?"
> Susan: Yeah. But then … she [the teacher] further questions them [students] about what they're saying. So like [line] 124 …. "Are you telling me the male has only one gene for this trait?" So she's just trying to get them [students] to clarify what they're saying.

Carol and Susan noticed that the teacher in the video asked the students clarification questions. They provided concrete examples from the transcript to show that the teacher asked questions to the students to clarify what they said. They did not, however, continue and discuss specifically *how* these clarification questions influenced or got influenced by students' thinking about the task. For example, the teacher's question, "Are you telling me the male has only one gene for this trait?" might have made the student to think further and understand that each organism has two alleles per gene.

The discussion in session-3 about the teacher's pedagogical actions was not always at a general level. Our analysis revealed that nearly half of the participants' pedagogy-related comments were grounded in students' thinking (43%). In other words, there was a clear reference in participants' comments to *how* the teacher's actions influenced or got influenced by what students said or did while working on the task. In all of these types of comments, though, the facilitator's prompting was influential for grounding participants' comments in students' thinking about the task. For example, one of the participants pointed out that the teacher in the video suggested that students use another resource (a previous task that they worked on) to scaffold their work on the task. Based on this comment, the facilitator asked why the teacher might have suggested students to use this resource at that time but not before. In response to that Linda said:

> I think she [the teacher] did it because this whole group is focusing on the word dominant, dominant blizzard, dominant traits, … and I think she wants them to maybe look back at that phenotype and see that the blizzard's not the dominant, because the females are normal color… So they're linking that thick band to the word dominant and the dominant to the phenotype blizzard. So rather than telling them that they were wrong … Let's just see if you can support that with the phenotypes, is where I think she would have been leading them.

As illustrated in this comment, Linda made an explicit reference to students' thinking about the task and how the teacher scaffold students to think differently about the DNA data from the mating of two geckos instead of telling them that their interpretation of the data was not accurate.

In session-3, when participants made comments about the teacher's pedagogical actions, they often did not discuss the consequences of these actions for *how* students were thinking as represented in different levels of the TAGS; rather their remarks were more about that students were *positioned to think*. There was an overall agreement among the participants that students in the video case were doing the thinking. For example, Barbara said, "I felt like she [the teacher] really didn't lead them [students] to any conclusions, which I thought was nice, because they were really coming up with it on their own". Similarly, Carol said, "She made them think different and explain or use different words. It was like massaging their brains". These types of comments by the participants generally suggested that the teacher made students "do the "thinking". Participants seemed to consider thinking (in a general sense) as a key aspect of higher-level cognition. They did not, however, often talk about a *certain* type and level of student thinking even though they could accurately identify that video case represented high-level student thinking.

The Nature of Discussion in Session-4: Contrasting Video Cases

In session-4, participants' comments about the teacher's pedagogical actions became more grounded in students' thinking about the task (1). Participants were often talking about the teacher's actions in relation to what students were thinking and saying about the task (57%). In contrast to session-3, about all of such pedagogy related remarks (except one) were made without the facilitators' prompting. The following comment by Linda illustrates such pedagogy related comments grounded in students thinking:

> Linda: The very first group did fertilization and didn't have alleles in their egg and sperm. She [the teacher] didn't make them pull them apart. She made them add the alleles. … It went against that biological concept of the alleles don't combine. So she didn't do the meiosis part. Second piece of evidence was once she started doing this and these with all those groups, she just kept saying, "How many combinations did you get? … It was all about the combinations for her, how many combinations –
>
> Co-Facilitator: Combinations not attached to the meaning
>
> Linda: The biology
>
> Co-Facilitator: The biological meaning
>
> Linda: The meiosis that made them, the fertilization that's happening.

As seen in the excerpt, Linda's remark is targeted on how students' were being encouraged to make sense of the task (or not). Comments like this were common across other remarks made by the participants; there was a close attention to what students did or did not understand about the task as a result of the teacher's facilitation. For example, Susan commented on how the teacher in the second video case helped students grapple with their uncertainty around constructing the simulation of inheritance since they could not apply their prior knowledge easily to what they were working on. Susan said:

> … in the last group that we watched, which is like line 46 there, 48 [in the transcript]: [The student says:] "I know there are two alleles for each gene, so, I mean, is it separate two?" And so she [the teacher] says, "Right, it could be black or white." But she's just helping clarify. But then she lets them [students] go through that whole process of putting two and two [alleles to the gametes]. She doesn't tell them, "Just go ahead and try it." … [So] they're [students] still having to work through it and figure out why they were wrong, whereas I feel like the first teacher would have just said, "No"…

With this comment, Susan clarifies how the teacher in the second video case facilitated students' making sense of the inheritance idea that there should be one allele per gene in each gamete as students are working on modeling how the genetic information is inherited from parent geckos to their offspring.

Participants' comments also revealed some patterns in terms of how students were positioned to think about the task through the teacher's facilitation in each video case. For example, regarding the first video case several of them said that students were focused on the procedures of the given task (e.g., creating the combinations) that had no connection to any biological sense making (e.g. fertilization, having alleles in egg and sperm). This observation by the participants reflects an aspect of students thinking at level-2 (scripted integration) according to the TAGS. Therefore, in session-4 participants' comments had implications for the characteristics of *particular* levels and types of student thinking (often as defined in the TAGS framework). For example, Carol said, "she [the teacher] removed the biology from it [the simulation about genetics]. At the end, they [students] weren't even making geckos [the animal used in the simulation task]. They were making

combinations." As revealed with this example, teacher-related factors that were discussed by the participants involved some reference to the consequences of the teacher's pedagogical actions in terms of *particular* kind and level of student thinking, which is more a salient feature of student thinking than only stating that the students were thinking.

Session-4 ended with a detailed discussion about the level and type of students thinking that was going on in the video cases as represented in the TAGS. There was not an agreement among the participants in terms of which levels of TAGS each video case represented even though they all agreed that video-1 represented low-level student thinking and video-2 represented high-level student thinking. Some of this disagreement was because participants were not clear about the distinction between all different levels in the TAGS framework (e.g. what is the difference between memorized practice at level 1 and scripted integration at level 2). The discussion helped to resolve some of these confusions that teachers had.

It is important to remember that, in the contrasting video cases, the same high-level task was enacted in the classrooms. This may have helped PD participants think more deeply about how students' interaction with the same task (i.e. how they were positioned to think) could be different in two different classrooms. Even though participants were told that the video cases depicted the enactment of the same task in two different classrooms, one of them said towards the middle of the discussion, "I think similarities-wise, it seemed like the kids got the same materials. They were working with the same stuff. And I don't know, but it also seemed like they had the same handout of directions." This comment was critical because it reminded them that they were focusing on how the teacher's actions shaped students' thinking about the ideas in the same task. Following up on this comment, the facilitator told participants, "I see like there are three variables … it is the same *task*…. There are *students* asking the same questions and now the *teacher* responding back to them in a very different way, which leads to a different conversation among them," thereby bringing the participants' attention to how the interaction of the teacher with the students surrounding the same task could create different opportunities for students' learning.

Discussion and Conclusions

Teacher learning has become a focus in the learning sciences (Fishman & Davis, 2006), and there has been a growing interest in designing new environments to support teachers' learning. In this paper, we described findings based on one such effort to support teachers' learning about the role they can play to maintain high cognitive demand levels in their classrooms. Specifically, our paper focused on the role of contrasting video-cases of the enactment of cognitively demanding tasks in revealing the distinctive features of teacher's pedagogical actions and the role that these actions plays in students' thinking. The results are promising because they indicated that in comparison to session-3 participants' talk about the teacher's pedagogical actions got more grounded in students' thinking in session-4 and participants began to see more details regarding the level and kind of student thinking that students were positioned to engage in. This all suggests that contrasting video cases may be a productive design feature of video-based PD for supporting teachers' learning about salient features of classroom interactions.

It's important to be cautious about the generalizability of the findings regarding the use and study of contrasting video cases. Even though we used high-level tasks in both of the sessions, the tasks used in session-3 and in session-4 were different from each other. The nature of the task might have created differences in terms of what can be "visible" in the contrasting video cases, which showed the enactment that task in two separate classrooms. However, if we showed the enactment of the same task with a single video case in session-3 to keep the task constant across the PD sessions, then exposing teachers to the task in session-3 would be a confounding variable while interpreting the nature of participants' comments in session-4; by knowing the task from the previous session, participants could attend to more details in the video cases in session-4. As a result, more research is needed to examine the potential of contrasting video cases revealing the salient features of classroom interactions that teachers should notice and make sense of.

Endnote

(1) The discussion about the contrasting video cases started with participants' debating whether the cognitive demand was declined in both of the video cases or not. Because their debate was staying at a general level, the facilitator suggested participants to discuss what was happening in the video cases that might have caused maintenance or decline instead of trying to make a decision about that. The facilitator's question, then, changed the nature of the discussion.

References

Ball, D.L., & Cohen, D.K. (1999). Developing practice, developing practitioners: Toward a practice-based theory of professional education. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession* (pp. 3-32). San Francisco: Jossey-Bass.

Blumenfeld, P. C., & Meece, J. L. (1988). Task factors, teacher behavior, and students' involvement and use of learning strategies in science. *The Elementary School Journal*, 235-250.

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist, 26*(3&4), 369-398.

Borko, H., & Koellner, K. (2008). *Situativity: a theoretical lens for designing and studying programs of professional development*. Paper presented at the International Commission on Mathematical Instruction Symposium, Rome, March 2-5. Retrieved on April 3, 2012 from www.unige.ch/math/EnsMath/Rome2008/WG2/Papers/BORKO.pdf

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

Bransford, J. D., Franks, J. J., Vye, N. J., & Shenvood, R. D. (1989). New approaches to instruction: Because wisdom can't be told. In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning* (pp. 470-497). New York: Cambridge University Press.

Bransford, J. D., & Schwartz, D. L. (1999). Rethinking transfer: A simple proposal with multiple implications. *Review of Research in Education*, *24*, 61–100.

Colestock, A. & Sherin, M. G. (2009). Teachers' sense-making strategies while watching video of mathematics instruction. *Journal of Technology and Teacher Education, 17*(1), 7-29.

Doyle, W. (1983). Academic work. *Review of Educational Research, 53*(2), 159.

Doyle, W. (1988). Work in mathematics classes: The context of students' thinking during instruction. *Educational Psychologist, 23*(2), 167–180.

Fishman, B., & Davis, E. A. (2006). Teacher learning research and the learning sciences. *The Cambridge handbook of the learning sciences* (535-550). New York: Cambridge University Press.

Garner, W. R. (1974). *The processing of information and structure*. Potomac, MD: Erlbaum.

Henningsen, M., & Stein, M. K. (1997). Mathematical tasks and student cognition: Classroom based factors that support and inhibit high-level mathematical thinking and reasoning. *Journal for Research in Mathematics Education, 28*(5), 524–549.

Koc, Y., Peker, D., & Osmanoglu, A. (2009). Supporting teacher professional development through online video case study discussions: An assemblage of preservice and inservice teachers and the case teacher. *Teaching and Teacher Education, 25*(8), 1158-1168.

Le Fevre, D. (2003). *Designing video-based multimedia curriculum for teacher learning*. Paper presented at the AARE Conference. New Zealand: Auckland. Retrieved on March 12, 2013 from http://www.aare.edu.au/03pap/lef03185.pdf

Marx, R.W., Blumenfeld, P. C., Krajcik, J., Blunk,M., Crawford, B., Kelly, B., et al. (1994). Enacting project-based science: Experiences of four middle grade teachers. *Elementary School Journal, 94*, 499–516.

Marx, R. W., Blumenfeld, P. C., Krajcik, J. S., & Soloway, E. (1997). Enacting project-based science. *The Elementary School Journal, 97*(4), 341-358.

Miller, K. & Zhou, X (2007). Learning from classroom video: What makes it compelling and what makes it hard. In R. Goldman, R. Pea, B. Barron, & S. J. Derry (Eds.), *Video research in the learning sciences* (pp. 321-334). Mahwah, NJ: Erlbaum.

NGSS Lead States. (2013). *Next Generation Science Standards: For States, By State*s. Washington, DC: The National Academies Press.

Sanford, J. P. (1987). Management of science classroom tasks and effects on students' learning opportunities. *Journal of Research in Science Teaching, 24*(3), 249-265.

Star, J. R., & Strickland, S. K. (2008). Learning to observe: Using video to improve preservice mathematics teachers' ability to notice. *Journal of Mathematics Teacher Education, 11*(2), 107.

Stein, M.K., Smith, M.S., Henningsen, M.A., & Silver, E.A. (2000). *Implementing standards based mathematics instruction: A casebook for professional development* (First Edition). New York, NY: Teachers College Press.

Stein, M.K., Grover, B. W., & Henningsen, M. (1996). Building student capacity for mathematical thinking and reasoning: An analysis of mathematical tasks used in reform classroom. *American Educational Research Journal, 33*(2), 455-488.

Tripp, T. R., & Rich, P. J. (2012). The influence of video analysis on the process of teacher change. *Teaching and Teacher Education, 28*(5), 728-739.

van Es, E. A., & Sherin, M. G. (2006). How different video club designs support teachers in "Learning to Notice". *Journal of Computing in Teacher Education, 22*(4), 125.

van Es, E. A., & Sherin, M. G. (2009). The influence of video clubs on teachers' thinking and practice. *Journal of Mathematics Teacher Education, 13*(2), 155-176.