

Design Considerations for Engaging Science Teachers in
Video-Supported Professional Development

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Abstract

The three-dimensional integration of science and engineering practices, disciplinary core ideas, and crosscutting concepts in the *Next Generation Science Standards (NGSS)* represent a shift in the vision for K-12 science education that necessitates attending to effective professional development for teachers. Reflective use of classroom video is a promising avenue for attending to teacher learning and sensemaking in the context of *NGSS* implementation. The current study is part of a larger research-practice partnership focused on a curriculum adaptation professional development model in which teachers collaboratively adapt and iteratively refine existing curricular materials. In this paper I seek to develop design considerations for using an online classroom video-sharing platform, Tch Teams, to support teaching and learning in the project. From the theoretical perspective of situated learning, I review the literature related to effective professional development, teachers' use of classroom video, and reflective practices for teachers in online spaces. I develop design considerations for using online platforms such as Tch Teams, and reflect on these principles in relation to the current project.

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Introduction

The *Framework for K-12 Science Education* (NRC, 2013) and the resulting *Next Generation Science Standards (NGSS)* signal a shift towards practice-focused instruction for teachers and students in the United States, presenting challenges for both practice and research. The term *practice-focused instruction* refers to having students learn science by engaging in science and engineering practices. While much emphasis currently revolves around developing curricula and assessments aligned to the *NGSS*, attending to teacher learning is fundamental to this reform movement as well, because of teachers' direct impact on learning in the classroom (Cuban, 1990; Elmore, 2009; NRC, 2013; NRC, 2015; Reiser, 2013).

Professional development needs to include sufficient opportunities for teachers to make sense of the new vision for science and engineering education as well as collaboratively learn through classroom practice. Classroom video is a promising tool for learning from instructional practice while working around practical constraints common in teaching, such as limited release time for observing colleagues and lack of a common understanding of classroom practices. Video case studies allow teachers to individually and collectively analyze student thinking and reflect on the effectiveness of instructional moves by the featured teacher in focused ways that are not always possible while in the act of teaching.

In the project described in this paper, teachers, researchers and professional developers had access to an online video-sharing platform, Tch Teams, which is designed to address the aforementioned goals and constraints. This was one of several professional development strategies involved in the effort. As we know from other studies of technology, the presence of a

new collaborative tool does not guarantee its use. In this case, simply presenting the tool for the team to use did not fully take into account what the field knows about teacher learning in professional development, scaffolding reflective practices for teachers in an online space, and issues related to using classroom video for teacher learning. Except in a few mediated instances, the video sharing platform went largely unused within this research and development project.

However, we anticipate that Tch Teams may further enhance shifts toward practice-focused instruction with a better understanding of its potential uses and with corresponding scaffolds and facilitation routines. In order to move toward a more effective design, I review the literature related to effective professional development, teachers' use of reflective online tools, and teachers' use of video to share instructional practices. I conclude with design principles to be considered when designing video-supported professional development for teachers, particularly in the context of implementing the vision for science education associated with the NRC *Framework* and the *NGSS*. I focus on synthesizing design considerations for teams of practitioners and researchers to use video from participating classrooms to support teacher learning.

Organization of the Review

In the first section of this review, I provide a narrative of the project work to set the context from which this paper emerged. The second section provides the theoretical lens through which I examine the literature related to features of effective professional development, issues that emerge from using classroom video for teacher learning, and reflective practices for teachers in online spaces. Next I review the related literatures and synthesize design considerations for using online video-sharing platforms in professional learning experiences. I

conclude by returning to discussing the narrative at the end of the paper to explicitly connect theory with examples of applying the design principles to instances of practice.

Context: The Use of Tch Teams in a Curriculum Adaptation

Research-Practice Partnership

In anticipation of adoption of the *NGSS* by Washington state policy-makers, a network of practitioners from two neighboring districts and educational researchers from a local university formed a research-practice partnership (Coburn, Penuel, & Geil, 2013). The goal of the three-year project was to support elementary and middle school science teachers in adapting their existing curriculum to incorporate the STEM disciplinary practices of constructing explanations, engaging in argument from evidence, and engineering design, as described in the *Framework* and *NGSS*.

In August 2013 the partnership participants gathered for the first annual summer institute, which was designed to: (a) introduce teachers to the three focal practices, (b) provide teachers and STEM professionals with opportunities to share knowledge and expertise, and (c) adapt existing curricular materials to incorporate the three focal practices. During the summer institute our research team also introduced ways in which we could further support a subset of interested teachers in implementing the curriculum enhancements back in their classrooms. We introduced an online video-sharing platform as a venue for collaborative learning, but did not register teachers for access until their first school-year PD release day a couple of months later. After the summer institute, the teachers met three times during the year (fall, winter and spring) by grade level to analyze and reflect on student work from the adapted units, work through emergent problems of practice related to implementation, and to further refine the curriculum adaptations.

Introduction of Tch Teams

Tch Teams is an interactive portal on the Teaching Channel website. It is described as a “walled garden” for networks of educators to share video, resources and reflections. A “Team” consists of a network of educators. In this case our Team consisted of the teachers, professional developers, district staff, and researchers involved in the project. Members of each Team have the capability to upload video clips from devices such as smartphones and flipcams. Within the Team, members can form private or public (still only visible to the Team) groups around focal areas such as the grade-level taught or for specific science content. Members also have access to all of the classroom videos produced for the public Teaching Channel branch of the website, and can tag the public videos within the Teams platform for discussion within their groups.

Supplementary resources such as lesson plans and rubrics can be uploaded in conjunction with classroom video. Each video is viewed with a time-stamped annotation sidebar so members can tag particular moments in the clip with questions, comments or reflections.

The teachers in the partnership worked intensively in groups of 5-7 during the summer institute, and the goal was for Tch Teams to facilitate collaboration within groups of teachers between professional development days—to serve as the “connective tissue” between face-to-face meetings. We did not design protocols or formally set expectations to support teachers in using Tch Teams beyond its existing functionality (e.g., online discussions, annotating video). The project leadership team (consisting of the leaders from each partner organization in the project) wanted the main focus to be on implementing adapted lessons in their classrooms and collecting student work for reflection. The platform was provided as an option, and we anticipated that some teachers would take up using it—and that we would likely need to provide some initial technical and social support.

Year 1 Implementation

While we did not initially have access to usage data, we anecdotally observed minimal use of the portal in the first two months of its availability to teachers. At the same time, teachers consistently expressed interest in seeing classroom video of the science and engineering practices "in action." A tension existed between wanting to see exemplary videos of practices in action, but everyone we worked with was still new at implementation and as such we did not have ready access to locally developed exemplary video. As researchers, we were interested in seeing video of teachers developing their instructional practices over time, but the teachers understandably felt a sense of urgency to see exemplary video that they could model their instruction after. In an effort toward the latter, the PD team decided to use classroom video during the school-year PD days to connect the adaptation work more directly with classroom implementation, and to model how Tch Teams might be used. Researchers collected samples of classroom video and uploaded select clips to a group limited to the facilitators and featured teachers within the Tch Teams portal. Prior to each of the remaining PD days, several members of the PD team logged in and used the annotation feature to collaboratively select which clip to use during the next PD day. The teachers featured in the video clips were also invited to participate in the selection process, however none of the teachers used the video annotation feature.

This process offered affordances and constraints. The online space allowed for interactions between researchers and practitioners on the PD team outside of scheduled planning meetings. However, the primary interactions were limited to the researchers and school district staff despite our best attempts to include collaborating teachers in the process. In general, neither district had a strong collaborative culture, particularly around classroom peer-

observation of practice, so there was a tension in choosing video segments that would support rich discussion while ensuring that the focal teachers were comfortable with what was shared. Additionally, several teachers expressed interest in seeing exemplars of classroom implementation of the focal practices, which we did not have. The featured teachers were implementing the first iteration of the adapted lessons and were still learning about the science and engineering practices themselves. While the video clips exemplified ways in which teachers were beginning to shift toward practice-focused instruction, they did not represent exemplary implementation.

Theoretical framework: Teacher Learning as Socially Situated

In this paper, I interpret teacher learning in professional development from a situated learning perspective. Situated learning theorists view learning as changes in participation in socially organized activities (Lave & Wenger, 1991), in which knowledge is situated in particular contexts, distributed across people and tools over time, and social in nature. From this perspective, learning is defined as coming to know how to participate in the discourse and social and material practices of a particular community (Lave & Wenger, 1991).

Teacher learning can be thought of “as a process of increasing participation in the practice of teaching, and through this participation, a process of becoming knowledgeable in and about teaching” (Adler, 2000, p. 37, as cited in Borko, 2004). The notion of increasing participation in the practice of teaching can be conceptualized as refining disciplinary ideas and specialized content knowledge for teaching (Ball, Thames, & Phelps, 2008), as well as the ongoing development of identity as a teacher (Peressini, Borko, Romagnano, Knuth, & Willis, 2004). In practice, this means a teacher deepens their knowledge of science ideas and phenomena as well as the ways in which particular instructional approaches afford or constrain

student learning of such ideas. This is typically referred to as “pedagogical content knowledge” (e.g., Davis & Krajcik, 2005; Magnusson, Krajcik, & Borko, 1999).

Applying the perspective of situated learning to teacher learning opens up opportunities for researchers to cast a wide net when examining both formal and informal opportunities for teacher learning (Putnam & Borko, 2002). Learning opportunities can be situated both in and out of the classroom to leverage various learning goals (Putnam & Borko, 2002). Teachers participate in a range of learning contexts, e.g., the classroom, professional development sessions, and brief hallway or lunch conversations – and each context privileges different cultural norms, modes of discourse, and forms of sensemaking. To make sense of teacher learning, we must take into account these multiple contexts in which teachers participate (Borko, 2004). For example, the refinement of instructional practices related to implementation of *NGSS* can be understood to be situated learning opportunities in the culture and practices of the classroom because that is where implementation occurs. At the same time, the vision of the *Framework* and *NGSS* represents goals for teaching and learning that may contrast starkly with existing instructional culture and practices. It is therefore appropriate to situate some *NGSS*-related teacher learning experiences outside of the classroom because “the pull of the existing classroom environment and culture is simply too strong” (Putnam & Borko, 2002, p. 6) and would inhibit teachers’ ability to deeply engage with the vision. As an example, it may be useful for teachers to learn about the multitude of ways scientists and engineers work with the science and engineering practices in *NGSS* in a different context than the classroom – in a situational context where they do not have to immediately consider classroom practices such as organizing small groups, assessment, and managing materials.

Spillane (1999) found that teachers were better able to shift instructional practices

toward reform-based initiatives in math when their learning was socially situated both in and out of the classroom, and distributed across individuals and curricular materials. Related to the notion of distributed cognition, Engeström's (2008) approach to mediating change in the workplace also contributes to my theoretical lens. Specifically, Engeström argues that effective interventions for supporting change in work practices include a "mirror" surface enriched with tools and artifacts that promote reflection of existing practices. In an activity as complex as teaching, Pea (1993) explains that "intelligence is often distributed by off-loading what could be elaborate and error-prone mental reasoning processes as action constraints of either the physical or symbolic environments" (p. 48). In order to account for the complex reasoning processes that teachers apply to instructional decisions, it is useful to consider the way knowledge is distributed across individuals and artifacts. In the current project, each curriculum adaptation—comprised of lesson plans, student assignments, scoring rubrics, etc.—is a collective sensemaking object during small group design sessions. Aspects of the vision are instantiated in the materials, and as such, knowledge is distributed across the members of the group and the materials they develop. The bundled adaptation then becomes a coordination tool during the act of teaching, and it ultimately represents a cumulative record documenting the iterative refinement of the new pieces of instruction developed by the small groups. From the perspective I am taking, the cognitive work associated with an individual teacher changing how they teach in their classroom is accomplished across this coordinated set of activities around and through associated artifacts.

The framework of situated learning from these perspectives as it applies to science teachers will be used to review the literature related to using classroom video to enhance learning opportunities for teachers.

Features of Effective Professional Development

Taking a standard from the NGSS was more complicated than thinking of a lesson that aligned with a standard because the standard included several performance expectations that formed the basis for assessments, curriculum, and instruction. The task was not as simple as finding a lesson for each performance expectation. I had to approach the problem of translating standards into classroom instruction with a perspective broader than a single lesson or hands-on activity. (Bybee, 2013, p. xi)

In the quote above, Rodger Bybee describes his process of venturing into aligning curriculum to the *NGSS*. Of note is that Bybee has extensive experience in both developing science curriculum and science standards to guide student learning, yet he still had to adjust his perspective on teaching in order to implement *NGSS*. Teachers across the United States have already begun a similar foray into implementation, and it is the responsibility of local and state school systems to develop professional learning opportunities that support teachers in shifting their instruction.

It is useful to consider Elmore's (1999) model of the instructional core to justify elevating teacher learning opportunities in the wake of new standards for science learning. The instructional core consists of the level of content, teachers' knowledge and skill, and student engagement—if one element of the core is changed then the other elements necessarily must change in order to see effects on student learning. At present, *NGSS* represents a new vision for science learning for students including ambitious levels of content, inclusion of engineering and three-dimensional learning focused on learning science through engagement with science and engineering practices. In order to achieve that vision, we must also develop responsive learning opportunities for teachers.

In the *NGSS*, the blend of the three dimensions of scientific practices, disciplinary core ideas and crosscutting concepts implicate significant shifts for teacher learning. The complex nature of each performance expectation necessitates that teachers have collaborative, sustained opportunities for learning how to relate the performance expectations to classroom instruction that would support students in being able to demonstrate those performances. Simply telling teachers about the changes to the standards is not enough. Existing structures for changing teaching practices, such as short-term professional development days and loosely-organized professional learning communities, do not adequately attend to the situated aspects of teacher learning necessary for sustainable and meaningful uptake of new teaching practices required for *NGSS* implementation. As Thompson, Windschitl and Braaten (2013) assert, “the decision to take up progressive forms of instruction requires developing affiliations with people and ideas within and across communities,” and it is unclear at best how existing professional development addresses this element at scale (p. 577).

Implementation of *NGSS* also necessitates shifts in educational research related to teacher learning. Prior to the past decade, the literature regarding teacher learning often followed the same pattern: how inputs (e. g., changes to PD structure, curriculum type, coaching, etc.) affect outputs (e. g., student outcomes), which is insufficient for research that will lend meaningful support for practitioners and policy makers aiming to shift toward practice-focused instruction. Additionally, there have historically been both internal and external validity threats in large-scale studies regarding the process of shifting instruction, as well as the structures and design elements that best support effective shifts (Penuel, Fishman, Yamaguchi, & Gallagher, 2007).

Despite this historical gap in research and implementation of effective teacher learning opportunities, the field has made some progress in the past decade. Only recently does the

literature suggest an emerging consensus regarding design elements of effective teacher professional development. As Desimone (2009) points out, further complicating the attempt to measure teacher learning outcomes related to professional development is the relatively recent shift in the research and policy communities regarding what counts as a high-quality professional development opportunity.

Garet, Porter, Desimone, Birman, and Yoon (2001) are recognized for providing the first empirical study of factors of professional development that impacted teacher learning. Teachers self-reported learning in the areas of curriculum, instructional methods, approaches to assessment, use of technology in instruction, strategies for teaching diverse populations, and deepening content knowledge. The researchers identified three core features that showed significant impact on teacher learning: (a) focus on content knowledge, both for the teacher and how students learn the content; (b) opportunities for active learning, which are also referred to as reform-oriented activities (Penuel et al., 2007); and (c) coherence with other professional learning activities (Garet, et. al, 2001).

The notion of coherence at different levels is supported by additional studies. Lumpe, Haney, and Czerniak (2000) found that when teachers perceived the professional development goals to be aligned with the social pressures of schools and district goals, they are more likely to commit to adopting or adapting the innovation. Penuel et al. (2007) also found that when professional developers discussed curriculum in relation to local, state, and national standards, as well as engaged teachers in aligning curriculum and planning for implementation, teachers felt more prepared for classroom instruction. Stein and Coburn (2008) refer to coherence as alignment, and explain that alignment refers to teachers actively making meaning of the multiple goals and learning opportunities provided by policy-makers.

In addition to illuminating the three core features of effective professional development, the data from the Garet et al. study (2001) allowed the researchers to identify particular *structures* of professional development that supported teacher learning: (a) the form of the activity (i.e., workshop vs. study group); (b) collective participation (i.e., teachers from the same grade, school or subject); and (c) duration, both in number of contact hours and span of contact time.

Several years later, Desimone (2009) synthesized data from ethnographic studies, national correlational studies, and randomized field trials to elaborate on Garet et al.'s (2001) core features as well as provide insight into the structures of effective professional development. The elaborated criteria included:

- content focus;
- active learning, including observing and being observed, interactive feedback, reviewing relevant student work, and leading discussions;
- coherence;
- duration, both in span and number of hours; and
- collective participation.

It has also been found that it is the critical features of the professional development, and not the structure of the opportunity, that made a difference in teacher learning (Desimone, 2009; Guskey & Yoon, 2009). Given the complexity of shifting toward practice-focused instruction, providing practitioners with a blend of professional development structures (e. g., summer workshops and school-year study groups) may allow for deeper integration of new instructional practices than offering PD in a single mode (Borko, 2004; Gallimore, 2009).

Gallimore's (2009) concurrent research emphasized the identification and effectiveness of core features that could be implemented across various professional development structures. The features identified by Gallimore could be categorized within "collective participation" as identified by Desimone (2009) and Garet et al. (2001). Gallimore argues for job-alike teams, trained peer facilitators, inquiry-focused protocols and stable settings, both in time and structure. It is important to note that these core features also have synergistic impacts, and may be less impactful if they are implemented in isolation. An example of a synergistic effect is when teachers are positioned as practice-based experts by facilitating professional development and engaging in inquiry-focused protocols, they are more likely to recognize cause and effect between their teaching practices and student outcomes (Cochran-Smith & Lytle, 1999; Gallimore, 2009; Margolis, 2008).

While the research above describes what may seem to be a fairly obvious list of essential core features of teacher professional development, it is worth identifying the themes that run through the various list. First, the core features emphasize the improvement of teaching practices, as opposed to the improvement of individual teachers (Hiebert & Morris, 2012). Second, the core features of effective professional development align with the sociocultural views related to situated learning for teachers (e.g., active learning, as defined in these studies, attends to the distributed nature of cognition across individuals and relevant artifacts). Finally, coherence plays a role both in the structure of the professional development itself as well as between the professional development as a whole and various other initiatives teachers engage in.

Professional Development for NGSS Implementation. Since the publication of the *Framework* and the *NGSS*, a subset of research literature and practitioner literature has centered

on professional development specifically related to implementing *NGSS*. The literature reflects the core features of effective professional development described above, nuanced to address the instructional shifts called for in the Framework and *NGSS*. In the remainder of this section I briefly describe the major shifts in *NGSS* and implications for teacher learning, citing both research and practitioner literature.

The performance expectations in *NGSS* represent an integrated 3-dimensional approach to learning in which students learn and apply disciplinary core ideas by engaging in science and engineering practices while making connections through crosscutting concepts (National Research Council, 2012; *NGSS* Lead States, 2013). This is a significant shift from learning the scientific method and scientific facts in isolation. The focus on science and engineering practices makes explicit the process of constructing knowledge in science. The vision outlined in the *Framework* and *NGSS* also highlights prior research demonstrating that students' initial conceptions of natural phenomena and problem-solving approaches should be leveraged instead of corrected through classroom instruction (Duschl, Schweingruber, & Shouse, 2007).

One of the most distinct shifts called for in the *NGSS* is a focus on the deep learning of fewer concepts, in contrast with the current emphasis on breadth of coverage or a wide range of concepts, often at the expense of in-depth conceptual learning. Reiser (2013) argues that “teachers need to shift their mindset toward viewing instruction as building a coherent storyline, in which questions are grounded on phenomena, leading to investigations, and students develop models through argumentation, and refine those models through new phenomena that challenge existing models” (p. 7). To address these concerns, Reiser (2013) recommends: (a) structuring teacher learning around “rich images of classroom enactment” (p. 15), (b) structuring collaborative learning opportunities as teachers apply *NGSS* to their classrooms, and (c)

“capitalizing on cyber-enabled environments” (p. 16). In relation to the vignette introducing this paper, the first recommendation echoes the queries from the teachers about wanting to see *NGSS* in action. One challenge for professional developers and researchers is to identify and cultivate a variety of rich examples of classroom enactment to support teacher learning. This is especially true given that there are multiple instructional models that can be used to implement the three-dimensional view of science learning.

The position paper from the National Association for Research in Teaching (NARST) regarding *NGSS* professional development suggests that teachers should be provided time and structure to develop a common vision for implementation that begins with the needs of learners, sets high expectations for all learners, and integrates research-based instructional strategies for each dimension (Banilower, Gess-Newsome, & Tippins, 2014). Professional development should also account for the different learning needs of elementary, middle, and high school teachers as well as the needs of teachers at different points in their careers (Banilower, Gess-Newsome, & Tippins, 2014).

Using Classroom Video for Teacher Learning

Analyzing classroom video can help teachers notice aspects of classroom experience, and begin to interpret student thinking in more robust ways. In order to adopt *NGSS* as a reform and shift classroom practice, PD efforts need to draw explicit attention between target practices and existing practices. One way to do this is by examining current classroom instructional practices directly through video, and analyzing and theorizing about the gap, or perhaps overlap between current practices and target practices.

Easily accessible classroom video may provide a strong platform to do so. Annotated classroom video exists in a constellation of artifacts and tools that can support mediation of new

instructional practices for teachers. However, technology-based interventions like annotated classroom video must be carefully designed to fit within the existing culture and structures of the school systems in which teachers work. If the school system does not have the capacity to meet the demands of the technology in terms of school culture, technical capacity, and policies, then the technology is less usable (Penuel, Fishman, Cheng, & Sabelli, 2011). In this section, I review the literature to identify design principles specifically related to supporting video-enhanced PD.

In order to implement the instructional changes called for in the *NGSS*, teachers need a clear picture of their current instructional practices as well as a clear goal. The former is difficult to achieve in the classroom because of the “demands of teaching, habituation, and confirmation bias” (Knight, 2014, p. 18). However, with increased access to video-capturing technology via smartphones, tablets and microcameras, there exists an opportunity for teachers to establish a clear understanding of current classroom practice by reflecting on video of their own classrooms as well as their peers’.

Role and types of video in PD. Classroom video can play a variety of roles in practice-based professional development. Highly-adaptive video experiences can be tailored to the needs, interests, and concerns of local participants, but limited by the quality of the local lessons and what videos can be clearly observed with minimal editing; whereas, highly-specified video experiences are carefully constructed for teachers, but the pre-determined learning goals and topics addressed may not meet local needs (Borko, Koellner, Jacobs, & Seago, 2010). In relation to reform-oriented PD such as *NGSS* curriculum adaptation, “rich (video) cases could provide the fodder for active sensemaking across the full range of the reform context from managing student talk to structuring the material activity of the classroom to support students’ engagement

in practices of science and engineering” (Reiser, 2013). However, analyzing video requires a new set of reflective practices for many teachers. Seidel, Stürmer, Blomberg, Kobarg, and Schwindt (2011) found that first watching one’s own classroom video activated teachers’ prior knowledge and experiences related to teaching and learning, which allowed them to eventually make more meaning out of watching others’ video. Zhang, Lundeberg, Koehler, and Eberhardt (2011) found that a PD model for science teachers that included analysis of published video, teachers’ own video, and peers’ video yielded affordances related to each type of video that contributed to teachers learning. A combination of highly-adaptive and highly-specified video experiences may support teachers in understanding the *NGSS* vision, prompt discussions and planning of how the vision may play out in classrooms, and anchor collaborative work in reflecting upon and analyzing implementation in classrooms.

Video clubs. Video clubs are “professional development environments in which groups of teachers come together to view and discuss videos of one another’s teaching” (van Es & Sherin, 2006), and are useful to understand in order to glean design principles for an online video-sharing platform, in which the interactions may be asynchronous. The establishment of video clubs may, over time, also support the development of collegial teacher learning communities focused on learning in and from instructional practice (Borko, Jacobs, Eiteljorg, & Pittman, 2008; van Es, Tunney, Goldsmith, & Seago, 2014). Here I describe findings from the literature on video clubs for teacher learning that may inform design considerations for an online video-sharing platform.

Several studies have shown that in structured video clubs focused on classroom video, the nature of teachers’ conversations about classroom practices shifted from pedagogical moves to student learning, while becoming increasingly interpretive over time (Sherin & Han, 2004;

Sherin & van Es, 2008). In this way video clubs can help develop a shared social language of practice (Frederiksen, Sipusic, & Sherin, 1998), which can provide them with a shared way of making sense of aspects of teaching and learning. Teachers in one study “explained that having opportunities to view lessons from other teachers’ classrooms and from other grade levels gave them valuable insights into the details of lessons and the broad goals of the curriculum” (van Es & Sherin, 2009). It is argued that this type of experience, in which teaching becomes learning for the teacher, is necessary for the implementation of reform such as the *NGSS* can happen (Sherin, 2002).

Multiple perspectives can be explored in a video club context, which is far less likely if the video is viewed alone (Tochon, 2007). However, widespread use of video clubs may be less than feasible due to teachers’ complicated schedules. As a way to approximate the benefits of exploring multiple perspectives by collaboratively analyzing classroom video in person, online video-sharing platforms offer opportunities for teachers to interact around video asynchronously. One advantage of asynchronous viewing and reflection is the affordance of time, and the ability to analyze classroom activity at a deeper level compared with in-class reflections or after-class reflections without video (Santagata, 2009). In Tch Teams, the asynchronous interaction is primarily facilitated by an annotation feature in which teachers can tag or comment on specific moments of a video. Although the research on video annotation tools for teacher reflection is limited, the advent of web-based video sharing platforms complete with annotation features can “augment and extend teacher reflection experiences by facilitating and structuring the analysis process” (Rich & Hannafin, 2008).

Facilitation of video reflection. In a review of the literature on the use of classroom video for teacher professional development, Marsh and Mitchell (2014) identified that learning

environments that fostered a shared pedagogical language amongst teachers with a range of experience led to the “active construction of theoretical perspectives” by teachers (p. 413).

Video-enhanced PD that supported teachers in making theoretical conjectures about the activities and learning processes that occurs in their classroom appears to be most effective.

It is imperative to model the desired discourse when first discussing classroom video (Santagata, 2009), which can be achieved by practicing with published video. It is important to maintain the reflective discourse when teachers view their own video or that of their peers; Borko et al. (2008) found that without a clear discourse structure teachers tended to empathize with each other and sometimes criticized their own lessons, but rarely critiqued each other. Particular discourse structures can serve multiple functions. For example, in a PD program with science teachers, Zhang et al. (2011) employed the same project-based learning (PBL) discourse structure in their video-enhanced PD that teachers were implementing in their classrooms. They found that the PBL discourse structure supported pedagogical reasoning by helping teachers notice relevant evidence of teaching and learning in the viewed video (Zhang et al., 2011).

Since online video-sharing platforms for teacher learning are a relatively new phenomenon, it is useful to consult the literature on general networking technologies for teachers to understand what may be important for online videosharing. Networking technologies can reduce teacher isolation and support sharing, foster reflection on practice, influence teaching practice and support the formation of communities of practice (Barnett, 2002). Social networking technologies have also been shown to engage teachers in meaningful discussions with like-minded peers, leading to learning and professional identity development, meaning that teachers identified as reform-minded science teachers and were recognized as such (Luehmann & Tinelli, 2008). However, it is important to note that providing the online video-sharing

platform does not guarantee the formation of a professional community of learners. The cultivation of any community of practice requires concerted effort and the establishment of social relationships, community routines (with relevant collective artifacts), and social norms for participation. If organizations are attempting to cultivate professional communities of practice, management teams (which may consist of facilitators, instructional coaches, researchers, etc.) must develop strategies that facilitate close working relationships between teachers in order to develop trust and mutual support in the community (Rhodes & Beneicke, 2002).

Design Principles

Based on this literature review I have identified six design principles to consider when implementing an online video-sharing platform in the context of professional development intended to support instructional improvement. The first five principles can be applied broadly to PD programs making use of classroom video, while the sixth principle applies specifically to when research-practice partnerships engage in this work. To enact these principles, the PD facilitator(s) must assume an active role in supporting the video aspect of the professional development program, as we have learned that simply providing the platform to teachers is insufficient.

Design Principle #1: Anticipate and design for teacher sensemaking regarding other state, district, and school initiatives as they arise in the context of NGSS implementation. The *NGSS* exist in a thicket of other policy initiatives for teachers. It is important for PD developers to help teachers identify points of coherence across initiatives, as well as acknowledge that the priority of initiatives may wax and wane over the course of a school year, as well as a teacher's career. When implementing a video-reflection aspect of PD, these outside issues (with respect to the target practices of the reform) may arise and become a

productive point of study and theorizing for the teacher. It is the facilitator's role to scaffold teachers in making sense of instructional implications and opportunities that may be related to multiple initiatives.

Design Principle #2: Professional development should allow for acknowledgement and problem-solving of a range of emergent problems of practice related to NGSS implementation. All significant changes to instruction will involve working through new emergent problems of educational practice. It is important to allocate professional learning time to a deep understanding of these issues—along with the identification or development of ways of working through the problems (Penuel et al., 2007). Video can serve as a rich stimulus for identifying and making sense of problems of practice (Derry, et al., 2010). Teachers in PD efforts often represent a range of experiences, perspectives and training, all of which influence how they interact with classroom video and reflect on their practice. Teachers may notice and want to work on different problems associated with a reform such as *NGSS*, and it may be productive to encourage groups of teachers to tackle different substantive problems.

Design Principle #3: Include exemplar videos—ideally cultivated from within the local network—along with “works-in-progress” video of teachers’ own instruction, and video of peers’ instruction. Observing a range of classroom videos helps teachers develop a more comprehensive understanding of the target practices of the reform. Collaboratively analyzing a range of classroom video may also help build and strengthen communities of learners. The salient pieces—or what are often referred to as the “look-fors” in practice discussions—in each video should be explicit in order to support substantive reflection around a specific topic or set of topics.

Design Principle #4: Develop and determine discourse norms and a facilitation plan for teachers' interactions around classroom video. A primary goal of video-enhanced PD is to establish a common language to describe and interpret relevant aspects of teaching and learning and to develop a common understanding of problems of implementation. Setting clear discourse norms up front, and providing teachers with opportunities to practice the norms, helps facilitate collaborative inquiry into classroom practice. In addition to discourse norms for interacting around video, teachers' sensemaking may also be enhanced by tools designed to capture teachers' reflections and thoughts as they engage with classroom video, such as the collective time-stamped annotation feature in Tch Teams. However, understanding how technological innovations such as this annotation feature support the distribution of cognitive work remains an area of future research. In terms of facilitating the online interactions, there are several questions to consider: who will upload video? How will video be collected? Who is responsible for initiating online discussion? Will the video only be discussed asynchronously via the annotation feature, or will the annotation feature supplement other face-to-face interactions? Based on the literature, different approaches and configurations are possible, but it is important for facilitators to have a vision for the online and face-to-face interactions that teachers will engage in.

Design Principle #5: Encourage teachers to develop evolving pedagogical theories rooted in evidence from classroom video. In the context of *NGSS*, teachers are asked to support students in developing causal explanations and evidence-based arguments. As teachers are encouraged to develop pedagogical theories related to their implementation of *NGSS*, it may be useful encourage the same practices using the video as a source of evidence in support or contradiction of particular claims being explored. Without video or direct observation, teachers

must rely on individual recall to account for student learning in relation to instructional practices—and personal memories are known to be selective and subject to change over time. Classroom video provides a veridical line of evidence that teachers can interpret and interrogate to support or refute their explanations and arguments about how and why student learning happens in moments of classroom instruction.

Design Principle #6: In a research-practice partnership, ensure buy-in and support from lead practitioners (e.g. district administrators and coaches) before attempting to implement an online video-sharing platform at scale with teachers. Research-practice partnerships hinge on mutual trust between all partners. Both researchers and practitioners have much to offer in a partnership, and the shared work must be carefully and repeatedly negotiated to ensure relevant expertise is leveraged appropriately and institutional needs are met. The relationship dynamics between lead district practitioners and teachers is necessarily different from the relationship between researchers and teachers. Engaging in the collection of, and reflection on, classroom video requires significant changes to the ways in which many teachers collaborate and critically reflect on teaching and learning. Lead practitioners can support and encourage this shift by allocating or protecting teachers' time for the video-related aspects of PD. In the case of researchers introducing an innovation such as an online video-sharing platform, fostering a commitment to the innovation across the partnership in order to meet stated goals increases the likelihood that the platform will be used in a way that improves teaching and learning.

Implications for Research-Practice Partnerships

District leaders, professional developers and researchers cannot force or guarantee teacher learning, but they can design conditions that will be supportive of the kind of

interactions that will provide opportunities for teacher learning (Stein & Coburn, 2008). In this paper I have outlined design principles specifically for the utilization of an online video-sharing platform, Tch Teams, to support teachers in shifting their instructional practices.

In research-practice partnerships in which the researchers initiate and offer supported access to a classroom video-sharing platform, it is crucial for researchers to take into account the local practices, policies, and culture that will mediate the effectiveness of any educational improvement strategy, including engagement in video-enhanced PD. If the teachers in the PD network are unfamiliar at best, and resistant at worst, to using the video platform, then PD leaders must work to develop a culture of trust and practices that provide insight in order to support teacher learning through sharing classroom video and resources online. Practices to be designed for include the challenging work of analyzing video, as well as more practical concerns such as how video will be collected. For example, Tch Teams provided a mobile app in which video could be collected and uploaded over wireless Internet, but none of the schools we worked in had an accessible network.

Developing a reflective culture around classroom video proved challenging in this study. The teachers in our partnership consistently asked to see exemplary *NGSS*-aligned teaching, which may have helped them recognize targeted *NGSS* instructional practices, however we did not have access to exemplary video. We were challenged in supporting teachers to recognize the value of viewing “practice in progress” in their learning of *NGSS*-aligned instruction. Ideally, teachers in the project would have viewed both exemplar videos and their own classroom video in order to develop working theories and plans for shifting their own instruction.

Research-practice partnership leaders must also take into consideration the leadership capacity to facilitate collaboration and reflection through the platform. In our study, the district

leaders and coaches, and many teachers, were initially open to the idea of using the online video-sharing platform in order to share and improve practice, but we collectively lacked the capacity to support a critical mass of teachers in learning how to use the platform. The stated goals of the PD were to increase teachers' content knowledge for *NGSS* practices and to adapt curricular materials to include particular STEM practices – both of which can arguably be accomplished without incorporating in-depth classroom video analysis. We initially thought Tch Teams could serve as an integral aspect of teacher learning in the project, but as other aspects of the project surfaced as more urgent and salient, the researchers and lead practitioners in our study were increasingly tasked with responsibilities directly related to the stated goals of the PD and did not have capacity to additionally facilitate video-related activities on Tch Teams. For example, by examining the adapted curricular materials and student work, the leadership team and teachers noticed the limited ways in which a particular explanation/argumentation framework was being employed in the enhanced curricular materials. While collaboratively analyzing the implementation of these enhancements through classroom video may have further enhanced our understanding of the limitations, we had enough evidence to understand how teachers and students were making sense of the explanation/argumentation framework in order to address the limitations and expand the ways in which explanation and argumentation were tested and refined in the curriculum. Additionally, as researchers, it was often challenging to balance our time between directly supporting the curriculum adaptation work in PD, implementation of enhanced curriculum in classrooms, and our research duties.

Online video-sharing platforms such as Tch Teams show promise in enhancing professional development for teachers implementing new instructional practices, however the research is limited at the present time. While we know a substantial amount about researcher-

supported professional development (i.e. video clubs), two aspects make Tch Teams a new area to study. First, the online accessibility poses both benefits and challenges for teacher learning. Theoretically, the platform is available to all teachers within the Team, however if they are not equipped with the tools (i.e. video-capturing device and protocols) then its utilization is limited. Additionally, several teachers in our project were concerned with their and their students' privacy with online video, despite the "walled garden" aspect. Second, the research is very limited on practitioner-oriented video sharing networks. In all of the studies reviewed here, the researchers served as facilitators and directors of the video-sharing networks. Tch Teams is designed by practitioners, for practitioners. Several Teams exist in PD networks and districts across the United States without the involvement of research teams, and both fields would benefit from understanding more about what makes particular Teams successful in such contexts.

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