Facilitating Reflexivity in Preservice Science Teacher Education Using Video Analysis and Cogenerative Dialogue in Field-Based Methods Courses

Christina Siry
The University of Luxembourg, LUXEMBOURG

Sonya N. Martin
Seoul National University, KOREA

This paper presents an approach to preservice science teacher education coupling video analysis with dialogue as tools for fostering teachers' ability to notice and reflexively interpret events captured during teaching practicum with the intent of transforming classroom practice. In this approach, video becomes a tool with which teachers connect theory and practice, and through dialogue, develop an appreciation for how one can inform the other. Specifically, we explore the role of cogenerative dialogue in structuring individual reflection and ongoing dialogue that help facilitate reflexivity. In doing so, we elaborate on the construct of reflexivity as a potential foundation for changing practices in the science classroom and we illustrate the ways in which reflexivity and action emerged from dialogic encounters around video analysis. We draw implications about the need for innovative teaching strategies, research initiatives, and changes in science teacher education

Keywords: preservice teachers, field-based methods courses, video analysis, cogenerative dialogues, reflexivity, science teacher education

INTRODUCTION

The value of reflection in teacher education has been well documented and explored for decades. In particular, the critical explorations about what it means to reflect-in-action, and reflect-on-action have had significant impact on research exploring the role of reflection in the growth and development of teachers as professionals (Loughran, 2002; Wilson, 2009). Schön's (1983; 1987) conception of reflection, both -in- and -on-action, in which the practitioner momentarily steps out of the practice of doing to consciously examine their understanding of the situation and make decisions regarding future action, has increasingly become a goal for many preservice teacher education programs. Hammerness, et al., (2005) argue that prospective teachers must cultivate a "metacognitive approach to instruction", as well as the "disposition to take an inquiry stance" if they are to develop as professionals. Specifically, they state it is important for teachers to "take control of their own learning by providing tools for analysis of events and situations that enable them to understand and handle the complexities of life in the

Correspondence to: Sonya N. Martin,
Professor of Science Education
Seoul National University, 599 Gwanak-ro,
Gwanak-gu, Seoul, 151-742, Korea,
E-mail: sm655@snu.ac.kr

State of the literature

- Pre-service teachers and practicing teachers need support to be able to effectively connect theory learned in university coursework to actual classroom science teaching
- Video analysis of classroom interactions can be a useful tool for supporting teachers to reflect on their teaching
- Teachers not only need to develop the ability to reflect on their practice – but they also need to be able to affect changes in their teaching based on their reflection
- Many science teacher education programs do not support new teachers to develop as reflective practitioners and do not provide them with tools necessary to identify problems and transform their teaching

Contribution of this paper to the literature

- This paper presents an approach to preservice science teacher education coupling video analysis with dialogue as tools for fostering teachers' ability to notice and reflexively interpret events captured during science teaching practicum with the intent of transforming classroom practice.
- In this approach, video becomes a tool with which teachers connect theory and practice, and through dialogue, develop an appreciation for how one can inform the other.
- We discuss the role of cogenerative dialogue in structuring individual and collective reflection and highlight how reflexivity and action can emerge from dialogic encounters around video analysis – which can help improve science teaching and learning

classroom" (p. 366). Currently, teacher education programs are criticized for their inability to provide preservice teachers with opportunities to learn how to develop either of these essential characteristics, both because of coursework that fails to integrate theory and practice and due to limited opportunities to engage in long-term teaching practica (Darling-Hammond, 2006).

In science teacher education specifically, providing practitioners temporal, physical, and social space to contemplate individual actions and interactions with others (Tobin & Roth, 2006; Roth, Tobin, & Ritchie, 2008) is critical for developing teachers to be able to effectively utilize student-centered instruction to scaffold science learning through social interactions (Bell, et al, 2013). Science education researchers widely accept that students learn science by actively engaging in doing science (Donovan & Bransford, 2005), which

includes conducting investigations and engaging in dialogue with teachers and peers to construct meaning, individually and collectively (NRC, 2000), from their experiences. Researchers also agree that science teachers play a significant role in guiding students to learn science by facilitating classroom discussions to develop students' conceptual understanding and by offering ongoing assessment of student ideas through constructive feedback (Duschl, et al., 2007). To be effective, science teachers need to be able to elicit responses from students (for example, via questioning strategies) and then facilitate dialogue to incorporate their students' ideas and experiences into the lesson (NRC, 2012). This requires that teachers be able to evaluate and make sense of students' responses 'in the moment' and then make instructional decisions about how to move the lesson forward based on student input. Learning how to build on a student's contribution during class discussion or finding ways to contextualize science in relation to a student's life requires a teacher who is able to engage students, evaluate their responses, and provide appropriate feedback that extends student thinking and conceptual understanding. This is particularly salient to work with prospective science teachers, as being able to manage the classroom interactions in such a way that they have the opportunity to engage students, listen and evaluate, and interact with them can support facilitating conceptual understanding of content and processes of science (Osborne, Erduran, & Simon, 2004).

Research in science teacher education shows that in order for new teachers to be able to do this, they need to develop skills and strategies related not only to science content knowledge – but they also need opportunities to develop pedagogical strategies, including learning how to effectively reflect on their practice (Zembal-Saul, Krajcik, & Blumenfeld, 2002; Friedrichsen, Abell, Pareja, Brown, Lankford, & Volkmann, 2009). There is emerging consensus that practice-based approaches to teacher preparation can better support preservice teachers to see connections between university coursework and fieldwork experiences (Lampert, 2010; Cochran-Smith & Lytle, 2009; Santagata & Yeh, 2012). We agree with other researchers (Rosaen & Florio-Ruane, 2008; Grossman, Hammerness, & McDonald, 2009; Zeichner, 2010) who argue that in order for this to happen, fieldwork needs to be repositioned to be a more productive learning experience intended to create expanded opportunities for prospective teachers to develop as practitioners who can enact complex, responsive teaching practices. In this paper, we examine the impact of a practice-based approach to teaching a science methods course that engages prospective science teachers in video analysis of their own teaching in conjunction with individual and

group-based reflective dialogues structured by cogenerative dialogues.

In the sections that follow, we elaborate on the use of video analysis with preservice science teachers as intended to facilitate reflective, and reflexive, practices. We begin by presenting a brief overview of various uses of video in science teacher education, and then elaborate the conceptual underpinnings that have guided the development of the practices we employ in our science methods courses and our research. In particular, we delineate our use of the notion of reflexivity as a critical construct in moving preservice teachers to noticing their own practices with the goal of working towards transforming classroom science practices during their field-placement teaching experiences.

Overview: Video in Science Teacher Education

Schön's theorization of reflection in- and on-action as a process has been criticized by some scholars for lacking consideration for the situatedness of practitioner experience (Russell & Munby, 1991; Munby & Russell, 1994), the impact of teacher knowledge in shaping the process (Shulman, 1987), and the importance of temporality and intentionality when engaging in the process of reflection (Roth, 2003). However, teachers often lack the time, space and support to engage in such analysis and reflection. The critique that reflecting on action (whether while in the moment or removed from it) results in change in teacher practice has encouraged researchers and teacher practitioners to closely examine the connections between reflection-in-practice, reflection-on-practice and change in practice. In considering ways to provide structures to support teachers' reflection on action, a continually growing number of researchers and teacher educators have emphasized the benefits of capturing and evaluating classroom activity with video (e.g., Brophy, 2004). While a lot of research has focused on teachers reflecting on video from other classrooms as examples of "best practices" (e.g., Abell & Cennamo, 2004; Watters & Diezmann, 2007), more recently researchers have been shifting focus towards engaging teachers in editing their own videos in an effort to foster reflection on their practices (e.g., Zhang, Lundeberg, Koehler, & Eberhardt, 2011).

Video as a Tool for Noticing

The use of video within science teacher education programs can allow for 'slowing down' the teaching process in order to focus on classroom interactions and then inquire into practices in other contexts (Sherin & Han, 2002). As such, video serves to support teachers in becoming aware of classroom events, which, offers them the possibility of a deeper level of analysis for teacher professional development (Roth et al., 2011). When teachers are positioned to become aware of events through the viewing of video, they gain opportunities to notice things that may have passed them by while engaging in interactions with one another in the classroom. In this way, video can facilitate teachers (and students) becoming aware of practices and actions that they may not be aware of 'in the moment' (LaVan & Beers, 2005). Such awareness can extend to finding ways to transform the climate of a classroom, as participants become more aware of aspects of their interactions. However, before video can become a tool for transformation, teachers must be able to effectively reflect on what they have noticed in order to make changes to their practice.

Video as a Tool for Facilitating Reflection

Recently we conducted an in-depth literature review on the different uses of video in science teacher education (Martin & Siry, 2012) and it became evident that many researchers in various discipline areas in teacher education have been using video as a tool to help practicing teachers reflect. We found van Es and Sherin's research on the use of video for "learning to notice" (2002) to be particularly interesting as they examine how inservice teachers learn how to pay attention to certain aspects of classroom interactions (van Es & Sherin, 2008; Sherin, 2007) and to verbalize what they know and understand about these theories in their own classrooms by looking at video of themselves (Sherin & Hans, 2004; van Es, 2009). More recent work by Sherin and van Es (2009) focuses on understanding how teachers make sense of what they notice (which students they focus on and what they talk about), how they select video clips (Sherin, Linsenmeier, & van Es, 2006), how they analyze the video based on their years of experience teaching and engaging in reflection on video of their teaching, and how video reflection affects teachers' practices in the classroom (van Es & Sherin, 2010). Talanquer, Tomanek and Novodvoersky (2013) also used the theoretical construct of teacher "noticing" to identify what prospective science teachers pay attention to when evaluating evidence of student understanding while viewing video captured from a peer teacher's inquiry-based science lesson. Preservice teachers of science are quite often used to watching exemplars of 'good teaching' through videos of other teachers' classrooms as this is a pedagogical tool that is becoming well established in teacher education (e.g., Hatch & Grossman, 2009). In addition to this established focus on the use of video for illustrating 'best practices', our recent review also found that when teachers are asked to record video of their own teaching it tends to be with the goal of evaluation (Martin & Siry, 2012). In these instances, teachers typically record one

lesson illustrative of their best teaching. Rather than focusing on video as an intended evaluation of 'exemplary' teaching, we build on these findings in this paper to consider use of video in teacher education as key to facilitating reflexivity.

Video as a Tool for Changing Practices

Once teachers have noticed classroom practices, their reflection on video can become a source of reference for changing structures and classroom practices that can transform teaching and learning. One example of using video to transform classroom climate is the work of Tobin and Roth (2010) who utilized video to examine features of high school teachers and students' interactions in science classrooms with a goal of raising awareness about ways in which teachers and students can shape the emotional climate of the science classroom by adjusting aspects of their talk, gestures, and use of space and time to become more aligned with one another. Video became central to the process of becoming aware and identifying specific behaviors or practices in teaching and learning for reflection. It is this notion of not only becoming aware, but then also using that new awareness to work towards new classroom structures that drives the work that we highlight in this paper.

A recent study supports this aim, in that researchers examining teacher emotions during teacher-student interactions in science classrooms engaged teachers and their students in analysis of their classrooms in an effort to identify teaching strategies that produced either positive or negative emotional interactions (Ritchie, Tobin, Hudson, Roth, & Mergard, 2011). The use of video to strategically increase practices promoting positive interactions with students was found to help the teachers feel more satisfied with their teaching. Other studies including middle and high school students and their classroom science teachers demonstrated that when analysis of video and audio recordings of classroom interactions are coupled with structured reflections on the roles and actions of individuals, video analysis can be a beneficial tool for engaging teachers in actually changing their classroom practices (LaVan & Beers, 2005; Wassell, 2004). In these studies, researchers and teachers used video as a tool to facilitate conversations about how to cogenerate changes in the classroom. Such findings provide a foundation for the research that we have undertaken, as we seek to engage individuals in analysis of video captured from their science teaching, to reflect (both individually and with others) on these videos, and to transform teaching and learning as a result.

In our work with preservice teachers in science methods courses, we have built upon the work of the researchers introduced above to use video-based, dialogic analysis of our science teacher education students' own classroom teaching to facilitate the development of reflection on practice that ultimately moves beyond being reflective, to being reflexive and situated to make changes in future practice. Video analysis among preservice teachers can be utilized as a structure in teacher education that provides a holistic tool (Masats & Dooly, 2011) to incorporate reflection, and reflexive practices, especially as part of a preservice teacher's science methods course and practicum teaching experience. While the use of video in preservice science teacher education courses and practica is certainly not new, we propose a theory driven approach for understanding what, specifically, can occur when faculty and preservice teachers work together to analyze video from the preservice teachers' own classrooms within dialogic exchanges intended to work towards future transformation of practice.

Goals for this Paper

There are two related goals for this paper. First, data from our courses are analyzed to examine the processes that emerge from using video analysis combined with cogenerative dialogue as an integral part of science methods courses. We do this by presenting excerpts from a series of video vignettes that illustrate the interactions of preservice teachers as they reflect on episodes from their teaching experiences during cogenerative dialogues, as part of our field-based science methods courses. A second goal is to conceptualize the role of cogenerative dialogue in structuring individual reflection and ongoing dialogue that help facilitate reflexivity in science teacher education. To reach this goal we present our approach and illustrate the different components through data to offer interpretations of how preservice teachers notice and reflect upon video, in order to do something different in their future interactions in classrooms.

By building on what is already known about video analysis in supporting becoming aware, and the use of dialogue in reflection, we integrate the two to provide a lens on the possibilities for transformation, both individually and collectively, in science teaching. Specifically, we articulate the role of Guba and Lincoln's (1989) authenticity criteria in structuring discourse during cogenerative dialogues that promotes not only individual and collective reflection on shared activities, but also reflexivity through transformative action. Thus, we seek to add to contemporary understandings of the use of video analysis in science teacher education by specifically incorporating reflexive practices enabled through dialogic exchanges that occur during cogenerative dialogue. Our ultimate claim is that this specific practice has the potential to facilitate transformations of teaching and learning practices

within science classrooms. In the following sections, we discuss the ways in which our research builds connections between video analysis and cogenerative dialogue as a means to develop reflexivity during preservice science teachers' practica experiences.

Conceptual Underpinnings: Critical Reflexivity

There are many uses of the term reflexivity in education and in education research, including teacher reflexivity, researcher reflexivity and reflexive methodologies. In this paper, we adopt sociocultural perspectives on the term 'reflexivity', grounded in notions emerging from qualitative inquiry methodologies. As we consider the role of video in facilitating reflexivity, it is important to begin by outlining our perspectives on the term, especially as seen in the literature on teacher education where the terms reflexive and reflective practice are often used together or interchangeably. We see a distinction between the two terms, and we agree with Bleakley who suggests that the expression 'reflective practice' is so commonly used in teacher education that it "is in danger of becoming a catch-all title for an ill-defined process" (1999, p. 317). Specifically, moving towards critical reflexivity, or reflexive awareness, can support reformulating reflection as a process that results in an action, and also supports considering the ethical components of interacting with others (Ruth-Sahd, 2003). Facilitating a reflexive practice in teacher education can be considered as supporting teachers' interpretation of the events in a classroom, an interpretation, which then changes their teaching (Elliot, 1993, emphasis ours). Within this change process there is an inevitable interpretation of, and changing of, the self.

This is an important component of facilitating reflexivity – encouraging introspection (and reflection) upon one's assumptions and actions, often with the explicit goal of changing practices moving forward past the point of reflection. We frame reflexivity through critical lenses, as we find it important to consider within the process of working towards highlighting oppressive structures in order to deconstruct them (and ideally reconstruct towards less oppressive structures). Methodologically, we build upon approaches that use the term to refer to the "process of critical self-reflection on one's biases, theoretical predispositions, preferences, and so forth" (Schwandt, 2001, p. 224). Thus, gaining a reflexive awareness can emerge from an interactive, iterative process between reflection and interpretation. Critical reflexive perspectives describe a person as "a plurality of situated identities that are culturally constituted" (Bleakley, 1999, p.317). With that perspective of culturally constituted identities in mind, teachers can engage in reflexive practices when they

"stand back and examine the underlying beliefs and values which are informing decision-making and actions in classroom situations" (Wilson, 2009, p. 17). This focus on revealing underlying beliefs and values is central to our use of video with teachers, and often within this process, we see that hidden or unconscious practices become revealed in the process of reflexively considering one's actions. It is an exploration of the construction of subjectivities that we seek to explore in teacher education, and the combined use of ongoing cogenerative dialogues coupled with video analysis serves to facilitate practices that can develop critical reflexivity.

Critical Reflexivity through Dialogue with Others

In order for teachers to develop reflexivity it is important to include dialogue, collaboration, and the establishment of trusting relationships (Warin et al. 2006, p. 243). The combination of dialogue, trust, and collaboration are central to our research introduced herein. As such, part of the approach we have embraced focuses on participants engaging in the methodological approach to collaborative dialogue termed cogenerative dialogues (Tobin & Roth, 2006). These dialogues are structured conversations where teachers and students engage in discourse with the intention to co-generate shared understandings about classroom interactions and student/teacher goals.

Various studies in many K-12 schools and university classrooms have demonstrated that teacher implementation of cogenerative dialogues with students can lead to increased student achievement and increased positive social interactions between teachers and students, which improves the learning environment for all (Carambo, 2009; Emdin, 2007; Lehner, 2007; Martin & Scantlebury, 2009; Roth & Tobin, 2001; Scantlebury & LaVan, 2006; Siry & Lang, 2010; Tobin, 2006). In our work, we enrich these dialogues by supporting preservice teachers to capture and clip short video vignettes from their classroom teaching experiences to analyze during cogenerative dialogues with us and the other preservice teachers in our courses. We have found that teacher research using cogenerative dialogues has shown to be effective without video – but it is much more effective with it (Martin, 2005; Martin, 2006a). In our research, we find that engaging in video analysis during cogenerative dialogues provides participants a resource for their reflections, while the structure of cogenerative dialogue helps to create the social space needed to reflexively consider and cogenerate individual and collective actions, which have the potential to transform practices, schema, and classroom structures. These connections between individual and collective actions are central to our positioning of video analysis
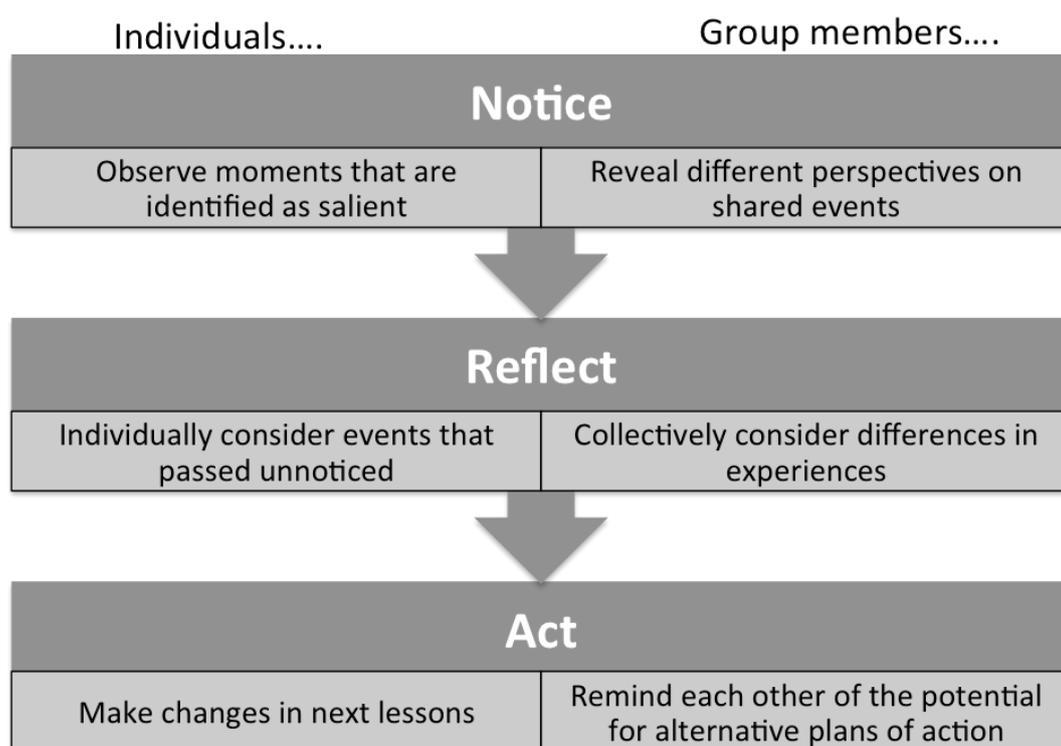
Individuals....   Group members....

Notice	
Observe moments that are identified as salient	Reveal different perspectives on shared events

Reflect	
Individually consider events that passed unnoticed	Collectively consider differences in experiences

Act	
Make changes in next lessons	Remind each other of the potential for alternative plans of action

Figure 1. Reflexivity as both an individual and collective process.

within cogenerative dialogue as part of our practice-based approach to our science methods courses. In the next section, we elaborate on the centrality of the relationship between individuals and group members within a course in considering reflexivity in preservice teacher education and we introduce the inseparable, related, components of the individual and the collective.

The Inseparability of the Individual and the Collective

As we work with preservice teachers to investigate teaching practices together, we learn both with and from one another (Tobin & Roth, 2006). As such, video analysis provides a resource to support reflexive examination of one's own practices, but importantly, together with cogenerative dialogues, this examination occurs partially in the presence of others. Our conceptual and methodological framework is grounded on theoretical underpinnings in cultural sociology and we share a grounding in dialectics, which assumes that there are parts to social life that come together to contribute the 'whole' experience. These parts are opposing, and inseparable. In particular, we are guided by an emphasis on the dialectical relationship between the individual and the collective (Roth, 2005). Through dialectical perspectives on social life, the individual needs of a student and the collective needs of all the participants in the classroom can be brought together dialectically so that each part combines to create the whole. In other words, the individual and the collective

evolve together and create a dynamic that mediates the emergence of reflexivity towards teaching practices that support learning. This process is represented in Figure 1.

As emphasized in this diagram, reflexivity as a process can occur on the individual level as well as on the group level. In holding such a focus on the relationship between the individual and the collective, there is an inherent goal of recognizing and appreciating difference, as such, we respect the others within our group and we acknowledge that differences exist and we do not try to change them. We believe that acknowledging and appreciating this relationship is crucial for preservice teachers if they are to develop the skills and strategies they will need to be successful when they transition from being pre- to inservice teachers. Along the same lines, video analysis can provide preservice teachers a means for collectively engaging in analytical discussions about how to improve teaching and learning in science education classrooms as they also individually consider their own experiences. This theoretical foundation serves as the basis for an approach for developing science teacher reflexive practices, grounded on noticing, reflecting and acting. Later in this paper, we elaborate on these three components of noticing, reflecting and acting through an analysis of data collected from video ethnographies. In the following section we elaborate on the methodological underpinnings that support our research foci.

METHODOLOGY

We use a qualitative case study design to examine the role of video analysis and cogenerative dialogue in supporting preservice teachers to reflect on and reflexively enact changes in their classroom teaching practices. The design of the study was based on an in-depth data collection involving multiple sources of information that were rich in detail (Creswell, 2007). Case study methodology is a valuable approach because it allows researchers to study complex phenomena within their own contexts using a variety of data sources (Yin, 2003). Framed as an explanatory case study (Yin, 2003), we seek to describe how video-based cogenerative dialogue can promote reflection and serve as a reflexive tool across two different science methods courses. In our analysis, we highlight the process of using video and cogenerative dialogues during pre-service teachers' science teaching practicum in two field-based methods courses in an effort to describe this process and to explain what emerges as a result of engaging in individual and collective video-based dialogue.

To create a detailed understanding of this particular activity, we focus our discussion on one specific ongoing activity within each of the courses: the discussion of videos during cogenerative dialogues. Data was purposefully selected from our two individual courses that represent possibilities for noticing, reflecting, and acting as a result of our students' engagement in video based cogenerative dialogue (see Figure 1). Presented as excerpts intended to demonstrate how video and cogenerative dialogue were utilized in our courses, we introduce data from two courses to contextualize and conceptualize the structure of the theory-driven approach that has been developed.

Using an emergent and iterative analytical process, we used the following questions to guide our data collection and analysis:

- *What is the role of video when analyzing one's own teaching?*
- *How do video analysis and cogenerative dialogue conducted within our methods courses impact preservice teachers' classroom practices?*
- *What kinds of practices / understandings do preservice teachers cogenerate with others?*

In answering these questions, we focus our attention on data that documents the development of reflexivity through participation in video analysis and cogenerative dialogues. We emphasize that the goal of our analysis is not to present a 'model' for incorporating video and dialogue in methods courses. Rather, as our work was done at distinctly different institutions with differing program structures, we seek to highlight commonalities in our implementation of video-based reflection to demonstrate how such an approach can support teacher reflection and reflexivity even in different contexts. In

the following section, we elaborate the specifics of each of our courses in further detail.

Context for our Collaborative Research

The data that we draw on for this paper was collected while we were teaching at two different private universities in the northeastern United States in large urban cities. We both taught small, field-based science methods courses (8-10 students) in which preservice teachers were expected to participate in classrooms over an extended period of time (average of 12-16 weeks). As instructors of these methods courses, we each accompanied our students to the field in science classrooms where we engaged in a variety of activities, including coteaching, video recording lessons, and engaging school children and inservice teachers in collaborative discussions to plan, implement, and reflect on science lessons taught by our teacher education students. Although each of our programs had different foci (elementary science or secondary science), we used similar conceptual and methodological frameworks to underpin the utilization of video as a tool for examining teaching practices in our courses. Our courses were designed to incorporate a variety of perspectives and to provide opportunities for participants to learn from these differing perspectives. In each of our courses, lessons were recorded with a stationary camera at the back of the room focused on capturing events at the front (to record teacher practices at the chalkboard) and one hand-held camera was used to capture what our preservice teachers said they were interested in examining more closely (i.e., small group interactions, interactions with a specific student or group of students, etc.). As such, the preservice teachers were supported to capture video of teaching and learning that was of interest to them.

In Sonya's class, secondary preservice teachers were coteaching over a 15-week period in two-student pairs in secondary science classrooms with an inservice 'host' teacher. During this period, the preservice teachers taught daily and as a result, they typically had only 1-2 lessons captured per week via video recording. Once per week, the preservice teachers met for an evening course at the university where they shared video data from their own teaching during small group cogenerative dialogues with two other peer teachers. In these meetings, teachers were expected to apply theory from course readings to analyze their videos and to reflect on their practices as beginning teachers. Following small group meetings, the students shared their analysis with the whole class during which all peers provided feedback and supported one another to cogenerate plans for changing their teaching practice in the next week of teaching. Teachers were expected to implement these changes in the upcoming lessons and to share the results

Table 1. Comparison of structures of the two preservice science education courses

Structure	Preservice elementary course	Preservice secondary course
Goal of course	Facilitate connections between educational theories and practices, as participants develop and then carry out a science unit in an elementary school classroom.	Prepare reflective science teachers by demonstrating how theory can be applied to practice through the use of video analysis, cogenerative dialogues, and coteaching in high school science classrooms.
Length of course	One 15-week course, twice a week, met once a week at university and once a week in school-based setting.	Two consecutive 15-week courses, met once a week at university and once a week in school-based setting.
Role of field experiences	Gain practical teacher experience as participants coteach lessons from a unit they have collaboratively developed through the science methods course.	Gain practical teaching experience, learn to apply theory to practice, and engage in inquiry-based research to improve teaching/learning of science.
Use of video	All science lessons are video recorded, and preservice teachers receive video of all their teaching during the semester. View individually and then select relevant excerpts for collective discussion.	Record one or more lessons each week to document growth and development over time. Use video data to identify challenges in teaching. Apply different theoretical lenses to analyze videos each week.
Use of cogenerative dialogues	Central to the organization of the course, as the unit is planned and each week the previous lesson is analyzed and interpreted. As such, future lessons are adapted in response to the video analyses.	Utilized to co-construct our methods course, to engage in collaborative reflection on teaching with others, and to engage high school students in dialogue about how to improve science teaching and learning.

of their changes in the following week. Acting as their field-based methods instructor, Sonya also met the preservice teachers each week at their school-based site to video record lessons, coteach science lessons, and to facilitate discussions between the preservice teachers and their cooperating teachers about their individual and collective roles in the classroom.

In Chris's class, the elementary preservice teachers were coteaching with her as a large group, and in small groups with one another, in a second grade science classroom over a 14-week period. This course had two meetings a week, with one meeting occurring at the college campus, and the second meeting occurring in a 2nd grade classroom. Built upon a foundation of coteaching, preservice teachers worked together to develop a science unit, with Chris's facilitation, that was then taught one day each week to the children in the 2nd grade class. The classroom teacher acted as a resource person and also was present and active during the lessons. The coteaching typically unfolded with one of the preservice teachers leading the lesson, and the rest of the preservice teachers coteaching by facilitating the lessons with small groups of children. Thus, in the first day's meeting each week, the preservice teachers would prepare for the coming lesson, and also debrief and reflect upon the previous week's lessons. The science unit plan development was emergent, as each week the plans shifted a bit depending on what occurred

during the previous lesson. Video-based analyses were central to considering the previous week's lessons and restructuring the following lesson. Table 1 presents an overview of the different pedagogical structures of the courses.

As is evident in Table 1 above, in both of our field-based science methods courses, video analysis was a required component of student coursework and coteaching was used as a central approach to learning about the teaching and learning of science (e.g., Siry & Martin, 2010). In both courses, teachers first viewed a video of their teaching individually, and then discussed it collectively with the express intent to reflexively consider how to enact changes in future classroom practice. Teachers were not given rigid guidelines to inform their selection of vignettes on which to focus. Rather, teachers were supported to watch their videos individually several times and to take note of events that were of particular interest to them. These events became a starting point for deeper analysis. In addition, weekly readings were assigned to focus our teachers' attention on issues like assessment practices, laboratory investigations, and collaborative learning. These weekly topics sometimes served as a focal point for teachers' examination of their video and the readings provided a structure for supporting our preservice teachers to consider what kinds of events and interactions one might examine – but teachers had full autonomy in

deciding what to notice and what to reflect upon during cogenerative dialogues. The ways in which we utilized video in our courses differs somewhat based on the structures of our university programs, but we have found that in our common theoretical groundings there are many overlaps in our experiences as teacher educators and science education researchers. What is relevant for considering our frameworks in both of these contexts is that preservice teachers individually analyzed video of themselves teaching in science classrooms and then collectively cogenerated plans of action for improving practice in ongoing dialogic interactions during small group and whole group cogenerative dialogues in our science methods courses.

Data Collection

As is introduced in Table 1, the courses differed in their overall institutional structure of weeks, foci, and goals, but consistent to both is the use of video and cogenerative dialogues throughout the course. We each utilized video-based critical ethnographies (Barton, 2001; Carspecken, 1996), design experiment (Brown, 1992), and cogenerative dialogue (Tobin & Roth, 2006) in order to catalyze improvements in our teacher education curriculum on an ongoing basis. These combined methodologies enabled us to document events in our interactions with the preservice teachers in our courses with a specific focus on creating transformative opportunities for these preservice teachers to begin to see themselves as new teachers. As part of our documentation of our courses over time, we collected videos from all course lessons from which we draw to support claims made in this paper.

As introduced above, all preservice teachers had their science lessons video recorded during the semester. Stationary cameras were set up at different locations within the classroom to document a variety of interactions and hand-held cameras were used to capture small group interactions. Each preservice teacher received copies of all video recordings captured for any teaching episodes in which the preservice teacher was engaged, both whole class and small group science teaching interactions. The teacher participants in our courses were aware that we were intentionally implementing video analysis and cogenerative dialogues in our science methods courses in an effort to better understand how these tools could support preservice teachers to be more successful in science classrooms. As such, we engaged the participants in our field based methods courses in a series of assignments which generated data from their teaching practicum experience, from which they were asked to select video to individually and collectively analyze with us and their peers.

Self-selecting video vignettes for analysis by preservice teachers is not common practice in science teacher education (Zhang, Lundeberg, Koehler, & Eberhardt, 2011). However, this is a crucial component of our courses, as preservice teachers are involved in the data collection, selection, and analysis, which can be more effective than viewing videos selected by us as their instructors (Yerrick, Ross, & Molebash, 2005). Building upon the conceptual frameworks introduced above, we utilize collaborative analysis of data across the two sites to learn more about the ways in which science teacher educators can structure teaching practicum to foster reflexive practices with preservice teachers.

Data Analysis: Examining the Role of Reflexivity in Practice

In order to frame our analysis of this expansive data set, we have chosen to "zoom in" (Roth, 2005) to one semester of each of our courses and select video vignettes to excerpt and transcribe that illustrate the role of video analysis combined with cogenerative dialogues in our preservice teachers' development as reflective/reflexive science teachers. After we portray the excerpts from different vignettes in narratives enhanced by photos and transcripts, we engage in an interpretive analysis to generate theoretical perspectives that further our understanding about the role of video-based analysis, situated together with cogenerative dialogues, in preservice teacher education. We discuss the connections between the data resources and the specifics of the approach to facilitating reflexivity in order to explore the implications for others' work in preservice science teacher education. Later we weave these together to lead to our central claims regarding the potential of video analysis for facilitating reflexivity in cogenerative dialogues. In the remaining sections, a focus on individual and collective analytic experiences within our science methods courses is introduced. The reflexive experiences and considerations of the preservice teachers are explored and analyzed as grounded within the process of reflexivity represented in Figure 1. We then engage in a synthetic analysis to highlight what has emerged from the video examination and cogenerative dialogue as situated within the individual | collective dialectical relationship in order to propose implications for the praxis of preservice teacher education for science. We conclude with a discussion about the role of the authenticity criteria as a framework for moving towards transformative practices in preservice science teacher education. Finally, we draw implications about the need for innovative teaching strategies, research initiatives, and changes in science teacher education.

Figure 2. Preservice teachers and Chris during a cogenerative dialogue during science methods course.

Elementary Methods Course: Using Video to Analyze Cotaught Lessons

We have utilized photo offprints, narrative description, and transcripts to contextualize the activity of video analysis with cogenerative dialogue, which allows us to examine what emerges in this process, vis-à-vis to the questions asked above. This first analysis section examines what unfolded in the context of the preservice elementary teacher education courses.

"I really didn't notice": Revealing conscious and unconscious practices.

In an effort to reveal moments that might have passed unnoticed in teaching science lessons to the elementary children, cogenerative dialogues between the preservice teachers and Chris focused on video viewing, and course participants each brought short self-selected clips to discuss. To guide the selection of the video clips, preservice teachers were asked to view the videos before the cogenerative dialogues, and focus on moments that interested, or surprised, them in the video. The videos were to be short (up to 4 minutes) and these were brought to the cogenerative dialogues and served as a point for discussion among the group. The first excerpt we use to contextualize our claims is from a cogenerative dialogue in which one of the preservice teachers (Tracie) responded to Chris's request that the preservice teachers view their videos individually, and then choose a moment in the video to write a commentary about which they would then share with the collective as part of a cogenerative dialogue taking place during the science methods course.

During the cogenerative dialogue, Tracie introduced a short clip to share from a lesson for which she was the lead teacher. Transcribed from the cogenerative dialogue in which Tracie elaborates her thoughts on the video, the following text reveals what Tracie identified as "something that surprised me". In Figure 2, we see an offprint of video taken from the methods course in

which Tracie is seated across the table from Chris, and from left to right are Marisol, Emma, and Lauren.

Important for considering the dynamics of a dialogue such as this is that it is evident in the photo that all participants were sitting in a circle as they spoke, and attention was clearly focused on the speaker. Chris was also sitting at the table as the course structure is based upon dialogue and exchange between the instructor and the preservice teachers. This exchange represented in excerpt 1 (below) is focused on cogenerating reflexive ways to move forward in the elementary classroom, after participants listened to Tracie reflect upon the difficulties she experienced while becoming aware of the many complexities of classroom teaching.

Excerpt 1

Tracie: You always plan it out on paper perfectly and you are like, this is how it's going to go, but when you are with the kids you never know how it's going to go, and how it's going to work out. Sometimes it can be disappointing, because you work so hard, but you never know how it's going to happen in actuality.

She then continued to build on this comment by retelling what she noticed during her individual analysis of her video. We present this dialogue as a transcript so we can analyze segments of the text with greater clarity by referring to the lines of the dialogue. We also present the transcript excerpts with conventions that demonstrate increases in intonation and volume, so that the reader can gain an understanding of the speakers' emphasis in these exchanges.

Excerpt 2

Speaker Dialogue

01 Tracie: But I noticed how hard it is to try to like, to try to like keep track of everything… I felt like I tried to call on all the students but I noticed there was ONE kid who was sitting in the corner, he was sitting right by you ((points to Chris)) and he had his hand up ((raises hand)) like for half my lesson, and you would THINK that sitting up there in front of everybody, that you would like NOTICE everybody
02 Chris: Uh huh ((nodding))
03 Tracie: Maybe I noticed him but I don't think so, but I don't know. I was watching it [the video] with my boyfriend and he was like 'what happened to my man over there? Come ON!' ((group laughter))
04 Tracie: I'm like WAIT, you know what? I really, I DIDN'T notice it. If I noticed him I would have called on him and in the video I can see you are sitting there talking to him because he's trying to say something and I'm not calling on him and you're nodding your head and you're like ((whispers)) 'that's good, that's good' I can even see you

saying it to him but like when you are UP there, there are just SO many things to remember and SO many things that you want to get to and sometimes you don't always call on all the kids that want to share but I don't want to be like that
05 Chris: ((nodding)) right
06 Tracie: That's like what I remember about school, you'd have something really good to say and the teacher just wouldn't call on you so I don't want to be like that ((shaking head side to side))

When we analyze the dialogue from this exchange in excerpt 2, we see that Tracie began somewhat apprehensively. She cleared her throat (turn 1), looked down at her hands, and spoke softly as she began to tell us about Kevin, the boy who was trying to participate in her introduction to the lesson. Her retelling of her boyfriend's comment (turn 3 "What happened to my man over there? Come ON!") created a space in the conversation for laughter and a release of tension for Tracie. In their shared laughter, the group provided support and a sense of solidarity to Tracie, and she appeared more confident as she continued vehemently expressing her concerns about what she remembers about being a student (turn 6 "That's like what I remember about school, you'd have something really good to say and the teacher just wouldn't call on you"), and about how she would like to be as a teacher (turn 6 "I don't want to be like that"). Through the use of the videos, Tracie noticed this moment and identified it as salient to her own development as a teacher. Her participation in this dialogue positioned her to be able to consider what she wants for herself as a teacher of science (turn 6 "I don't want to be like that").

The ongoing, weekly, cogenerative dialogues around the video structured a social space that is focused around support for one another, and the shared laughter of the participants also appears to have created a support for her as she begins to express her concern that she apparently did not see Kevin's hand was raised. As she began to laugh in turn 3, the rest of the group turns towards her, makes eye contact, and laughs with her. It is common in this course that preservice teachers leave the elementary classroom expressing their surprise that they are so 'in the moment' that they are not able to recall direct experiences and are not able to dwell upon the choices they made in their teaching and conversations they had with children.

Important features of cogenerative dialogue use in our courses included engaging in consistent, on-going dialogues over time. This excerpt highlights a particular feature of cogenerative dialogue as we used them, close physical proximity, around a table or in circle with a video source serving as a common reference on which to reflect and to guide the dialogue about a particular event that was identified not by us, but by a teacher. Key features in our courses include small group

discussions that are focused on something identified by participants, with the goal of paying explicit attention to the video as directed by the preservice teachers' noticings. From this point, the dialogue structure can serve to move the conversation to the point of examining what can be done in the future. This is the role that we as instructors facilitate at first, but as we show in the coming sections, this role shifts to be collective as the dialogues unfold over time.

Reflecting upon moments that passed unnoticed

The exchange between Tracie and Chris in excerpt 2 ended with a focus on what Tracie could do next time she is in the classroom, as represented in excerpt 3 below.

Excerpt 3

Speaker Dialogue
07 Chris: So, now then, let's think about this, what will you DO next time? What will you need to keep in mind next time you are in the classroom?
08 Tracie: ((Smiles)) wellll definitely try to pay attention to all the students ((nodding))

Through viewing the video individually at home prior to the cogenerative dialogue in excerpts 1 and 2, Tracie became aware of a practice that she had not intended in the moment or been previously aware of. While the video revealed the practice to her, the cogenerative dialogue provided a space for her to discuss the episode, and share her surprise at what happened with the boy with his hand up. This individual collective video analysis and cogenerative dialogue process allows for analysis in hindsight and supported her interrogating taken-for-granted assumptions and practices as she developed a reflexive awareness of herself as a new teacher. Certainly she had not intended to ignore the boy with his hand up, and the video provided one lens on moments that had passed. As she reflected upon the moment in the cogenerative dialogues, she smiled in response to Chris' question about what she would do next time. When Chris spoke to her afterwards, she explained that she had smiled because this was a question that she had thought about as well, and hopefully one that will be able resolve by "definitely paying attention to all the students" (line 08).

After this cogenerative dialogue, Chris reviewed the video that Tracie was reflecting on, and was able to see for herself the boy to which she was referring (see Figure 3).

This video offprint shows the moment from Tracie's lesson to which she was referring to in excerpt 2 during the small group cogenerative dialogue. It was the beginning of her lesson, Tracie asked the children to recall their experiences from previous lessons. Chris was

seated on the floor next to the chart facing the children and looking at the boy as he first raises his hand. During five minutes of this discussion, the boy's hand went up 10 times to contribute. Chris was sitting next to him, and on several occasions he initiates discussion with her. Although Chris was sitting next to him, as is seen in Fig. 3, she did not remember this part of the lesson until Tracie pointed it out. Thus, Tracie's individual video analysis and the collective discussion and analysis in the cogenerative provide allowed for both Tracie and Chris to notice these moments that had passed unaware.

Intrigued by the discussion that occurred around Tracie's video clip in the previous class meeting, Chris chose to bring the same clip to the next cogenerative dialogue meeting so that the group could re-view it together again and so she could model for the preservice teachers how they might reflect further on Tracie's initial observations made during her own analysis of her teaching video. Upon viewing the clip in the second cogenerative dialogue the following week, the group discussed how without the benefit of being able to re-view the events of this teaching episode on the video clip, they may never have been aware of this incident, and thus, would not have been able to learn from it. Using the cogenerative dialogue to engage the group in a more focused analysis of this video clip provided the opportunity for all of the course participants to focus on a shared moment in the classroom and connect it to their practice moving forward. Having captured the teaching episode on video allowed for both an individual focus (Tracie's) as well as a collective focus on learning from the video, as the rest of the preservice teachers were able to witness the ways in which Tracie was unaware of the boy's attempts to contribute to the discussion.

Reflexively, they were able to discuss how to make changes in their teaching approaches in future lessons so that they could actively become aware of all students during whole class discussions, and find equitable ways to acknowledge all children who wanted to participate in discussions. Further, Tracie examined this experience from the perspective of both teacher and student as she expressed she had experienced the same practices as a child who wished to participate in whole class discussions, but who was not called upon by her teacher to do so. As science teacher educators, we see it as central to support preservice teachers in making these connections while they are pre-student teaching, in an attempt to scaffold a variety of experiences to from which they can begin to reflexively consider the ways in which one's actions may impact a child's participation in science.

Building on this collective experience of learning from reflecting on Tracie's video, another preservice teacher, Marisol, made a connection the following week from this particular cogenerative dialogue to a moment

Figure 3. Tracie (l) and Chris (r) with boy whose hand was raised during lesson

she identified as salient from her own teaching videos. Marisol offered that the coteaching arrangement in which both Chris and the classroom teacher worked with Marisol to support her to teach her science lesson to the second graders was very beneficial for her development as a new teacher.

Excerpt 4

Marisol: I really like it that we were able to like, to do that, and sit there and be the teacher. Even though we did have the help of the two of you guys, to do our first lessons, with the two of you on either side of us, even like when I was sitting there, I was watching myself on video, and I was like, 'oh man, these kids are really here in front of us…' ((laughs))

As Marisol discussed seeing herself on video, she recalled the realization that she was actually teaching her first lesson to children. She ended this comment laughing, while recalling that what she had been thinking during the actual moment the lesson was captured on video (oh man, these kids are really here in front of us…). The rest of the preservice teachers shared Marisol's laughter as her comment represented a shared feeling that each of them had individually spoken of during prior conversations, what one of them had called the 'almost surreal nature' of teaching a first lesson. All semester, the group had worked towards being the teacher, and Marisol's comment, as well as the group's shared laughter, represents a shift in their perceptions of how they saw themselves (oh man, these kids are really here in front of us…).

These comments are typical of the weekly cogenerative dialogues throughout the semester, as these conversations were built upon a sense of shared responsibility, and provided opportunities to identify what worked and what did not work in the existing structures of the collaborative field-based course. Thus, we shared these excerpts to illustrate the ways in which cogenerative dialogues based on video analysis can serve

as a mediating tool for preservice teachers to review and examine classroom events together with others. In this process, we, as methods instructors, were provided with the space to draw attention to a real event that was shared in the classroom, in order to discuss what happened and to plan for future teaching.

Making changes and focusing on different perspectives.

In using video to reflexively consider her realization that she was "actually" teaching in the vignette above, Marisol and the group were positioned to discuss the ways in which many moments often passed unnoticed. After these preservice teachers facilitated their own lessons, they expressed their concerns that they were so "in the moment" that they were not able to dwell on individual moments for long, or that moments similar to Tracie's may have occurred without their realization. After Tracie's noticing of her unconscious practice of not calling on the boy in the front of the class, she explicitly went out of her way to not only try to have an overview of which of the children would like to share their ideas, but she also encouraged the other preservice teachers to do the same. Several times on the video for the weeks after the cogenerative dialogue highlighted above, Tracie can be seen during science lessons making comments to her peer teachers, such as, "Natalie, Mario's hand is raised, I think he wants to talk about the question you asked".

The use of video for both individual analysis as well as collaborative discussion allows the group to explore alternatives to situations that they encountered in their teaching and facilitated continuing critical reflexive development. Additionally, the participants discussed their different perspectives of what had occurred in the classroom, and elaborated ways to make changes in their practices moving forward. For example, after Marisol introduced her feelings about watching herself on video in excerpt 4, Olga introduced her reflection on the video in which she explains her surprise at her perspectives of the children in the group.

Excerpt 5

Speaker   Dialogue
01 Olga: You know, it's funny, when I watched my video, I saw something totally different than you did [to Marisol]. I feel like I was really aware of what was going on during the experiment, and Maria ((one of the 2nd grade students)), she was totally IN the experiment and [WITH me
02 Anna: [She's always with us – she's so great
03 Olga: Yeah, I thought that too, and I really thought she's my best kid in the group.
But I saw that Alberto was totally with me too, but whenever I turned   around to pay attention to what

he was doing, he didn't seem to be getting the purpose. I remember feeling really frustrated that AGAIN he wasn't getting it, but when I watched on video though, I saw that he was doing JUST what he should be doing
04 Anna: Maybe we should each try to pay attention a little to some of the other groups too, not just our own. Do you think that might work?
05 Olga: It could get crazy, but let's give it a shot.

In this excerpt, Olga expressed her surprise that a student that she thought was not "getting it" (turn 03) was actually "doing just what he should be doing" (turn 03). Video provided Olga the chance to see a contradiction between her expectations of what was happening (the boy wasn't doing what should be done, or understanding the purpose) and what the reality of that moment was. She expressed surprise as she sat up straight in her chair, eyes wide, and said that he was "doing just what he should be doing" (turn 03). Building on this observation, Anna quite enthusiastically offers the suggestion that perhaps the preservice teachers should each be trying to focus on the other groups as well as their own groups.

While it is critical to have opportunities to discuss past events in the classroom, video can be particularly powerful for helping students and teachers to make change as a result of what they see (Martin, 2009; Siry, 2011). As Olga guessed, this did not become manageable as the teachers maintained their focus on their small groups, but important is that there was the space to discuss this possibility, and try it out. These types of small collective changes occurred frequently in the cogenerative dialogues around the videos, whether in response to moments that passed unnoticed (like Tracie's), to contradictions (like Olga's), or to different perspectives (like Marisol's). These different excerpts represent the complexity of using video analysis with preservice teachers, and also can be situated within the framework introduced earlier (see Figure 1) as a means of conceptualizing how these different components (notice, reflect, act) fit together to create a reflexive process.

Important to this process are both the role of video as a tool for individual noticing and reflecting and the role of cogenerative dialogue for providing the social space and structure for collectively generating plans for improving practice. These two tools came together within the dialectical relationship of the individual and the collective in order to make it possible for reflexivity to occur in the above excerpts. The preservice teachers were able to see themselves in relation to others, as they became aware of conscious and unconscious practices in their teaching. Preservice teachers could identify contradictions and consider how these might be removed, either through adaptation of roles or elimination of certain practices. As well, they were unpacking not only what they had seen on video, but

also heard what others thought about the same experiences. In this way, we move from teacher education being a solely individual process to becoming a collective, organic process that emerges from opportunities to come together with a shared purpose of improving practice.

Secondary Methods Course: Applying Theory to Analyze Video of Classroom Teaching

In this section, we focus on how preservice secondary teachers selected moments to edit and analyze from their videos by actively applying different theories we had read about in our courses. In the fourth week of the semester, all preservice teachers were asked to select an event of interest from their teaching, to transcribe the event, and to apply a theoretical lens of their choice based on one or more assigned course readings. In addition, participants were asked to compare their practices as viewed in the video to their beliefs about what they wanted to accomplish as a teacher, which they had previously written about in journal reflections. The teacher education students were expected to share their analysis in small group cogenerative dialogue with 2-3 other teachers during the first hour of class to invite additional perspectives. Following this small group interaction, students were asked to engage in a whole class cogenerative dialogue where the focus was on sharing how their perspectives had been expanded, changed, or challenged while discussing their video and analysis with their peers in the small groups. The explicit goal of the whole class cogenerative dialogue was for each teacher to develop a plan for action to be implemented in their science classrooms during the following days, prior to when our science methods class would meet again.

In the sections that follow, we share excerpts from small and whole group cogenerative dialogues to illustrate a typical cycle of noticing, reflecting and acting in our courses. In this section, we share video transcripts and offprints to describe interactions captured between a student named Alix as she taught a chemistry lesson and video transcripts and offprints captured from video taken of the same student while she engaged in small group and whole class cogenerative dialogues to discuss her video. In addition to sharing longer excerpts from the video transcriptions of all cogenerative dialogues, shorter segments are excerpted and integrated into the following narratives. These italicized excerpts are intended to provide greater detail and description of the interactions among participants during cogenerative dialogues that took place in the science methods course.

Applying different theoretical lenses offers multiple perspectives from which to notice

An important aspect of the course was the explicit connections teacher education students were asked to make between the theories we read about and the practices they engaged in during their teaching. Video provided a shared event for teachers to examine and the cogenerative dialogue provided a social space for the teachers collectively gain experience using theory to discuss what they have noticed while examining their videos. In this section, we offer excerpts that illustrate the types of interactions preservice teachers have collectively analyzing videos using different theoretical lenses. During week 4 of the semester, preservice teachers had been instructed to select short episodes (.30sec – 2min) from their teaching and to prepare short, descriptive narrative vignettes of the activities as seen in the video clip. Using these video vignettes, preservice teachers were asked to apply different theoretical lenses to interpret the same teaching episode in an effort to demonstrate how different theoretical lenses could provide multiple differing perspectives from which to view the same interactions.

The following excerpt is from a transcript of video captured of student named Alix during a small group cogenerative dialogue with two other peers (Eileen and Eunhee) during the science methods course. In this excerpt, Alix read aloud from a journal reflection she wrote about two assigned readings by William Sewell (1992; 1999).

Excerpt 6

Alix: It is important to analyze the structures that are part of a classroom in order to understand WHY different agents act as they do, and to be able to determine HOW a classroom can be changed. It is important to think about the physical and ideological structures that exist in the classroom, and who has the power or agency to manipulate them…((1.0)) Sewell discusses different NODES where culture or practices are enacted, and the value that nodes have in analyzing power structures. We can use this theory as a way to evaluate the power structures that exist in the science classroom, and determine whether or not they are enabling or hindering the goal of education for the students.

After explaining her understandings about the readings to her peers, Alix shared that she was using these theories as a "lens for looking" and for "explaining what happened". Following this introduction, Alix shared that she decided to "focus on the structures she had set up [rules in her classroom] to involve students in whole class discussion by requiring that students raise their hands before being called upon to speak [practices she enacted]".

She continued, explaining that after watching the video "like 20 times", she decided she also wanted to consider a reading from Week 4 of the course [Ann Swidler, 1986] in an effort to "identify what strategies of

action were available to me and to my students as part of our cultural toolkits at the different nodes". In the following excerpt, Alix shares how she intended to utilize these theories (Sewell, 1992; 1999; Swidler, 1986) as lenses for analyzing her actions in at different nodes.

Excerpt 7

Alix: Something that's really interesting about thinking about what I read in these papers is that I can think about a few things. I can examine how my practices were being shaped (0.5) shaped by the resources at the different physical nodes. Like, the way the desks are arranged [physical resource], that puts some kind of limit sort of, like on where a person can even move. So, look, ((points at screen and plays segment of her video several times at the normal speed)), you can see here that I have to sort of walk around the projector to even get to the board. But now look! ((points at screen and moves cursor to play video at faster speed)). When you speed up the video, you can really see patterns in movements in class. See how I move? Only in these three spaces basically. ((Alix laughter)) And look at this, you can see patterns in student movement too. This kid ((points at student)) watch this ((plays video forward and back at fastest speed)). He is ALL OVER the place! He is dancing in his seat!! ((group laughter)). (0.5) So basically, I want to use these theories to look at the video with you guys and I want to think about how the physical structures and the rules in my class, how they sort of affect our strategies of action – especially at different nodes.

From this excerpt, we see how Alix has cobbled together a few different concepts to focus her analysis of her video by narrowing her focus as to what she will "notice" to specific points in the video. She also outlined a plan for how the theories she selected will guide her analysis and her group's discussion of her video. This excerpt highlights an important aspect of our work, namely that when an individual preservice teacher leads a cogenerative dialogue to discuss their teaching, they have considerable autonomy in choosing the videos they will share and the theories they want to apply. These features allow the teacher to focus their analysis on aspects of their teaching that are of interest to them and provides them some control is setting the initial goals for the dialogue.

Manipulating speed of video to "show" others what an individual has noticed

Mentioned previously, each preservice teacher has an opportunity to lead their small group in the analysis of short segments of video(s) they have selected from their own teaching. In leading the conversation, the student has the responsibility to first explain theoretical lens they will apply in their analysis and then by articulating what they noticed when individually examining their video. In the following excerpt, Alix begins by telling her peers what she noticed when looking at the video.

Excerpt 8

Alix: In reviewing my video, I noticed THREE points or NODES ((1.0)) and I am using these nodes ((speeds video up with cursor to show her movement to all three physical spaces)) as points for analyzing my teaching practices. The three nodes that stood out for ME ((manipulates speed to show movement at each node)) were 1) standing at chalkboard ((shows still print at board)), 2) sitting on the edge of table near the students' desks ((shows still print on table)), and 3) standing next to student tables to talk to different student groups ((shows still print at tables)).

Alix pointed out each of the nodes to her peers by tapping her finger on the screen while replaying the entire video of her lesson at the fastest speed (by moving the cursor forward). In this manner, Alix demonstrated that the majority of her teaching occurred in only three physical spaces in the classroom. This excerpt allows us to highlight how changing the speed of the video (slowing down and speeding up) can support teachers to notice patterns that are not visible when replaying video in "real time". Using a technique we specifically teach our teacher education students, Alix sped up the video and found that she repeatedly moved to and stood in three different places in the classroom while teaching.

Inviting others to collectively reflect on what is happening

After the teacher has articulated what they have noticed during their individual analysis, they are encouraged to invite their peers to share their perspectives in an effort to learn how others view what is happening in the video. After watching the video several times, Alix instructed her peers to watch several short video vignettes she had edited from her video in an effort to analyze what type of practices she enacted at each of the three nodes. She then asked her peers to consider what they noticed about her practices at these different nodes and she specifically instructed her peers to consider how the practices she enacted at the different physical spaces [the 3 nodes] shaped her students' engagement with her during the lesson. In the following excerpt, Alix's peers engage in the analysis.

Excerpt 9

Speaker   Dialogue
01 Eileen: I think we need to COMPARE your practices at each node, and not just see what you did at each node. We can see you enact different practices at each place, but we should see if there is any overlap in the practices, BECAUSE, if there is, it could REALLY be confusing for your students!

02 Eunhee: That could be interesting. AND it could explain some of the problems.
Yeah, 'cause maybe some kids don't see a difference
03 Alix: ((laughs)). I had not thought of that. I just noticed the nodes and saw I was like, doin' different things at these different places.

During this phase of the cogenerative dialogue, Eileen's suggestion became an important focus for the group's collective analysis of the video. Over the next 18 minutes, the three participants reviewed the videos at different speeds and they collectively observed that when Alix moved away from the chalkboard (node 1), she engaged in more "free-flowing conversations with students". Through multiple analyses of several video vignettes (edited from the same lesson) of Alix's interactions with students while at the board (node 1) and while seated on the edge of a desk (node 2), Eileen noted that when Alix was seated on the desk, "you [Alix] engaged in a more open kind of discussion with students". Eunhee noted that at this node, Alix " did not require students to raise their hands to speak". And Alix noted that while she was standing next to students' desks and was speaking to small groups (node 3), she also "just let students say what they wanted".

The realization that she enacted different practices at node 1 than at nodes 2 and 3 was somewhat disconcerting to Alix as she felt she had established "very clear rules" about her expectations for student participation, but the video revealed that her rules changed at different nodes and that the different expectations for engagement were not clear for all of the students in her chemistry class. When asked by Eunhee, "why do you think you are less flexible when at the board?", Alix reasoned that the board (node 1) represented a particular structure that "resonated with me [Alix]" and "elicited the practices and schema I have associated with being a teacher". At this node, Alix explained she felt she needed to "control her students". She noted, for example, that when she was at this node, she was doing what a teacher does, like " writing on the board, being listened to, giving instructions".

During this conversation, Eunhee drew from readings (Anderson, 1999) in the previous semester to describe what she thought was happening when students could not anticipate Alix's changing rules as she moved from node to node.

Excerpt 10

Eunhee: ((laughter)) The students who don't notice when you [Alix] move away from the board [node 1], they can't able to code switch, right? So those kids never take the chance to jump in the whole class discussions. They just sit there with their hands up.
This groups' analyses of Alix's videos revealed that while many students seemed to understand her implicit

classroom rules, those who were unable to "code switch" were routinely chastised for calling out "at the wrong time" while others were never called on to speak because they raised their hands when it was "appropriate to call out." While on the surface, their collective analysis might appear of little importance, but when negative interactions (such as chastising a student or ignoring a student) occur on a routine basis, they can become a source of discontent for students and can result in a breakdown in communication between students and the teacher. For example, in Alix's case, one of her students had been suspended from school the week prior to this cogenerative dialogue a result of an angry outburst during whole class discussion. When Alix reviewed the video from this interaction, she noticed that the student had been waiting with his hand raised to speak, but Alix did not acknowledge him because she was seated at node 2, where she did not intend for students to raise their hands to speak. The student became frustrated and eventually yelled out, for which the cooperating teacher expelled him from the room.

Through her individual analysis of the video, Alix had only recognized that she had a tendency to stand at different physical positions in the classroom. With the support of the theoretical lenses she selected, she intended to use these nodes as focal points for closer analysis. The small group cogenerative dialogue provided Alix a social forum in which to articulate what she had noticed when viewing her video and to apply theories she had read about in her course as a lens for noticing her actions and interactions with her students. By engaging with others in collective reflection from each participant's perspective, Alix was offered more insights, which allowed her more opportunities to understand how the structures in the classroom shaped her practices and her interactions with her students. This was a critical realization for Alix as she realized that confusion about the rules by students who did not "code switch" could have real consequences for her students. This activity also provided Eileen and Eunhee an opportunity to engage in a focused discussion about the need for educators to consider how rules that implicitly and explicitly govern student participation in different types of activities can have a significant effect on student engagement.

This could have been the extent of their learning, but the structure of cogenerative dialogue require that participants go beyond simply identifying problems and reflecting on them with others to attempt to resolve them. Applying theory to her video and engaging in shared analysis with her peers positioned Alix to reflexively consider potential actions she could take to remediate this situation in her classroom. In the following section, we share an excerpt from video of Alix during the whole class cogenerative dialogues in

which she relayed what she and her peers had noticed as part of their small group collective reflection. We conclude this section with a discussion of the groups' collective attempts to "act" by co-generating a plan of action for Alix to implement in her upcoming week of teaching.

Expanding the circle of reflection and creating opportunities for action

During week 5 of our science methods class, Alix lead a whole class cogenerative dialogue with the explicit intention to first share what she and her peers noticed in the small group cogenerative dialogue and then to invite her peers to provide their input and support her to cogenerate a plan to improve her situation. To provide some context for the videos she would be sharing, Alix displayed an excerpt from a journal reflection that highlighted differences between her intended lesson and the actual practices she enacted in the class as captured on the video.

Excerpt 10

In my class I needed to teach my students about the history and structure of the atom. Rather than just give my students a lecture and have them take notes, I wanted them to gain an understanding and appreciate for this discovery. Using the resources that were available to me I created four atom models, representing what scientists thought about its structure at different points in history. Each table of students got one model and was asked to make observations about it, and decided how they thought it represented an atom. Although some students were initially skeptical, eventually students' curiosity got the best of them and they wanted to investigate their model. Through their observations and reports we constructed notes about the atom (Excerpt from Week 4 journal reflection).

Building from this introduction, Alix explains how her small group's collective video analysis revealed the need for her to be more explicit about her expectations for student engagement in the classroom (see Figure 4a). In the following sections, we pair still shots captured from video of the whole class cogenerative dialogue with excerpts from Alix's introduction to her problem.

Alix: Uhm (0.5) some of the rules that I think I established in the classroom, one that I noticed which really surprised me, was when I first started talking there was a student over here ((points at student on screen)) who had his hand raised when I first asked the question ((turns back to class)) and I COMPLETELY ignored him and responded to students who were just calling out ((smiles while she advances the video to show peers)).

Figure 4b shows how Alix paused the video at different intervals to describe her actions at the different nodes from which she sent conflicting messages to students about her expectations for student-teacher

Figures 4a. Alix shows her peers the student she is discussing in her clip

Figures 4b. Alix shows her peers the student she is discussing in her clip

interactions. During her introduction, Alix used the video to discuss how she employed the Sewell (1992; 1999) and Swidler's (1986) work to conceptualize nodes as particular spaces within a field, such as her classroom, from which she could critically consider her strategies of action at different physical spaces within the field. In the following excerpt, Alix shared evidence of when she stood at different places in the classroom, for example when stood next to a student's desk (node 3), she would engage students in a free-for-all conversation, allowing them to shout out their answers rather than raise their hands.

Excerpt 11

Alix: So, uhm, ((shrugs shoulders and looks embarrassed)) the practice that was enacted there was pretty much a "I'm asking questions. Shout out whatever you think ((swings arms wide)). This is kind of a free for all dialogue type thing". And they enjoyed more of the class kind of banter ((points at two students on video who are smiling and

talking)), you know of "Oh, it's air!", you know ((advances video to show interaction))? And I am asking them to prove it, and they are saying ((advances video and narrates action as it occurs)) there is white stuff on the bag ((points to bag on screen)) and this boy ((circles boy on screen)) actually challenges that there is stuff in it and so I give it to him ((pauses video)), although ((laughs)) I give it to him for about a second ((mimics handing bag to student in front row)) and then I quickly take it back ((jerks hand back from student in front row and holds invisible bag next to chest – advances video while talking)) because clearly I need to feel like I am in control of the model [atomic model] and I'm running the class. Finally the girl at the end ((points to student on screen who is seated near Alix)) got up to sit closer to me ((advances video)). Whatever I had done up to that point to engage her and interest her in the lesson was working ((smiles and nods)) and she moved closer and wanted to interact with the model and with me ((advances video and circles model on the screen)).

In her analysis, Alix highlighted how her practices initially engaged her students in her lesson about the model of the atom, but that her schema related to rules about how students should engage in whole class discussion and about how teachers should be "in control" prevented her from maintaining these positive interactions with her students. In the following excerpt, she describes how her unexamined beliefs resulted in unintended barriers for students' science learning in her class.

Excerpt 12

Alix: BUT ((stops video and turns back to the class)) one of the rules that I have in my classroom was that, you know, she needs to be in her seat ((lips turn down into a frown)) and she should be taking notes, so ((pause and turn to the screen)) as soon as she stepped out of that sort of expected behavior, I immediately asked her to go sit back down ((advances video to show this)) and as soon as I did that ((pauses video and points to student)) this student here ((circles student)) laughed and turned back away from me and kind of disengaged. So they sort of crossed the line of interaction with me and when I made it clear that wasn't acceptable in my classroom, a number of students took that cue and turned back around and lessened their engagement with the plastic bag and with me. ((purses lips together in a downward frown))

Following her presentation, the whole class took a moment to reflect on what they had seen and to ask questions to clarify any information they felt they needed to better understand Alix's class, her assignment, and her personal goal for moving forward. Alix reiterated that she felt the analysis and discussion to this point had helped her to make unconscious practices conscious and that in doing so, she had begun to question her assumptions regarding norms for

classroom discourse. At this point in the conversation, Sonya reminded the preservice teachers that the purpose of the whole class cogenerative dialogue was to help Alix move beyond the analysis she had completed with her peers in the small group cogenerative dialogue to provide collective insights from all of her peers to help her develop a realistic "action plan" that could be implemented in her teaching during the following days or week, with the goal of explicitly re-visiting the issue during the following week's small group and whole class cogenerative dialogues in an effort to collectively assess the outcome of the cogenerated action.

Each week, participants were asked to prepare a "cogenerative dialogue write-up". In the first week they described the problem(s) they identified in their teaching during small groups and they described the plan they made during their whole class discussion to try to address the problem. After implementing the planned action, they completed the write up by describing the outcome from their enacted actions in the classroom, including the need for additional analysis, reflection, and follow-up. At the end of the semester, the preservice teachers were asked to review their write-ups to generate a list of useful teaching strategies that had emerged from their own teaching experiences to share with their peers.

In the previous section, we traced Alix's noticing and reflecting in both small and large groups, paying particular attention to the value of being able to manipulate video speeds to enhance noticing and the role of applying theory for making sense of what was seen, individually and in a small group. In the next section, we provide examples of the ways in which sharing what was noticed and reflected upon with others lead to transformation in not only Alix's teaching, but also on of her peers.

Co-generating possibilities for changing practice

After Alix completed her introduction to her problem, she asked that her peers provide their feedback, with a special focus on suggesting possibilities for affecting change in the classroom. Based on her presentation, another student, Jose, suggested that Alix ask students from her class to volunteer for a lunchtime cogenerative dialogue where she would share video the same vignettes of interactions she had clipped from each of the three nodes and then ask her students to tell her what they noticed. Jose reasoned this was a good approach because, "it's great to get our feedback, but I think we all have learned it is equally important to ask students from the actual class for their feedback too (0.5), cause what they notice as students may be different than what we notice as teachers." During the whole class discussion, each student is expected to offer

their insights and is also encouraged to provide some support for the advice they offer, either based on their own experiences or something they have read in their courses. Jose continued, "I know in my own case, when I showed the video to students from our class, they noticed a lot of things I had not considered, like things I did not even notice was a problem. And they noticed some good things too!"

Over the next 10 minutes, Alix fielded comments from her peers while Eunhee wrote them on the board under the heading "Alix's Plan for Change". Collectively, the teachers felt it was important for Alix to first, personally clarify her expectations for student involvement during different types of activities. Her peers encouraged her to explicitly discuss these expectations with her students, and to especially be careful to provide reasons for her actions. For example, when describing why she thought it was important for students to raise their hands to speak, Alix stated, "sometimes it is the best way to assess what an individual student knows and if everyone is yelling out, I have no idea what each student thinks." Agreeing that this seemed like a legitimate reason for having students raise their hands while she was at node 1 (blackboard), her peers encouraged her to work with her students to develop some method of eliciting individual student contributions that would enable her to selectively assess student comprehension, but to also make sure there were opportunities for students to engage in more spontaneous, open-ended whole class discussions so they could share their personal experiences with various science phenomena (which Alix had identified as an important way to engage students in activities while at nodes 2 and 3). So Alix left the class with a plan to hold a cogenerative dialogue with volunteers to discuss these issues and to be prepared to share her findings during the science methods class in the following week.

Transforming teaching in the science classroom

During the next science methods whole class cogenerative dialogue, Alix shared several short video vignettes from the cogenerative dialogue she had with three of her chemistry students. In the videos, Alix explained to the students that she had identified a "need to create a new set of class rules" that made explicit when students needed to raise their hands and that reflected sound pedagogical reasoning about how to "most effectively support me [Alix] to teach and you guys [students] to learn chemistry". Alix shared brief video vignettes in which she articulated to her students the reasons she felt she had enacted different practices at each node and in which we saw her ask the students what they thought about her practices at each node. From the video, one of her students agreed that it made sense that when she was "lecturing" (at node 1,

chalkboard and overhead projector) she was generally "providing new information for the lesson", so it was a better use of time for her to act "like some kinda air traffic controller".

After sharing these videos, Alix confirmed for us that she and her students had clarified that her role at node 1 (chalkboard) would be to have students raise their hands to speak so that Alix could individually assess student ideas and to move quickly through the lecture materials so students could begin the experiential learning activities that would follow. Next Alix shared a video vignette in which she and her students discussed her role during the lab activities, when Alix was at nodes 2 and 3 (student desks or near her own desk). In this clip, her students agreed that her position at these nodes signaled the times when Alix would engage with students in a more relaxed conversation about the science phenomena they were investigating. Following her presentation of these two video clips, Alix informed us that she had scheduled a whole class cogenerative dialogue on the following day, where she and the students with whom she met in the previous cogenerative dialogue would share what they discussed with the whole class and they would invite all of the students to offer their input.

During the next week of the science methods course, Alix shared two video vignettes she had clipped from the whole class cogenerative dialogue to show us what happened. In the video, a student expressed he had often been frustrated with Alix because she did not call on him when he "was being good and raising my hand and others were yelling out." The boy shared that he thought Alix did not like him because he always had his hand raised and she never called on him. He stated he "felt better it was not personal and now that he knew the rules, he would be able to participate and not get in trouble or get mad". In this clip, Alix noted that her unconscious practices had indeed been contributing to negative interactions between her and her students. In the next clip, Alix pointed out several modifications she had made to her classroom as a result of her discussions with her high school students. Specifically, she showed us how had "altered structures in the classroom to try to make clear to students which practices she intended to enact at different nodes". Using still prints taken from video of the classroom, she demonstrated how she had added red-colored tape on the wall next to the chalkboard (node 1) and green-colored tape on the edge of the first row of student desks (node 2) and on the floor next to student desks (node 3) so that both she and her students had a visual cue for which rules were in effect at each node. Next Alix also show us a still print of herself as she pointed to a poster on the wall on which she had written her "rules" for engagement at the three nodes (chalkboard, overhead, and in middle of

room) so that students knew when to raise their hands and when it was acceptable to call out.

As a result of this cycle of notice, reflect and act, Alix was able to re-establish a positive rapport with her students, which allowed her to effectively re-engage students to learn chemistry. We selected these excerpts to demonstrate that as result of analysis of video of her own teaching practices with both her peers and her students, Alix was able to utilize theory to reflect on her practices, identify problems, and then collectively act to develop a plan for action that, once enacted, resulted in positive changes in her chemistry classroom learning environment. In the section that follows, we argue that this activity was not only powerful for Alix, but that the transformative potential of engaging preservice teachers in video analysis coupled with cogenerative dialogue can extend beyond the student of focus to expand what their peers are learning about how to improve science and learning.

Transforming individual practices based on what is learned from Other's experiences

During the mid-point of the science methods class (week 7), Sonya asked her students to collectively reflect on what they saw as the benefits of conducting video analysis and peer-debriefing through cogenerative dialogues. Several students mentioned that while they felt it beneficial to examine their own work so closely, they felt that the opportunity to learn from other students' experiences was just as powerful. Eileen shared that, "even though I may not have necessarily identified the same issue others did in their videos, the analysis and the conversations made me question what about my own teaching practices I had not even considered as important to reflect on". Eileen pointed out that not only was the initial video sharing and reflection significant for her development as a preservice teacher, but she was particularly encouraged that Alix "went back to her chemistry students and shared what she had found with them". She was impressed that Alix engaged her students in an effort "to co-generate a plan with her students" to enact a more equitable plan for engaging students in classroom discussions. Several students agreed, reporting that after Alix's reflection cycle, they had gone back to their own videos and re-analyzed them using the theoretical lenses chosen by Alix in an effort to identify particular nodes and associated practices in their own classrooms.

For example, Eileen conducted a new analysis of her videos and she found her "calling on student practices to be somewhat disconcerting". Eileen noticed she tended to call on several students much more frequently than the others and that she specifically called on girls more often than boys. As evidence, Eileen shared still shots from her class on which she tallied the number of

times she called on each student. From her analysis, we saw she only called on five students, all of which were female. In the photo, it was clear that some other boys had their hands raised, but by the end of the lesson, they still had no tallies next to their photo, indicating Eileen never acknowledged them to speak. After sharing her analysis, Eunhee asked why she felt she engaged in these practices. Eileen responded, " because I believed girls were more interested in class and were more likely to give a correct answer that would not be disruptive".

With prompting from another peer-teacher, Eileen began to reflect on the inherent inequity in this statement. This led to a general discussion about research on gender inequities in science classrooms. By the close of the meeting, Eileen had decided she would invite some students in her 9th grade biology class to engage in a cogenerative dialogue about how to improve the interactions between her and the boys in her class. Eileen invited two girls and two boys to discuss what she had noticed about her teaching and to ask for student input about more equitable strategies she could use to engage students in class. During this meeting, Eileen and her students cogenerated a new system in which each student was given a popsicle stick to decorate with their own name and then Eileen would used these sticks to call on students. Each time a student answered a question, Eileen would move the student's name stick from one jar to another. Eileen would only selected from one jar until all sticks had been transferred to the other jar, and then she would start the process again. Eileen and her students implemented the system the same day. She and her students introduced the new method in a whole class cogenerative dialogue where it was agreed that everyone would try the new system for a couple of days and then meet again to discuss the outcome.

We believe that Eileen benefitted from what Alix learned through her reflection on her own videos and from the actions Alix took in her classroom as a result of the whole class cogenerative dialogue with her peers. Eileen taught in the same school with Alix and she admitted that prior to learning about Alix's experiences, she had thought "kids in our school would never participate in something like this" because she saw the students as "not caring about school, improving it or otherwise". Other students in this class also taught in schools with high rates of poverty, low attendance, low achievement, and low graduation rates. None of the preservice teachers in this course had experienced schools like these as students and they often found it challenging to connect with the students in positive ways. Eileen shared that, "after seeing with Alix was able to do, I was inspired to try to catalyze some changes my own class. I was surprised by how open the kids were to helping me."

During week 9 of the science methods class, Eileen actually brought two students from her class to the university to discuss the results of their plan and to share their views about the importance of having new teachers engage their students in conversations about teaching and learning. Because these students were not participants in the study, data from this session cannot be shared in this paper. However, we will note that these high school students spoke about how powerful an experience it had been for them to examine classroom interactions on video. They also reported that they were previously unaware of many of their peers' or teacher's practices and that the opportunity to discuss these interactions with Eileen in a cogenerative dialogue had been valuable for them. Finally, they appreciated that Eileen worked with them to resolve the issue immediately and that she implemented their idea.

DISCUSSION: LEARNING FROM COLLABORATIVE ANALYSES

If teachers are to transform their practices, they must be able to reflect on what has occurred and then use this information to reflexively affect changes in their practice. However, watching video and reflecting on video does not necessarily translate into reflexive practices. This is because reflection is not simple. It requires application of theory, connection of theory to practice, and being able to focus reflection, which all require more than just having teachers look at video of themselves teaching, alone and with others. This requires structure and, in our opinion, it also requires dialogue and an opportunity to expand our teacher education students' recognition of what is happening and what could happen beyond their own sphere of understanding. For this reason, we advocate engaging teachers in cycles of noticing, acting, reflecting – through video analysis, the application of theory, and cogenerative dialogue. Thus, the preservice teachers used video in our courses to 1) notice, 2) reflect, and 3) act (as represented in Figure 1 above). Video and cogenerative dialogue were central to the process of noticing, reflecting, and acting.

Analyzing data from our two courses together, in order to synthesize what is learned from different contexts can further illuminate the ways in which a reflexive process emerged within the structures of video-based reflection and cogenerative dialogues. We selected the excerpts in the previous sections as representative examples to emphasize the process of engaging in video analysis and cogenerative dialogue as they occurred in our two courses, and we explored how preservice teachers' practices changed as a result of what they learned. We propose this process supports preservice teachers in not only noticing and reflecting upon moments in the classroom, but also moving

towards individual and collective action in future lessons. In this approach, participants are supported to engage in reflexive action because Guba and Lincoln's (1989) authenticity criteria, which underpin cogenerative dialogue, require that participants not only to learn about one another's perspectives, but to also attempt to catalyze change to affect positive transformation in the way individuals experience school.

In our coursework, we engage students in cogenerative dialogue with the understanding that our interactions are framed by the need to be ontological, educative, catalytic, and tactical. By this, we mean that as a result of our interactions around a student's video, participants can expect to experience a shift or change in their individual perspectives (change in ontology), that we should each strive to learn from one another (become educated about the perspectives of others), that we engage in dialogue in order to affect positive change in practice (catalyze change), and that we consciously consider the limits of our abilities and our ethical responsibilities to our students and the other teachers with whom we work (that we be tactical). We argue that it is the structure of cogenerative dialogue that provides an explicit framework for supporting preservice teachers to move beyond simply noticing and reflecting toward reflexive action in an effort to affect real changes in their classroom teaching practices. In the sections that follow, we revisit the questions asked earlier in light of the representative excerpts we have presented.

What is the Role of Video when Analyzing One's Own Teaching?

One focus of our attention for analysis (as represented in the excerpts above) has been on considering the role of video analysis of one's own teaching (question 1). The capturing of teaching episodes on video provides a "permanent, and exchangeable, representation of practice" (McCullaugh, 2012, p.147). Our analysis has revealed that video provides a physical resource for supporting preservice teachers to consider classroom interactions from their own teaching, which allows them the opportunity to "step back" (Rich & Hannifin, 2009) and use the video replay to "learn to notice" (van Es & Sherin, 2008). Selecting and watching video of their teaching in classrooms revealed moments in time that the preservice teachers had not been aware of and enabled them to re-consider their experiences from the classroom. For example, Tracie had not been aware that she had not addressed a boy who very eagerly trying to share his comments to questions she was asking.

However, noticing is not enough, as preservice teachers must also learn to interpret what is noticed (van Es & Sherin, 2002). As seen in Alix's vignette, for

example, the consistent application of theory in the analysis of her videos helped Alix to not only become aware of what she had not previously noticed, but to also become aware that she was often unaware of her practices in classrooms, and as a result, she could unknowingly engage in practices that disadvantaged some learners. Considering what preservice teachers notice, as well as how they interpret what they notice can lead to possibilities to support students to develop abilities to effectively engage with their students while "in the moment" in the science classroom (Talanquer, Tomanek & Novodvoersky, 2013). We believe that by viewing these representations of self from one's own classroom, teachers are presented a contextualized view of learning about their own teaching. And by engaging in structured dialogue with other teachers around these representations of self, over time, we believe teachers become better able to problematize the issues they see in the classroom.

We characterize 'noticing' and 'reflecting' as two constructs that reflexively inform one another as the students engage in interpretation of the events they have noticed via the reflective process. As our teachers applied different theories, verbalized their ideas, shared evidence of what they noticed in their videos with others, and then collectively discussed it with their peers - we argue that the structure of cogenerative dialogue supported the teachers to consider what they noticed from an individual perspective (meeting the need to be ontological), while simultaneously positioning them to reflect on their actions with their peers (and to be educative). Specifically, we argue that it is the situatedness of this activity (reflecting with others during cogenerative dialogue), which helps to concretely connect noticing with reflecting. Doing so expanded teachers' possibilities for considering perspectives that differed from their own. That is, that through the individual and collective process of reflexively engaging in video analysis within cogenerative dialogues, there emerged the possibility for preservice teachers to position themselves to transform their practice moving forward.

How do Video Analysis and Cogenerative Dialogue Impact Preservice Teachers' Classroom Practices?

The excerpts we shared from our courses demonstrated that video analysis and cogenerative dialogue offered valuable structural supports for these teachers that expanded their professional roles and supported them to critically reflect on their teaching with others. Dialogic video analysis can serve as an effective tool for identifying negative interaction patterns and co-generating more inclusive, equitable decision-making processes between teachers and

learners that led to both increased achievement by students and improved satisfaction of all participants around classroom interactions. This process of using video and dialogue to notice, reflect, and act impacted our students' classroom teaching practices by enabling them to cross cultural and social boundaries that increased their knowledge about urban life. But it is not until our teacher education students had interpreted their experiences were they situated to consider how they might transform their practices and interactions with their students as an extension of their reflection on practice.

Cogenerative dialogue promotes noticing with an explicit focus on change. The reason that students are being supported to notice and reflect is to catalyze changes. We encourage our preservice teacher education students to focus their 'noticing' to identifying patterns that need attention. This includes practices that appear to be working well and should be strengthened, as well as those that could be improved so they are more effective. In each instance, we found that our participant preservice teachers were able to do this, as they worked to consider possible practices to change, and then implemented new practices in the classroom, including Tracie's explicit focus on children who wanted to participate in a conversation and Alix's purposeful restructuring of the rules for engaging in dialogue with her students at different points in her lesson.

In addition, we believe that this approach, which asks teachers to consider the tactical authenticity criteria, is valuable for preservice teachers because we explicitly support our teachers to recognize and appreciate the limits of what they have the power to change – both personally (i.e., because they are new to the profession and have limited resources and experiences from which to draw upon to solve all of the problems they will encounter) and systemically (i.e., because some structures in schools and districts have greater power to shape what is possible in individual classrooms, which limits teacher and student agency). Beginning teachers often face challenges in their teaching that can overwhelm them and leave them feeling powerless to affect change. Learning how to individually and collectively examine a situation and determine which aspects of the problem can be affected by individual teachers and students can relieve teachers from some of the pressure to assume that they are responsible for all of the problems they face in the classroom. The tactical authenticity criteria asserts that individuals have the responsibility to do what they can do affect change, but also leaves room for making sense of the limits of our ability to resolve all issues, even when engaging other peer teachers and students in tackling problems. We believe that being able to realistically assess the issues teachers and students face (individually and collectively) with the goal of changing what can be changed is

empowering for teachers. But we also believe this process provides support for teachers to make sense of the ways in which larger structures limit the possibilities for how individuals and small groups of people can transform all circumstances, which may help new teachers not to become overwhelmed by challenges and failures they face in the beginning years of their career. This could play an important role in stemming teacher attrition.

What Kinds of Practices / Understandings do Preservice Teachers Cogenerate with Others?

By evaluating video of classroom events using cogenerative dialogues, teacher educators, preservice teachers and their K-12 students can reflect upon their practices and the practices of others to catalyze change and develop new strategies for building an effective science learning environment. These results build upon the work of Talanquer and colleagues (2013) who emphasized science teachers need to "learn what is most crucial to notice and respond to [it]" (p. 205). As individual preservice teachers noticed moments in their science teaching that they identified as salient to their development as teachers, the group members within the cogenerative dialogue were in a position to share differing perspectives on the same events. This becomes part of the reflective process in which individuals can consider events that may have passed unnoticed, and collectively the members of the cogenerative dialogue consider differences in their individual experiences. It is this recognition of difference (different perspectives, different opinions, different experiences) on the same moments that guides the process of reflexively making changes in their teaching moving forward. Doing so helped them to foster shared responsibility for improving the science learning environment, both with peer teachers in our courses and with their actual students in the K-12 classrooms.

The preservice teachers in these science methods courses found the use of video analysis and cogenerative dialogues to be such powerful tools for supporting their learning in the field that they engaged in a variety of experiences in which they took agency for their own learning and exercised reflexivity in other settings. In the elementary preservice study, the teachers requested video cameras from the teacher education program, and encouraged another field-based course instructor to utilize video recording of their shared experiences. In the secondary program, the preservice teachers asked the director of the teacher education program if they could develop and present a workshop on employing video analysis as a continuous tool to be used not only during student teaching, but they advocated it be continued into the first few years of teaching. These preservice teachers felt that coupling video analysis with

their field-based methods course supported them to identify questions from their own experience and to actually use the theoretical lenses from course readings to connect the theory being learned about at the university into their teaching practice.

Students felt that bringing their video into the methods course allowed them to share with other science preservice teachers what was happening in their own contexts. A benefit of the cogenerative dialogues was the emphasis on not only identifying problems to be addressed, but also the application of theory with the intent of co-generating an understanding of what is happening and then developing a plan for engaging new practices aimed at improving the classroom by addressing the problems head on. As such, we draw a clear distinction between the use of video of one's own teaching as being more significant than merely watching video of other classrooms, which is a practice that is more commonly enacted in teacher education programs whereby teachers are shown exemplars of good teaching (by other teachers in classroom contexts that are not known to the viewers). Reflexively considering past events in the classroom as captured on video provides a valuable strategy for improving teaching practices moving forward. When coupled with involving students in cogenerative dialogues about their experiences in school, video can provide teachers with valuable insights into how their students learn science. Research involving teachers and students as researchers of their own practice has the potential to transform approaches to science teacher education and teacher education at large, to increase professional development for inservice teachers and to stimulate science education reform at all levels of K-12 education.

Concluding Thoughts: Moving Towards Transformation of Practice

In our work with video, we have become interested in the purpose of using video as well as the method in which video is used in teacher education – specifically as it relates to promoting change in practice. Through the recent review of the literature in the field of science teacher education (Martin & Siry, 2012) we found that while there are many publications that discuss the possible merits of using video with teachers, there remains a need for research that provides a detailed analysis of what actual impacts result from using video with teachers. In this paper, we have presented evidence to illustrate our claim that dialogic video analysis can be transformative in the classrooms of preservice teachers. By analyzing these videos and shared conversations, we are able to de-construct our students' experiences to highlight the ways in which this approach to video analysis was informative not only for our preservice teachers' learning about science teaching, but also our

learning about how to better prepare preservice science teachers. The collective reflection on teaching in our courses, and the individual reflections on the videos, and discussion as part of teacher induction programs (West, Rich, Shepherd, Recesso, & Hannafin, 2009). Rather than using video as a tool for evaluative
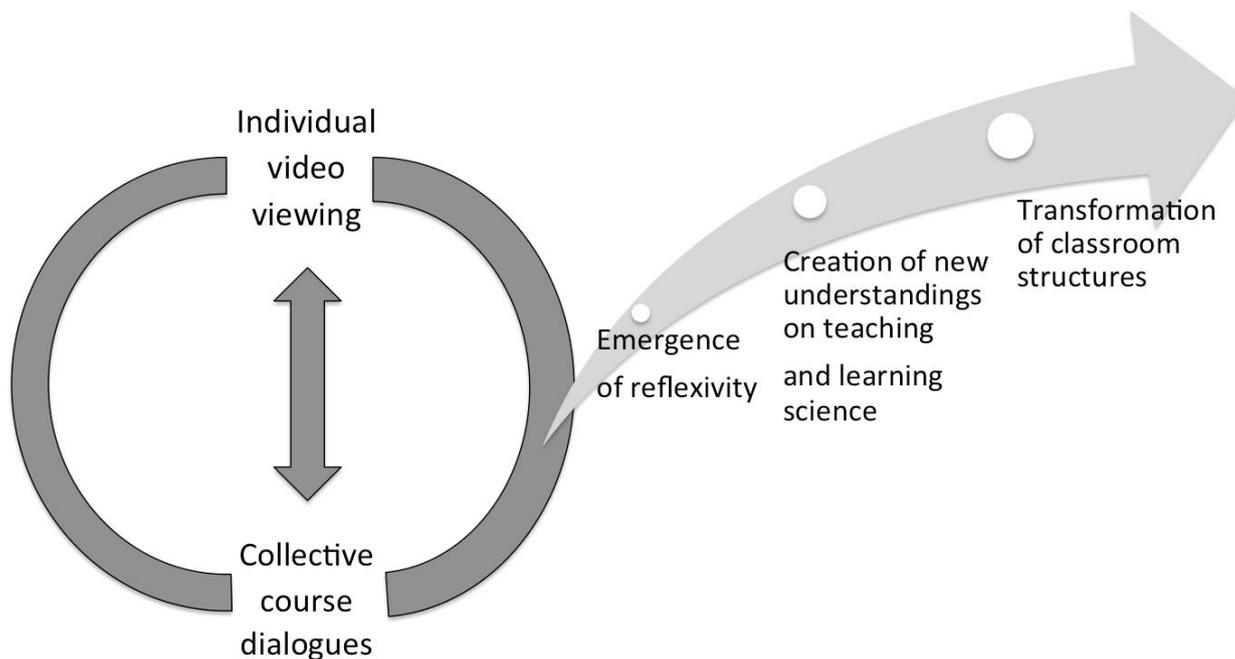

Figure 5. Constructs emerging through the individual and collective processes.

connected to emphasize not only what happened in the classroom, but also more importantly, what could be learned from it that was be relevant for future praxis. In each of the examples previously shared, the central approach to learning how to teach was through sharing responsibility for the success of the classroom experiences through cogenerative dialogue. In considering what changes, practices, and understandings were cogenerated through the use of video analysis by the preservice teachers, we turn attention to Figure 5 below.

The focus of a course experience built around video analysis becomes about not only the 'noticing' (characterized by selective attention and reasoning processes as described by Seidel, et al, 2011) but also the changing of practices. Earlier we introduced a particular trend in the literature on teacher education, which is that video in preservice teacher education is incorporated specifically as a tool for evaluation. For example, video commonly offers field supervisors a means to manage multiple observations of teacher candidates with greater ease and can expand observations and critiques of teaching by discussing illustrative moments from the candidate's lessons during supervisor-teacher consultations (Sherin, 2004). Other examples include using video analysis as a teacher-participatory model of assessment in which new teachers and their mentors/administrators analyze video of the teachers teaching and engage in group reflection

purposes in preservice teacher education, our contribution builds on the notion of 'noticing' to provide tools for transforming. In offering teachers tools for engaging in research on their own practice, this is done for one purpose – to improve the practice.

We draw attention to the ways in which this approach supports individuals and the collective to not only acknowledge differences in the science classroom, but to consider the ways in which differences can become a resource for enacting different practices in the classroom that afford the agency of teachers and students. This approach can not only provide them a tool for learning about how to improve science teaching and learning, but also a tool for developing relationships, learning across difference, developing and appreciating individual goals that may differ. This is especially important for new teachers and for teachers working in urban contexts, as we believe that the feeling of support that emerges from collective analysis can help to stem the teacher attrition and teacher turn over commonly associated with urban schools. The preservice teachers in our study all had control over what videos were shown to the group, and as such, they were individually positioned to structure the events at the collective level. The teachers we highlighted had individual realizations about their teaching practices that took place with in the group, and as such, these mediated the perspectives of the collective and also changed the focus of the collective dialogue.

Collaborative video analysis can serve as a structure to support the critical reflexivity required to make changes in individual teaching. By supporting preservice teachers to examine video vignettes of their classroom teaching experiences, we allow for reflexive analysis in hindsight. This is the central point of our courses, by viewing video, applying theory introduced in coursework to collectively discuss their ideas with others, and then implementing changes that both improve their teaching practices and generates new local theory, individuals can transform their classrooms.

Moving Forward: Dialogic Video Analysis in Science Teacher Education

There are a number of considerations in framing the use of cogenerative dialogue coupled with video analysis in preservice teacher education. A logistical point is that it requires flexible course arrangements. Our universities' support of small class sizes enabled us to build relationships and to foster a sense of care and respect for one another over time. This can allow students to take risks with their noticing and reflecting, both individually and with others. Thus our approaches also require time to build relationships with students and among themselves, and time to see our students in the field and at the university. Instructors also need to understand cogenerative dialogue, not just as a method for organizing a conversation, but they also need to understand the overarching methodology that frames it. Cogenerative dialogues are more than a series of steps related to individuals and collective sharing and conversation as they also require emphasis and thought about how we know what we know, how we share what we know with others, and how we support one another to be in a position to learn from our interactions as we experience a shift in our ontologies.

There is a recognized divide between campus and field-based teacher education approaches to learning to teach. We see our approach as one way to bridge this gap. We advocate for a strong connection between theory we learn about in university, the research we conduct on how people learn, and the actual practices of teachers in classrooms. As former K-12 teachers, we are concerned about the de-professionalization of both elementary and secondary teaching and we see our approach as a means for us to push back. We believe this approach can support methods instructors to foster dispositions to act in certain ways – to promote the need for teachers to take an inquiry stance towards teaching (Darling-Hammond, 2006). We think it is critical that teacher educators are working to create "hybrid spaces for linking practitioner knowledge and academic knowledge" (Zeichner, 2010) in ways that are both feasible and empowering for practitioners and their students. We believe that the experiences our teachers have in our courses support them to develop identities as researchers, as well as providing them with tools, strategies, and practical experience in problem solving in their own classrooms. Further research is needed into the sustainability of the practice beyond the methods course. We have some evidence that our teachers continue this practice, as they engage their own students in cogenerative dialogues, but more empirical evidence and studies over longer periods of time are needed.

REFERENCES

Abell, S., & Cennamo, S. (2004). Videocases in elementary science teacher preparation. In J. Brophy (Ed), Advances in Research on Teaching, Vol. 10, Using video in teacher education (pp103-129). Oxford: Elsevier, Ltd. DOI: 10.1016/s1479-3687(03)10005-3

Anderson, E. (1999). Code of the street: Decency, violence and the moral life of the Inner City. New York, NY: W.W. Norton & Company DOI: 10.5860/choice.37-2223

Barton, A.C. (2001). Science education in urban settings: Seeking new ways of praxis through critical ethnography. *Journal of Research in Science Teaching.* Vol. 38(8), pp. 899-917. DOI: 10.1002/tea.1038

Beardsley, L., Cogan-Drew, D., & Olivero, F. (2006). VideoPaper: Bridging research and practice for preservice and experienced teachers. In R. Goldman, R. Pea, B. Barron, & S. Derry (Eds.), Video research in the learning sciences (pp. 479–493). Mahwah, NJ: Erlbaum.

Bell, R.L., Maeng, J.L., & Binns, I.C. (2013). Learning in context: Technology integration in a teacher preparation program informed by situated learning theory. *Journal of Research in Science Teaching*, 50(3), 348-379. DOI: 10.1002/tea.21075

Bleakley, A. (1999). From reflective practice to holistic reflexivity. *Studies in Higher Education*, 24 (3), 315-330. DOI: 10.1080/03075079912331379925

Brophy, J. (2004). Using video in teacher education. San Diego, CA: Elsevier, Inc. DOI: l01016/S1479-3687(03)10001-6

Brown, A. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences*, 2, 141-178. DOI: 10.1080/10508406.2013.873673

Carambo, C. (2009). Evolution of an urban research program: The Philadelphia project. In K. Tobin & W.-M. Roth [Eds.], World of Science Education: North America (pp. 473-490). The Netherlands: Sense Publishers.

Carspecken, P. (1996). Critical ethnography in educational research: A theoretical and practical guide. New York: Routledge. DOI: 10.1525/aeq.1996.27.4.05x1155k

Cochran-Smith, M., & Lytle, S. (2009). Inquiry as a stance: Practitioner research in the next generation. New York: Teachers College Press.

Creswell, J.W. (2007). Qualitative inquiry and research design: Choosing among five approaches (2nd ed.). Thousand Oaks, CA: Sage. DOI: 10.1177/0011000006287390

Darling-Hammond, L. (2006). Constructing 21st-century teacher education. *Journal of Teacher Education*, 57, 300-314. doi:10.1177/0022487105285962

Donovan, M. S., & Bransford, J. D. (Eds.). (2005). How students learn: Science in the classroom. Washington, DC: The National Academies Press. DOI: 10.2307/30036810

Duschl, R. A., Schweingruber, H. A., & Shouse, A. W. (Eds.). (2007). Taking science to school: Learning and teaching science in grades K-8. Washington, DC: The National Academies Press. DOI: 10.1007/s11191-011-9353-4

Elliott, J. (1993). Reconstructing teacher education. London: Falmer.

Emdin, C. (2007). Exploring the contexts of urban science classrooms. Part 1: Investigating corporate and communal practices. *Cultural Studies of Science Education*, 2(2), 319-341. DOI 10.1007/s11422-007-9055-z

Friedrichsen, P.J., Abell, S.K., Pareja, E.M., Brown, P.L., Lankford, D.M., & Volkmann, M.J. (2009). Does teacher experience matter? Examining biology teachers' prior knowledge for teaching in an alternative certification program. *Journal of Research in Science Teaching*, 46, 357-383. DOI: 10.1002/tea.20283

Grossman, P., Hammerness, K., McDonald, M. (2009). Redefining teacher: Re-imagining teacher education. *Teachers and teaching: Theory and practice*, 15(2), 273-290. DOI 10.1080/13540600902875340

Guba, E., & Lincoln, Y. (1989). Fourth generation evaluation. Beverley Hills, CA: Sage.

Hammerness, K., Darling-Hammond, L., Bransford, J., with Berliner, D., Cochran-Smith, M., McDonald, M., & Zeichner, K. (2005). How teachers develop. In L. Darling-Hammond & J. Bransford (Eds) in collaboration with P. LePage, K. Hammerness, & H. Duffy, Preparing teachers for a changing world: What teachers should learn and be able to do, (p. 358-389). Hoboken, NJ: Jossey-Bass. DOI: 10.5860/CHOICE.43-1083

Hatch, T., & Grossman, P. (2009). Learning to look beyond the boundaries of representation: using technology to examine teaching. *Journal of Teacher Education*, 60(1), 70-85. doi:10.1177/0022487108328533

Lampert, M. (2010). Learning teaching in, from, and for Practice: What do we mean? *Journal of Teacher Education*, 61, 21-34. doi:10.1177/0022487109347321

LaVan, S.K., & Beers, J. (2005). The Role of Cogenerative Dialogue in Learning to Teach and Transforming Learning Environments. In K. Tobin, R. Elmesky, and G. Seiler (Eds), Improving Urban Science Education: New Roles for Teachers, Students, and Researchers (p. 167–185). New York: Rowman & Littlefield Publishers, Inc.

Lehner, E. (2007). Describing students of the African diaspora: Understanding micro and meso level science learning as gateways to standards based discourse. *Cultural Studies of Science Education*, 2(2), 441-460. DOI: 10.1007/s11422-007-9062-0

Loughran, J.J. (2002). Effective reflective practice: In search of meaning in learning about teaching. *Journal of Teacher Education*, 53(1), 33-54. DOI: 10.1177/0022487102053001004

Martin, S. (2005). *The social and cultural dimensions of successful teaching and learning in an urban science classroom.* Doctoral dissertation, Science and Mathematics Education Centre, Curtin University, Perth, Australia.

Martin, S. (2006a). Teachers as researchers. In K. Tobin [Ed.] Teaching and learning science: A handbook (pp. 227-233). New York: Praeger Publishing.

Martin, S. (2006b). Where practice and theory intersect in the chemistry classroom: Using cogenerative dialogue to identify the critical point in science education. *Cultural Studies of Science Education*, 1(4), pp. 693-720. DOI: 10.1007/s11422-006-9031-z

Martin, S. (2009). Learning to teach science. In K. Tobin & W.-M. Roth [Eds], World of Science Education: North America (pp. 567-586). The Netherlands: Sense Publishers.

Martin, S., & Scantlebury, K. (2009). More than a conversation: Using cogenerative dialogues in the professional development of high school chemistry teachers. *Educational Assessment, Evaluation and Accountability*, 21(2), pp. 119-1136. DOI: 10.1007/s11092-008-9062-y

Martin, S. & Siry, C. (2012). Using video in science teacher education: An analysis of the utilization of video-based media by teacher educators and researchers. In B. Fraser, K. Tobin, & C. Campbell [eds.] Second International handbook of science teaching and learning (417-433). The Netherlands: Springer. DOI: 10.1007/978-1-4020-9041-7_29

Masats, D., & Dooly, M. (2011). Rethinking the use of video in teacher education: A holistic approach. *Teaching and Teacher Education*, 27, 1151-1162. DOI:10.1016/j.tate.2011.04.004

McCullagh, J.F. (2012). How can video supported reflection enhance teachers' professional development? *Cultural Studies of Science Education*, 7, 137-152. DOI: 10.1007/s11422-011-9375-x

Munby, H., & Russell, T. (1994). The authority of experience in learning to teach: Messages from a Physics methods class. *Journal of Teacher Education*, 45(2), 86-95. DOI: 10.1177/0022487194045002002

National Research Council. (2000). Inquiry and the national science education standards: A guide for teaching and learning. Washington, DC: National Academies Press.

National Research Council. (2012). A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. Washington, DC: National Academies Press.

Osborne, J., Erduran, S., & Simon, S. (2004). Enhancing the quality of argumentation in school science. *Journal of Research in Science Teaching*, 41(10), 994-1020. DOI: 10.1002/tea.20035

Rich, P., & Hannafin, M. (2009b). Scaffolded video self-analysis: discrepancies between preservice teachers' perceived and actual instructional decisions. *Journal of Computing in Higher Education*, 21, 128-145. DOI: 10.1007/s12528-009-9018-3

Ritchie, S.M., Tobin, K., Hudson, P., Roth, W.-M., & Mergard, V. (2011). Reproducing successful rituals in bad times: Exploring emotional interactions of a new science teacher. *Science Education*, 95(4), 745–765. DOI: 10.1002/sce.20440

Rosaen, C., & Florio-Ruane, S. (2008). The metaphors by which we teach: Experience, metaphor, and culture in teacher education. In M. Cochran-Smith, S. Feiman-Nemser, J. McIntyre, & K. Demers (Eds.), Handbook of research on teacher education: Enduring questions in changing contexts (3rd edition) (pp. 706-731). New York: Routledge, Taylor & Francis.

Roth, K., Garnier, H., Chen, C., Lemmens, M., Schwille, K., Wickler, N. (2011). Videobased lesson analysis: Effective science PD for teacher and student learning. *Journal of Research in Science Teaching*, 48 (2), 117-148. DOI: 10.1002/tea.20408

Roth, W-M. (2005). Talking science: Language and learning in Science Classrooms. Rowman and Littlefield Publishers.

Roth, W.-M. (2003). Video as tool for reflecting on practice: theoretical perspectives. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Philadelphia, March 23–26, 2003.

Roth, W.-M. (Ed.) (2005). Auto/biography and auto/ethnography: Finding the generalized other in the self. In Auto/biography and auto/ethnography: Praxis of research method (pp. 3–21). Rotterdam: Sense Publishers.

Roth, W.-M., & Tobin, K. (2001). The implications of coteaching/cogenerative dialogue for teacher evaluation: Learning from multiple perspectives of everyday practice. *Journal of Personnel Evaluation in Education*, 15 (1), 7-29. DOI: 10.1023/A:1011100117706

Roth, W.-M., & Tobin, K. (2010). Solidarity and conflict: aligned and misaligned prosody as a transactional resource in intra- and intercultural communication involving power differences. *Cultural Studies of Science Education*, 5(4), 807-847. DOI: 10.1007/s11422-010-9272-8

Roth, W.-M., Tobin, K., & Ritchie, S. (2008). Time and temporality as mediators of science learning. *Science Education*, 92, 115-140. DOI: 10.1002/sce.20238

Russell, T., & Munby, H. (1991). Reframing: The role of experience in developing teachers' professional knowledge. In D.A. Schön (Ed), The reflective turn: Case studies in and on educational practice (164-187). New York: Teachers College Press.

Ruth-Sahd, L. (2003). Reflective practice: A critical analysis of data-based studies and implications for nursing education. *Journal of Nursing Education,* 42 (11), 488-497.

Santagata, R., & Yeh, C. (2013). Learning to teach mathematics and to analyze teaching effectiveness: evidence from a video- and practice-based approach. *Journal of Math Teacher Education,* 1-24. DOI: 10.1007/s10857-013-9263-2

Scantlebury, K., & LaVan, S-K. (2006, March). Re-visioning cogenerative dialogues as feminist pedagogy [32 paragraphs]. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research* [On-line Journal], 7(2). Retrieved March 5 2007 from http://www.qualitativeresearch.net/fqs-texte/2-06/06-2-41-e.htm

Schön, D. A. (1983). The reflective practitioner: How professionals think in action. New York: Basic Books, Inc.

Schön, D. A. (1987). Educating the reflective practitioner: Toward a new design for teaching and learning in the professions. San Francisco: Jossey-Bass.

Schulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57(1), 1-22.

Schwandt, T. (2001). Dictionary of qualitative inquiry (2nd Ed). Thousand Oaks, CA: Sage.

Seidel, T., Stürmer, K., Blomberg, G., Kobarg, M., & Schwindt, K. (2011). Teacher learning from analysis of videotaped classroom situations: Does it make a difference whether teachers observe their own teaching or that or others? *Teaching and Teacher Education*, 27, 259-267. DOI: 10.1016/j.tate.2011.04.004

Sewell, W. H. (1992). A theory of structure: Duality, agency, and transformation. *American Journal of Sociology*, 98, 1–29. DOI: 10.1086/229967

Sewell, W. H. (1999). The concept(s) of culture. In V. E. Bonnell & L. Hunt (Eds.), Beyond the cultural turn (pp. 35–61). Berkeley, CA: University of California Press.

Sherin, M. G. (2004). New perspectives on the role of video in teacher education. In J. Brophy (Ed), Using video in teacher education (Advances in Research on Teaching, Vol. 10, pp. 1–27). Oxford: Elsevier, Ltd.

Sherin, M. G. (2007). The development of teachers' professional vision in video clubs. In R. Goldman, R. Pea, B. Barron, & S. Derry (Eds.), Video research in the learning sciences (pp. 383–395). Mahwah, NJ: Erlbaum.

Sherin, M.G., & Hans, S. (2004). Teacher learning in the context of a video club. *Teaching and Teacher Education*, 20, 163-183. DOI: 10.1016/j.tate.2003.08.001

Sherin, M. G., Linsenmeier, K.A., & van Es, E. (2009). Selecting video clips to promote mathematics teachers' discussion of student thinking. *Journal of Teacher Education*, 60, 213-230. doi:10.1177/0022487109336967

Sherin, M.G., & van Es, E. (2005). Using video to support teachers' ability to notice classroom interactions. *Journal of Technology and Teacher Education*, 13(3), 475–491.

Sherin, M. G., & van Es, E. (2009). Effects of video club participation on teachers' professional vision. *Journal of Teacher Education*, 66(1), 20-37. doi:10.1177/0022487108328155

Siry, C. (2009). *Fostering solidarity and transforming identities: a collaborative approach to elementary science teacher education*. Unpublished doctoral dissertation, The Graduate Center, City University of New York, New York.

Siry, C. (2011). Emphasizing collaborative practices in learning to teach: coteaching and cogenerative dialogues in a field-based methods course. *Teaching Education,* 22(1), 91-101. DOI:10.1080/10476210.2010.520699

Siry, C. & Lang, D. (2010). Creating participatory discourse for teaching and research in early childhood science. *Journal of Science Teacher Education*, 21, 149-160. DOI: 10.1007/s10972-009-9162-7

Siry, C. & Martin, S. (2010). Coteaching in science education courses: Transforming science teacher preparation through shared responsibility. In C. Murphy & K. Scantlebury [eds.] Coteaching in international contexts: Research and practice (pp. 57-78). The Netherlands: Springer. DOI: 10.1007/978-90-481-3707-7_4

Swidler, A. (1986). Culture in action: Symbols and strategies. *American Sociological Review*, 51, 273–286. DOI: 10.2307/2095521

Talanquer, V., Tomanek, D., Novodvorsky, I. (2013). Assessing students' understanding of inquiry: What do prospective science teachers notice? *Journal of Research in Science Teaching*, 50 (2), 189-208. DOI: 10.1002/tea.21074

Tobin, K. (2006). Learning to teach through coteaching and cogenerative dialogue. *Teaching Education*, 17(2), 133-142. DOI:10.1080/10476210600680358

Tobin, K., & Roth, W-M. (2006). Teaching to learn: A view from the field. The Netherlands: Sense Publishers.

van Es, E. (2009). Participant's roles in the context of video club. *Journal of the Learning Sciences*, 18(1), 100-137. DOI: 10.1080/10508400802581668

van Es, E., & Sherin, M. G. (2002). Learning to notice: Scaffolding new teachers' interpretations of classroom interactions. *Journal of Technology and Teacher Education*, 10(4), 571–596.

van Es, E., & Sherin, M.G. (2008). Mathematics teachers' "learning to notice" in the context of a video club. *Teaching and Teacher Education*, 24, 244–276. DOI: 10.1016/j.tate.2006.11.005

van Es, E., and Sherin, M.G. (2010). The influence of video clubs on teachers' thinking and practice. *Journal of Mathematics Teacher Education*, 13(2), 155-176. DOI: 10.1007/s10857-009-9130-3

Warin, J., Maddock, M., Pell, A., & Hargreaves, L. (2006). Resolving identity dissonance through reflective and reflexive practice in teaching. *Reflective Practice*, 7(2): 231–243. DOI: 10.1080/14623940600688670

Wassell, B. (2004). *On Becoming an Urban Teacher: Exploring Agency Through the Journey From Student to First Year Practitioner.* Unpublished doctoral dissertation, University of Pennsylvania, Philadelphia.

Watters, J.J., & Diezmann, C.M. (2007). Multimedia resources to bridge the praxis gap: Modeling practice in elementary science education. *Journal of Science Teacher Education*, 18, 349-375. DOI: 10.1007/s10972-007-9051-x

West, R.E., Rich, P.J., Shepherd, C.E., Recesso, A. & Hannafin, M.J. (2009). Supporting Induction Teachers' Development Using Performance-Based Video Evidence. *Journal of Technology and Teacher Education*, 17(3), 369-391.

Wilson, E. (2009). School-based research: a guide for education students. London: Sage.

Yerrick, R., Ross, D., & Molebash, P. (2005). Too close for comfort: Real-time science teaching reflections via digital video editing. *Journal of Science Teacher Education,* 16, 351–375. DOI: 10.1007/s10972-005-1105-3

Yin, R.K. (2003). Case study research: Design and methods (3rd Ed). Thousands Oaks, CA: Sage.

Zeichner, K. (2010). Rethinking the connections between campus courses and field experiences in college- and university-based teacher education. *Journal of Teacher Education*, 61, 89-99. DOI 10.1007/s10857-013-9263-2

Zembal-Saul, C., Krajcik, J., & Blumenfeld, P. (2002). Elementary student teachers' science content representations. *Journal of Research in Science Teaching, 39*, 443–463. DOI: 10.1002/tea.10032

Zhang, M., Lundeberg, M., Koehler, M., Eberhardt, J. (2011). Understanding affordances and challenges of three types of video for teacher professional development. *Teaching and Teacher Education*, 27, 454-462. DOI: 10.1016/j.tate.2010.09.015

◈ ◇ ◈

Appendix

Transcript conventions are adapted from W-M. Roth (2005), as follows:

((points.))	Double parentheses have actions relevant for the situation.
:	Each colon is to represent a lengthening of the preceding sound be approximately 1/10 second.
(1.6)	The length of a pause, represented in tenths of a second.
?!	Punctuation indicates intonations
=	Indicates that there is no pause, but also no overlap between speakers
THIS	Capitalized words or parts of words are louder than the rest of the speaker's utterances
[]	Brackets indicate overlap between speakers