ABSTRACT

Title of Document: EXPLORING THE VARIABILITY IN HOW EDUCATORS ATTEND TO SCIENCE CLASSROOM INTERACTIONS

Colleen Elizabeth Gillespie, Doctor of Philosophy, 2013

Directed By: Associate Professor Andrew Elby, Department of Teaching, Learning, Policy, and Leadership

Many researchers assert that educators must develop a shared instructional vision in order for schools to be effective. While this research tends to focus on educators' alignment around *goals* of science classrooms, in this dissertation I argue that we can't assume that educators agree on what they *see* when they look at science classrooms. Recent work has explored teacher attention when watching a classroom episode, and in this dissertation I expand that work to explore leaders' attention in addition to teachers' attention. Specifically, I explore the variability in what teachers and leaders notice in science classroom episodes and how they reason about what they notice. I ground my studies in real classroom practice: a videotaped lesson in the first study and a live classroom observation in the second. In Chapter 2, I discuss the importance of grounding discussions about teaching and learning in classroom artifacts, a commitment that motivates my dissertation: educators may have a shared

vision when discussing teaching and learning in the abstract but disagree about whether that vision is being realized in a classroom. I then illustrate this phenomenon with my own vision for science teaching and learning. I first describe what I consider to be good teaching and learning in the abstract, a description that I expect all readers to agree with. I then describe and analyze the video clip I used in my interviews, highlighting moments that I consider to be good teaching and learning. I argue that discussing teaching and learning in the context of this episode not only gives a much clearer picture of what I think good teaching and learning is but also gives the reader something to analyze herself and compare her interpretations with mine. In Chapter 3, I present my first study, in which I showed this episode to 15 different science teachers, science instructional leaders, and principals. I found that participants attended to many different features in the episode, which led to significant disagreement about what is happening in the episode. Additionally, I found that these differences in attention corresponded to differences in how participants were framing the activity of watching the clip. In Chapter 4, I explore the attentional variability of one science instructional leader, Valerie, in multiple contexts. In addition to interviewing Valerie about the videotaped lesson, I also observed Valerie engage in an "observation cycle" with a teacher. In all of her teacher observation cycles, Valerie is required to use a district-mandated observation rubric. Even though Valerie is quite skilled at attending to student thinking in some contexts, I found that Valerie's attention is strongly context-dependent and gets pulled away from students' scientific thinking when she uses a district-mandated form. Finally, in Chapter 5 I summarize my findings and describe the implications my work has for both research and practice. I argue that educators must first become more aware of the pulls on their attention to more thoughtfully navigate the complex demands of the classroom. I also call for districts to be more cautious in their adoption of observation tools that might pull observers' attention away from the disciplinary practices that recent educational reforms champion. I consider some alternatives to these observation tools such as distributing the task of classroom observation to disciplinary experts. Finally, I discuss implications for how researchers and educators can work to develop truly shared instructional vision.

EXPLORING THE VARIABILITY IN HOW EDUCATORS ATTEND TO SCIENCE CLASSROOM INTERACTIONS

By

Colleen Elizabeth Gillespie

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Advisory Committee:
Associate Professor Andrew Elby, Chair
Professor David Hammer
Professor Linda Valli
Visiting Assistant Professor Daniel Levin
Professor Jordan Goodman

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Chapter 1: Introduction

Shared Goals for Science Education

A number of reform documents from the past two decades (e.g., AAAS, 2009; National Research Council [NRC], 1996, 2000, 2005, 2007, 2012) have put forth a new vision of what students should be doing in the science classroom. State science standards have embraced these reforms (Abrams, Southerland, & Evans, 2008) and much of the practitioner literature cites them (e.g., Gess-Newsome, Luft, & Bell, 2009; Keeley, Eberle, & Farrin, 2005; Lawson, 2010; Llewellyn, 2002). However, as Windschitl (2004) points out, there are problematic assumptions concerning the widespread adoption of these science education reforms:

> This vision, however, is based on the assumption that within the science education community there is a shared, if not explicit, notion of what these disciplinary practices entail. It is further assumed that individual teachers have developed functional models of what it means to ‘‘do science’’ and are capable and willing to act as mentors of inquiry. Unfortunately, none of these assumptions is well-grounded, and the negative impact on how learners come to understand science cannot be overstated. (p. 481-482)

Indeed, science education researchers are *still trying to figure out* what students should be doing in the science classroom. Entire books are dedicated to sorting out the nuance in terms like “inquiry” (e.g., Abrams, Southerland, & Silva, 2008; Duschl & Grandy, 2008; Flick & Lederman, 2006) and “argumentation” (e.g., Erduran & Jiménez-Aleixandre, 2007). Abrams, Southerland, and Evans argue that pushing these reforms before reaching a clear, shared understanding of “nebulous construct(s)” (p. xii) like inquiry could jeopardize the success of the reforms.

The most recent science education reform document (NRC, 2012) focuses on disciplinary practices of science, crosscutting concepts, and core ideas, in lieu of using the term "inquiry." The National Research Council (2012) explains why this is the case:

> [B]ecause the term "inquiry," extensively referred to in previous standards documents, has been interpreted over time in many different ways throughout the science education community, part of our intent in articulating the practices… is to better specify what is meant by inquiry in science and the range of cognitive, social, and physical practices that it requires. (p. 30)

To help specify scientific inquiry, the NRC lists and describes 8 key disciplinary practices: asking questions, developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, constructing explanations, engaging in argument from evidence, and obtaining, evaluating, and communicating information. While the list of practices may help specify the work of scientists and give educators a starting point for thinking about adopting the ideas in the framework, it does not solve the fundamental problem of interpretation. What does it look like when students are "constructing explanations" and "engaging in argument from evidence"? What should principals expect to see when they walk into a science classroom that is aligned with the vision of the NRC? In order to make progress toward a coherent, sophisticated vision of science education, researchers and educators must engage in deep discussions around actual classroom practice.

Problematizing Instructional Vision

While Windschitl (2004) and Abrams, Southerland, and Evans (2008) problematize the notion that educators agree on the *goals* of science classrooms, in this dissertation I will argue that we also can't assume that educators agree on what they *see* when they look at science classrooms. In other words, we need to consider how leaders interpret what they see in a classroom in addition to their goals for science education. Instructional leadership literature tends to only focus on the latter - how leaders "make sense" of complex classroom environments is largely absent from the literature (Nelson & Sassi, 2005). Furthermore, within the instructional leadership literature, researchers often only consider whether or not leaders *have* a vision, not what that vision is. For example, Leithwood, Jantzi, and Steinbach (1998) identified eight dimensions of effective leadership; one dimension is that the leader "identifies and articulates a vision" for the school. An unasked question in this type of work is: If educators did agree on an articulated vision for teaching and learning, would they agree if that vision were being achieved in a classroom?

The previous question implies a second one: What do educators see when they look at a classroom? Researchers have begun to tackle this question by studying what teachers *attend to* in a classroom, either while teaching or when watching classroom video. Sherin and van Es (2009) emphasize that *what* an educator attends to in a classroom influences their reasoning about and evaluation of a classroom interaction. Therefore, to study educators' views of what *should* happen in a classroom, we must also study what educators attend to in the classroom and how they interpret what they see. Furthermore, in order for educators to make progress toward a *true* shared vision for science education, they must become more aligned in how they interpret what happens in an actual classroom episode. Together, these commitments motivated my first research question:

> *Research Question 1:* What are the different ways that teachers, science coaches, and principals attend to and interpret a classroom science episode?

In the pilot interviews for my study, I learned about an observation rubric that is used extensively in the school district in which my participants work. While I was initially interested in the unseen misalignments in what educators consider to be good teaching and learning, I became interested in the contextual factors that likely influenced what educators see in classrooms. Due to the prevalence of the particular observation rubric in the county, I decided to also study its influence on one instructional leader's work with teachers. Thus, my second research question was developed:

> *Research Question 2:* How does an observational tool influence what one science coach attends to and values in science classroom interactions?

In this research question, I recognize the context-dependence of educators' attention and seek to characterize that variability for one science instructional leader.

How my teaching experience informs this work

As I worked on my dissertation, I transitioned from being a full-time graduate student to a full-time science and math teacher. This has been a significant change that has brought with it substantial tensions that highlight many of the themes of my dissertation. In graduate school, my research group championed students' engagement in authentic scientific inquiry in the classroom, where inquiry is defined as "the pursuit of coherent, mechanistic accounts of natural phenomena" (Hammer, Russ, Mikeska, & Scherr, 2008, p. 150). To support students' mechanistic reasoning, teachers must attend closely to the substance of students' scientific thinking and their engagement in scientific practices (Hammer & van Zee, 2006). With this theoretical commitment, much of my time in the four years prior to teaching was spent attending to and interpreting students' ideas. In professional development activities, we worked to help teachers elicit and respond to their students' scientific thinking. In research group meetings, we often watched video of students to analyze how they were engaging in the work of science. We also studied how *teachers* attended to their students' thinking. In sum, I was constantly thinking about attending to student thinking, and developed stability around that approach in graduate school.

In my fourth year of graduate school, I began to dream of having my own classroom where I could have more of a direct influence on students. I decided to apply to a few teaching jobs and was fortunate to get a job teaching science at a local progressive K-12 independent school. In many ways, my school is a best case scenario when it comes to attending to student thinking. My administration is incredibly supportive of whatever I want to do in the classroom, and in fact part of the reason they hired me was my progressive stance toward building curriculum from students' ideas. I have none of the traditional institutional constraints that many teachers experience. My students will not take a standardized test covering the materiel from my classes, and standardized testing in general is not emphasized at the school. I was not handed a list of standards that I must "cover," and I do not have to turn in lesson plans or a long-term plan of what I will be doing in class. While administrators occasionally drop by for informal observations, I am not evaluated on any sort of standardized rubric (that I know of). Administrators *want* to see teachers doing creative, student-centered activities and lessons and are impressed with the student argumentation they see in my class. In other words, my environment is incredibly conducive to attending to the substance of student thinking and engagement in scientific practices.

Despite my strong philosophical commitment to attending to student thinking, significant experience doing it for the four years prior to teaching, and seemingly ideal school environment, I have not maintained a consistent focus on student thinking this year. During the first few months of the school year, I kept a detailed journal of my experiences teaching. I started it with an explicit goal of creating a space for me to record and think about student thinking. As the year progressed, I wrote less about student ideas and more about lesson planning and to-do lists. I constantly experienced tensions in where my attention was pulled, and I was frequently aware of those tensions. Reflecting on that shift now, I realize that what seemed like tensions at the time may not be tensions at all. Attending to student thinking cannot be the only thing that a teacher does, and as I will show next, the teacher must sometimes attend to other things in the service of building a curriculum from student ideas.

I will now share a few excerpts from my journal to illustrate these attentional shifts. On the very first day of school, I started my 8^{th} graders with the following question: If you have a cup of ice water, as the ice melts, does the water level go up, down, or stay the same? After class, I recorded the following reflection:

> *Hmmmm they are going to be a tricky class. Very talkative, some on task, some not. Just a tough age. Might think about making discussions more structured for them. So perhaps having a graphic organizer where they------- OKAY I'm stopping myself right here. First I need to think about the ideas from class! Then I can think about my menu of options. So it seems like we were pretty split down the middle, with some saying the water level would go UP because when the ice melts, that's creating more water. Plus, with the icebergs melting, the water level is rising!*

Right away, I started thinking about their behavior and classroom management, but I quickly noticed this focus and explicitly shifted to thinking about the students' ideas. This explicit focus and awareness of my attention to student thinking was a frequent occurrence in my journal. When I wrote about things that were not connected to student thinking, I noticed and tried to shift back. Later in the year, I also started considering why I was not always focusing on student thinking, which I will show in a later excerpt.

In 9th grade physics, I started the year with the "key drop question": If you are walking while holding a set of keys and you want to drop them so that they hit a spot on the floor, do you drop them *before* you get to the spot, *immediately above* them spot, or *after* you pass the spot. For the first few days, all students were very engaged in the discussion and sharing great ideas. We branched off the initial question consider the influence of things like speed, height, and gravity, and after a week, we still had many open question to figure out. However, some students began to lose interest in the discussion:

> *Yesterday by the end of class, some were super frustrated and some were still incredibly engaged in the debates… It's hard to tell what everyone's thinking at this point - I told them that a lot of their ideas had pieces that were right, and it seemed like maybe S1 still thought he was right? but I couldn't tell. Because it is dropping straight down in relation to the person walking/car, but that's not what he was arguing earlier, I don't think. At any rate, we have to move away from this for a while so the kids don't kill me.*

In this reflection, I first attended to affect and engagement: some students were "super frustrated" and some were still "incredibly engaged." In the journal entry, I continued reflecting on their affect and considered how to help them have more respectful discussions, and then I tried to shift my focus to the substance of their thinking. I had trouble sorting through all of the ideas, but ultimately I realized we have to move onto something new "so the kids don't kill me," which lessens the need for me to figure out exactly what they were thinking. In this example, it would not make sense for me to spend much time thinking about their ideas, either in class or in reflection after class. I knew we needed to move on to keep students engaged, and as a teacher's time is a precious resource, I chose to spend my time planning for the next unit instead.

Four weeks into the school year, the 8th grade class was still exploring questions around density and buoyancy. I decided to wrap up the unit, give them a test, and move onto a new topic. After class, I wrote the following:

> *8th grade science – really liking them more and more. Although I'm tired of density, and I think they are too. But their behavior is good! And they have good ideas and are willing to share! I could spend time thinking about and writing down some of their ideas from today, BUT I feel like I don't have time, plus they're taking a test tomorrow on it, so there's not really time to extend the discussions. For those reasons, I don't think it's worth my time right now to think about student ideas.*

Here, I first attended to their behavior and their engagement in the topic – I could tell they were tired of density too. I also noted that "they have good ideas" and was pleased that they liked to share their ideas. But, I explicitly chose not to think more about the substance of their ideas because the unit was over, so we wouldn't continue the discussion anyway. I also mentioned I didn't have time to think about their ideas, a sentiment that appeared regularly in my journal. As in the previous example, I knew attending to student thinking was a valuable practice, but not in all situations. Recognizing this was challenging for me, since I had been steeped in the importance of always attending to student thinking during my four years in graduate school.

While I was full of energy and enthusiasm at the beginning of the school year, as the year progressed, I became overwhelmed and exhausted. I had high standards for myself – I felt like I knew what an excellent classroom looked like, and mine didn't seem to match that vision. After one especially hard day in October, I wrote the following reflection:

> *All of the "inquiry" stuff we preach… takes a lot of brain power and attention - you always have to be "ON." This is exhausting, and I'm not very good at it.*

Keeping this journal helped me to be constantly reflecting on my attention in the classroom and outside of the classroom. The downside of this was that I was also constantly thinking about my shortcomings. I've experienced countless tensions throughout the year, and my awareness of those tensions has helped me to think about this work in a new light. As I have reflected on my experience, I am rethinking my navigation of these tensions. In the moment, my lack of attending to student thinking felt like a failure on my part, but I am coming to realize that is often not the case. Attending to student thinking without attending to affect or behavior or engagement is not very useful for a teacher to run a successful classroom; attending to other things can be in support of attending to student thinking. However, a teacher cannot let student thinking get lost in the many pulls on a teacher's attention.

A teacher's attention is constantly being pulled in multiple directions, a phenomenon that I have experienced first-hand. Sometimes teachers have a greater awareness of these attentional pulls, which allows them to try to navigate them in a deliberate way. Other times, these pulls can be less obvious, and educators are greatly influenced by their institutional contexts without realizing it. Either way, these demands influence educators' attention when teaching and when observing classroom. Consistently attending to the substance of students' ideas while teaching is exhausting, and even in the best of circumstances, it is not possible to do all of the time. My experiences have led me to be sensitive to the many reasons that educators' attention can be pulled in directions other than student thinking. As a result, I will do my best not to treat a *lack* of attention to student thinking as a skill deficit or failure on the part of the participant. Instead, I will characterize the nature of the attentional variability and explore some of the possible reasons for this variability.

A description of what follows

In Chapter 2, I will present my own vision for what successful science teaching and learning looks like. I will then analyze a short classroom episode to further specify my vision and show how *I* approach attending to and interpreting classroom interactions.

In Chapter 3, I will explore the many different ways educators can attend to the same classroom episode. I will show that there was significant disagreement in what is happening in the episode. More importantly, I will argue that participants were actually *framing* the activity of watching the classroom episode in different ways.

In Chapter 4, I will focus on the attentional variability of one science instructional leader. I will show that her attention is strongly context-dependent and gets pulled away from students' scientific thinking when she uses a district-mandated observation rubric.

Finally, in Chapter 5, I will summarize my findings and describe the implications my work has for both research and practice.

Chapter 2: Goals for Science Education in the Context of a Classroom Episode

In this chapter, I seek to do three main things. First, I want readers to become familiar with the video clip I used in the interviews that serve as my data for Chapter 3 and part of Chapter 4. Second, I want to share my own vision for what successful science teaching and learning looks like. Finally, I want to convince the reader that describing good teaching and learning in the context of a real classroom episode is significantly more effective than an abstract description.

What "doing science" looks like in K-12 classrooms

I begin with a description of what I believe is effective student learning in science class. After laying out the targets for student learning, I will explain what sorts of science instruction can help us move towards these learning goals and what evidence of progress looks like. Of course, describing what students should be doing in science class without grounding in actual classroom practice has limited value because people can interpret the same terms in different ways, so I will also illustrate the general descriptions with an accompanying analysis of the focal five-minute classroom episode used throughout the study.

Students should be engaging in the process and practices of science in the classroom, and should reflect on and understand that process (NRC, 2000, 2007, 2012). The work of science is inherently social; scientific progress happens when people engage in discussion and argumentation around ideas (Gallas, 1995; NRC, 2012). There is not one single scientific method, or one definitive set of scientific practices that make up the work of scientists (NRC, 2000). Instead, science consists of a multitude of practices and processes, and students in a science classroom should learn about and engage in many of those practices. While many practices make up the work of science, next I will describe the core practices that science education researchers generally agree are important for students to be doing in science class at all grade levels.

In science class, scientific investigations and explorations often begin with questions. Ideally, students should be asking the questions, and those questions should be personally relevant and meaningful (Gallas, 1995). While students should be encouraged to pursue questions that interest them, they should also learn what questions are answerable by science (Why is it hot in the summer vs. What is the best Pixar movie?) (NRC, 2000). The best questions in science are ones that ask *how* a natural phenomenon occurs, and students should be pursuing mechanistic explanations of that natural phenomenon (Russ, Scherr, Hammer, & Mikeska, 2008; Sandoval & Riser, 2004; NRC, 2012)

Students can do a number of different things to develop their mechanistic explanations. Students can engage in reasoning and discussion to construct explanatory models, continually coordinating their explanations with evidence. Evidence can be obtained through investigations (controlled experiments) or observation (as in astronomy, geology, etc.) Students should not prioritize either theory or evidence, but instead constantly be evaluating both theory and evidence in light of each other (Kuhn, 1989; NRC, 2000, 2012). Controlling variables should not be done for its own sake, but instead, should be done in order to sort out what's going on in the scientific phenomenon. If multiple plausible mechanistic explanations exist, students should be controlling the variables that matter in those explanations (Hammer & van Zee, 2006). In other words, controlling variables is important when you anticipate counterarguments to your explanation, and you want to make sure you can rule out that counterargument.

In traditional science classes, students often learn to ignore their common sense and instead "play school" and memorize the right answer. In reformed science classes, we want to see students *using* their common sense when reasoning about natural phenomenon (Hammer & van Zee, 2006). Students should constantly be thinking about whether an explanation, idea, or piece of evidence makes sense to them, and if it doesn't, they should find out why and question what's being done or said. Students should also be seeking logical consistency and coherence in their explanations. So, if one line of reasoning or evidence leads them to conclude something that contradicts with another line of reasoning or evidence, they should try to sort out that inconsistency.

Finally, I'll make a note about ontology of mind and teaching implications. So far, my description of classroom science will likely be agreed with by most readers (and most science education researchers). Now I will put forth some ideas related to the popular notion of "student misconceptions" that are not the majority view in science education research. I align with a small but growing minority of researchers who argue that students don't come into the classroom with stable, coherent misconceptions. What might look like a "misconception" to some is actually often better characterized by an idea that can be constructed on the spot in response to a particular instructional situation or problem to be solved (Strike & Posner, 1992). Accordingly, progress in science isn't a matter of removing misconceptions or replacing incorrect knowledge with correct knowledge; instead, successful science students must learn to refine their intuitions about how the world works (Hammer & van Zee, 2006). In other words, students learn what bits of knowledge are relevant in what contexts, and those knowledge bits are gradually refined toward the scientific canon. This cognitive view has significant teaching implications: good teaching isn't defined by telling the students the correct answer, or identifying and replacing misconceptions. Instead, a good teacher tries to really understand students' ideas and sets up an environment in which students can work together to refine their thinking. As Gallas (1995) argued, in an excellent science classroom, "the children co-construct, or build together, ideas about seminal questions through real dialogue, and the teacher listens and reflects without immediately agonizing over what *ought* to be said" (p. 11, emphasis in original). By really listening to students' ideas, a teacher can create meaningful curricula and experiences that help students to learn the practices of science.

Selection of a focal clip for my interviews

I suspect that many readers will agree with most of what I have written so far because of its relatively general, context-free nature. When science learning is described in the abstract, there is not much to disagree with. It is when educators begin looking at actual classroom practice together that rich, nuanced conversations can happen and misalignments begin to emerge. Indeed, professional developers and teacher educators have come to recognize the value in watching and discussing classroom video together. Video case studies and repositories of classroom video from math and science classrooms are important tools for professional development, and thus development of these resources has been supported by a number of grant-funded projects (e.g., BSCS, 2011; Hammer & van Zee, 2006; van Es & Sherin, 2008).

In choosing a focal clip for the studies in the dissertation, I considered many factors. One major consideration was public availability of the clip: I wanted others to be able to access the clip so they could do their own interpretation of the episode and compare it to what my participants said about it. I also wanted to minimize the chance of any of my participants knowing the teacher or students in the clip so that a participant's relationship with the teacher wouldn't influence their interpretation of the clip to put all participants on a level playing field.[1] These considerations meant I could not use a video clip from our research project; instead, I looked at what was publicly available. I received a recommendation for BSCS's Videocase project (ViSTA), which was in beta development when I began planning my dissertation study, and is now available to teacher educators for a registration fee. I asked for (and was granted) access to the ViSTA modules, and I found a great wealth of videos of K-8 science classrooms.

As I searched the ViSTA video clips to choose one for my study, I was looking for several things. I wanted a clip that was between 4 and 6 minutes long and contained a lot of student reasoning; I knew this would give us plenty to talk about in a one-hour interview. I also wanted a clip that I did not think was clearly "great" or

[1] In making this choice, I realize that this decreases the authenticity of the observation task; when administrators observe their own teachers, they

"terrible" – I wanted an episode that would garner a variety of opinions; in other words, I wanted something that people would disagree about. If I selected a clip that everyone liked (or everyone hated), I would not be able to analyze the nuanced differences in what participants think students should be doing in the science classroom. I also considered the science content contained in the clip: I interviewed principals in addition to science specialists, so I wanted the topic of the lesson to be something approachable for everyone. Finally, I wanted a clip with good quality audio and video.

Summary of the focal clip

The clip[2] that I selected is from a 3rd grade class in Pennsylvania. The teacher has 22 years of experience in the classroom, and she studies science with her students three days per week. In the clip, students are studying air, aviation, and weather, and they are on the 9th out of is the 9th out of 15 lessons on these topics. On the day prior to the clip, the students studied evaporation, with the following "main learning goals"(1) Evaporation is when liquid water changes into gas (water vapor) and (2) Heat and wind can speed up evaporation. On the day of the clip, the learning goals are: (1) Condensation occurs when water changes from a gas into a liquid form; (2) The liquid water comes from the humid air and not from any liquid water that is part of the experiment; and (3) Water vapor needs a surface so condensation can occur.

The lesson begins with a review of what the students learned about evaporation the day before, and then moves to an activity to explore condensation with the students. To introduce the activity, the teacher explains that the night before

[2] Clip used with permission from BSCS (2011). *Videocases for Science Teaching Analysis* (ViSTA). vista.bscs.org,

she got a glass of cranberry juice with ice in it and put it on a napkin on the table. Later, she noticed that the napkin was wet, and she wondered where the water came from. She asks the students to do an experiment to figure out where the water came from – each group gets a glass of ice water (that she has put red food coloring in to simulate cranberry juice) and a napkin. She asks the students to observe what happens and try to figure out where the water is coming from. While the students are doing the activity, the teacher circulates around the room and asks students probing questions.

In the first clip, the teacher stops at a table with two boys, and she asks them where the water came from. Daniel says it's from the air, but Casey says no, it has to come from the water inside the glass because otherwise all glasses would have to be wet all the time (and he points to some empty glasses that are dry). The teacher presses Casey, asking how it could have gotten from the inside to the outside of the glass. Casey responds by saying the water in the glass is taken up by the air and then goes back down the side of the glass, and that both him and Daniel are right. The teacher then asks Casey what it's called when water changes into a gas, and he answers water vapor. The teacher keeps asking about water vapor:

> What makes you think there might be water vapor in the air?
> Do you think it makes sense that it's water vapor?
> So do you think that the water vapor is changing back into a liquid, maybe?

The students follow her questions, concluding that the liquid on the glass must be from the water vapor in the air. Daniel asks if they should write that down, and she says, "well if that's what you think is going on, then yeah. You're doing some really great thinking!"

The teacher goes to talk to some other groups, and then comes back to Daniel and Casey, which is where the second clip starts. She asks them to read what they've written down, which is "We think that it's water vapor that turns into liquid water." The teacher then asks the students what that's called, and offers both evaporation and condensation before settling on condensation (with much teacher probing). The teacher then asks what might influence the condensation, and after a few guesses, they reach the intended answer "ice," but Casey asserts that non-ice water would do the same thing as ice water. Ms. D tells Casey to go get a glass of water and try it out, and while he's gone, Daniel notices that a closed coke can has condensation on it, which proves it can't be coming from inside the glass.

The complete transcript of the clip is available in Appendix A. Before reading my own analysis of the clip, readers are encouraged to analyze the transcript on their own. Readers are asked to look for evidence of student learning and engagement in scientific practices, as outlines in the previous section. Readers are also invited to consider what instructional moves are facilitating that learning and what might be hindering that learning.

What I find significant in this clip with respect to students' knowledge and inquiry

In the beginning of this clip, the teacher approaches two students, Daniel and Casey, who have noticed there is water forming on the outside of the glass. The teacher directs the students' attention to the condensation[3] and asks them where it's coming from:

[3] I will use the word condensation for simplicity, but the students and teacher are not yet using this word to describe the phenomenon

1. Teacher:	So, guys, I have a question for you. I want you to look at this with me. I want you to look at this. Where is this water coming from on the outside?
2. Daniel:	From the air?
3. Casey:	(shaking head no) I think it's from in there (pointing inside glass) - because the-

Right away, Daniel and Casey disagree about where the condensation is coming from. Daniel suggests the condensation is coming from the air, but he uses a rising intonation suggesting he is unsure; his response is more of a question than a definitive statement. Casey, on the other hand, seems confident that the water is coming from inside the glass: he disagrees explicitly with what Daniel has just said and starting to give a reason for why he thinks the condensation comes from inside the glass. However, at this point it is unclear how Casey thinks the water gets from inside the glass to outside the glass; he could either think the water goes directly through the glass or that it goes up and over the sides of the glass, or he could have no particular explanation in mind. Next, the teacher interrupts Casey to ask him why he thinks the condensation is coming from inside the glass:

4. Teacher:	Okay, Casey thinks it's from in here. Let's talk- let's talk a minute about why you think it's from in there, Casey.
5. Casey:	Because where-- I don't think there is as much- enough moisture to make it come from the air. And like the glass over here or the glasses over there don't have any water on them, unless they've been like washed. They don't get it like this one did. And if it came from the air. It would have to- all glasses would be wet when-
6. Teacher:	If it came from the air, all glasses would have to be wet.
7. Casey:	All the time.
8. Teacher:	All the time. Huh!

Note that even though Daniel had the “correct” idea in Line 2 that the condensation came from the air, the teacher attended first to Casey’s “incorrect” idea. The teacher’s move is a nice one because she is not only focusing on correctness, and she made space for Casey to explain his reasoning for why he thinks the condensation is coming from inside the glass. Casey gives two reasons in response to the teacher's probing. He starts by saying "Because where-" which sounds like he might say "where else would it come from," which in itself is a pretty sensible response: they are observing water on the outside of a glass, and there is water inside the glass, which is very close to the outside of the glass compared to all the air in the room. Casey doesn't complete this thought, however, and instead says there's not enough moisture in the air. He doesn't elaborate on this thought, but taken with his first reaction (where else would it come from?), he might be suggesting that the air doesn't feel wet, but there is actual water in the glass, so it is more likely that the condensation is coming from inside the glass.

Next, Casey critiques Daniel's reasoning, which itself is an important practice in inquiry (NRC, 2007), and how he critiques it is quite sophisticated. Specifically, Casey asserts that if the condensation came from the air, all glasses would be wet all the time. In this statement, Casey takes seriously Daniel's idea that condensation comes from the air, extends it to all glasses, and determines its logical implications are absurd – empty glass don't have condensation on them. Daniel didn't specify that the glass needed to have water in it, or that the water needed to be cold for condensation to form on the outside, just that the condensation came from the air. To Casey, Daniel's idea is ridiculous – if there's water in the air, then why don't all things exposed to air get wet? In this moment, Casey is using logic to reason about theory and evidence, a practice that is part of sophisticated scientific inquiry (NRC, 1996, 2000, 2007). Furthermore, Casey is using evidence (i.e., that glasses filled with water develop condensation, while empty glasses do not) to formulate his explanation of the phenomenon, another important practice of scientific inquiry (NRC, 2000).

In Lines 6 and 8, the teacher repeats what Casey has said, evidence that she is listening to what Casey is saying and values it enough to repeat it herself without correcting him. She is visibly interested in what he is saying and adds a “huh!” after his reasoning in Line 8, further showing her interest in the idea. Again, the teacher is making space for students to make their thinking visible, even when it is canonically incorrect, a practice that is in line with many science education reforms as detailed earlier in the chapter.

Returning to the episode, after Casey explains his “inside the glass” reasoning, Daniel does not respond to Casey’s idea but instead switches to a new guess at what the condensation is:

9. Daniel: Um, I think it's actually steam.
10. Teacher: Well, where's the steam?
11. Daniel: I don't know.
12. Teacher: How- where is the steam?
13. Daniel: In the air.
14. Teacher: You think there might be steam in the air?
15. Daniel: Mmm hmm.

In this segment, Daniel offers a new suggestion for what the water on the glass is called. After he says he thinks it’s steam, the teacher asks Daniel where the steam is, a question that likely doesn’t make a lot of sense to him, since he just said he thinks the condensation is “actually steam.” The teacher’s question pulls him away from his line of reasoning, and he answers “I don’t know” with a downward intonation while he runs his hand over his forehead. His tone and gesture suggest he takes the teacher’s question as a signal that his idea is incorrect, and he is frustrated that he has not been able to get the answer she is looking for.

The teacher asks Daniel a second time where the steam is, and his mood and tone perk up when he answers “in the air,” with a rising intonation suggesting a guess. The teacher restates his answer (“you think there might be steam in the air?”), and he confirms that this is what he thinks, possibly because the teacher’s restatement signals that he is on the right track.

Next, the teacher challenges Casey on his assertion that the condensation is coming from inside the glass:

16. Teacher:	So, Casey, my question for you is, if you think it's coming from inside the glass, how does it get from there to the outside?
17. Casey:	I think it's both. I think that him and me are kind of right.
18. Teacher:	You think you're both kind of right?
19. Casey:	The air takes it up and then it kind of makes it come back down onto this.

In Line 16, the teacher asks Casey to explain how the condensation moves from the inside to the outside of the glass, but note that she hasn’t yet (and never does) ask Daniel to explain how the condensation might get from the air to the glass. Casey responds by combining his idea with Daniel’s idea to form one single mechanism for the water getting to the outside of the glass. He is still confident that the condensation must come from the water inside the glass, but now he’s adding to his previous story by elaborating on how the water gets to the outside: the air is taking the water up and dropping it back down on the outside of the glass. He hasn’t fully explained the mechanism (how does the air take it up? how does the air make it come back down?), but he is showing productive seeds of mechanistic reasoning (e.g., Russ, Scherr, Hammer, & Mikeska, 2008) in recognizing that there should be a mechanism that explains the phenomenon and suggesting air as the agent for that mechanism.

After Casey's explanation, the teacher pushes him to think about the first part of his story, which the teacher seems to interpret as being about evaporation:

20. Teacher:	Okay, so let's think about that a minute. You think the air takes it up. What do we call that when- when it changes from liquid?
21. Casey:	Water vapor.
22. Teacher:	It changes it to-
23. Casey:	Water vapor.
24. Teacher:	Water vapor. So do you think there's water vapor in the air around here?
25. Daniel:	Yeah.
26. Casey:	Yeah.
27. Teacher:	Yeah? What makes you think there might be water vapor in the air?
28. Casey:	Well, because there's mostly water vapor everywhere.
29. Teacher:	So you think there's a lot- there's water vapor everywhere.
30. Daniel:	So is it water vapor?

In this segment, the teacher starts by asking the students for the vocabulary word for the phenomenon by which liquid changes to a gas (i.e. evaporation). Casey responded not with evaporation but with water vapor, the gaseous form of water, which was in line with what she was looking for, so she adjusted her question slightly ("it changes it to-"). While Casey had previously been sense-making and reasoning mechanistically, the teacher's "what do we call it" question move him away from sense-making and toward naming vocabulary words.

Casey says he thinks there is water vapor in the air, but from this segment alone, we cannot determine Casey's understanding of how water changes from a liquid to water vapor. Indeed, researchers have found that when students say that water "goes into the air" during evaporation, they can mean a number of different things; from just this statement, we cannot assume that a student has a coherent mechanism in mind for how the water gets into the air (Johnson, 1998). Furthermore, when the teacher asks Casey why he thinks there is water vapor in the air, his response – that there's water vapor everywhere – is somewhat tautological and he does not actually provide any evidence for his claim, which is an important part of scientific inquiry (NRC, 2007). Finally, Daniel's question to the teacher ("so is it water vapor?") is an interesting epistemological point – he sees the teacher as the science authority and seems to see this activity as more about finding the right answer than reasoning about the phenomenon.

After Daniel asked if the answer was water vapor, the teacher seemed to recognize that he was just looking for the answer, so she redirected him epistemologically by telling him that's what they're trying to figure out:

31. Teacher:	Well, Daniel, that's what we're trying to figure out. Does it- do you think it comes directly from inside out to here?
32. Daniel:	No.
33. Teacher:	That- that doesn't- does that make sense?
34. Casey:	It has to go up and then-
35. Teacher:	It has to go up and then come-
36. Daniel:	(back down the outside?)
37. Teacher:	-down to here. Do you think it makes sense that it's water vapor?
38. Daniel:	Yeah.
39. Casey:	Cause there's also water in here. (pointing to the inside of the glass, above the water level, where it's also wet)

In Line 31, the teacher asks Daniel if he thinks the water comes directly from the inside of the glass to the outside. Note that Daniel has never said he thinks this, so she is essentially asking Daniel what he thinks about Casey's idea. Recall that a major goal of science education is to get students to engage with each other (rather than with the teacher) in scientific practices and reasoning, so this move might be the teacher's attempt to start scaffolding that process. The teacher is quite leading in her questioning in Lines 33-37. In Line 33, she starts to say "that doesn't make sense" before switching to asking the students if it makes sense, suggesting that she may have realized she was being too leading and tried to back off. This shift might be evidence that she is in the process of rethinking her instructional practice; of course we would need more data to make any real claims about this.

In Line 34, Casey repeats the story that the water must come up from the glass and then go back down over the sides, so it's unclear if he thinks in this moment there's water vapor everywhere (as he said previously) or if water vapor just forms directly over water (as he says here), or if he isn't sure himself yet. Because his thinking is changing moment to moment, it is likely he hasn't yet developed a stable or coherent story about where the water is coming from. At the end of this segment, Casey notices that there's also water on the inside of the glass, above the water level, which he uses as evidence that the water vapor must be coming directly from the water in the glass. While his reasoning is "incorrect," this shows that Casey is very observant, something everyone would agree is important scientific practice. Casey's utterance in Line 39 suggests that at the beginning of the clip, he may have been talking about the water going directly through the glass, and now that he sees this new piece of evidence, he uses it to support the new story that it is water vapor coming up from the water in the glass.

Next, the teacher continues to probe the students about water vapor:

40. Teacher: Do you think water vapor- okay, so we know that water can change from liquid to-

41. Daniel: Solid.
42. Teacher: to- to-
43. Daniel: No wait, solid and water vapor.
44. Teacher: and to water vapor. So we know that the liquid can change into a gas. My question for you is, can the gas change back into a liquid?
45. Daniel: Yes, because I think this is water vapor.
46. Teacher: So do you think that the water vapor is changing back into a liquid, maybe?
47. Daniel: Yeah.
48. Casey: Because we can see it then.
49. Daniel: Yeah.
50. Casey: We- we can't see it right away. But then it kind of-
51. Teacher: Can you- can you see some evidence that the-
52. Casey: Yeah.
53. Teacher: that it's- that something has changed back into a liquid here?
54. Daniel: Yeah.
55. Teacher: Yeah.
56. Daniel: Should we write that down?
57. Teacher: (to a student in another group) Well, that's okay. Just put down what you have now. That's okay.
58. Daniel: Should we- should we write that down?
59. Teacher: Well, I- if that- if that's what you think is going on-
60. Daniel: Yeah.
61. Teacher: Yeah, yeah, go ahead and write that, guys. I think you're really doing some great thinking here.

In Line 40, the teacher is presumably about to ask “Do you think water vapor can change back into a liquid” because that is what she later asks in Line 44, but she changes her question to ask what “we know” liquid water can change to. This move allows the students to connect their reasoning with what they have learned in a previous lesson. In Lines 41 and 43, Daniel sounds really confident that water can turn into solid and water vapor, but there is still little evidence regarding what he thinks water vapor actually is – it still might be just a science word to him without much meaning.

When Daniel says “I think this is water vapor” in Line 45, “this” likely means the condensation, so he seems to be saying that the condensation is water vapor. However, in the next line, the teacher asks if the water vapor is changing back to a liquid, slightly changing the meaning of what Daniel said. This is evidence that the teacher isn't really trying to understand what the students are thinking in this moment but instead she has a clear conceptual goal in mind that she wants to lead them to. Note that the teacher's question in Line 46 is a yes-or-no question; Daniel answers "yeah," but Casey answers with some reasoning ("because we can see it"). This is further evidence that Casey is treating this activity more as a sense-making task than Daniel is.

Casey's explanation for why the condensation is coming from water vapor in Line 48 is that they can see it on the glass, but he is just pointing out the evidence of the water without explaining why that water must be coming from water vapor. Note that after Casey shares his observation in Lines 48 and 50, the teacher then asks if he can see evidence. This move does two things: it validates Casey's observation as being worthwhile, and it gives a vocabulary word (evidence) to his observation. However, while Casey is citing evidence, he doesn't actually connect it to his reasoning. In other words, why is the presence of liquid actually evidence that a *gas* changed back into a liquid? Here, Casey is talking about evidence and theory without connecting the two; coordinating theory and evidence is a crucial part of inquiry that is missing in this moment (Kuhn, 1989; NRC, 1996, 2000, 2007). Finally, Daniel asking "Should we write that down?" in Lines 56 and 58 supports my previous claim that Daniel is framing this activity as primarily being about getting the right answer to write down on his worksheet.

After their interaction with the teacher, the students spend a few minutes completing the worksheet about the activity, and then the teacher returns to see how Daniel and Casey are doing:

62. Teacher: Okay, Daniel, are you done drawing what's going on here? Okay, I need you guys to see if you can give me an explanation of what's going on here and what it's called, okay? "We think that..." what?
63. Daniel: It's just water vapor that turns back to liquid water.
64. Teacher: Yeah, do you- there's a word for that. Do you have any idea what it might be called?
65. Daniel: No.
66. Teacher: Any idea what it might be called?
67. Daniel: Evaporation.
68. Teacher: Well, is this evaporation?
69. Daniel: Condensation.
70. Teacher: Hm, where did you get that word?
71. Daniel: I just heard it before.
72. Teacher: You heard it before, you guessed. Well, is it- it- is this evaporation?
73. Daniel: No.
74. Teacher: if water vapor turns back into liquid?
75. Daniel: No.
76. Teacher: Okay, so do you think it might be called condensation?
77. Daniel: Yeah.
78. Teacher: Well, both evaporation and condensation are going on a lot of times when it- with rain, with clouds. So, what do you think this one might be called?
79. Daniel: Condensation.
80. Teacher: Well, let's- let's come back and talk about it as a group and see if other people think that- that that makes sense, too.

In this segment, the teacher asks the students to do two things: (1) explain "what's going on" and (2) say "what it's called." Daniel starts by reading what he wrote on his worksheet, which is the beginning of a mechanistic explanation of condensation, although he does not say anything about how the water vapor turns back into liquid water. Note that Daniel's explanation in Line 63 ("It's just water vapor that turns back to liquid water") is almost exactly the same as the teacher's question in Line 46 ("So do you think that the water vapor is changing back into a liquid, maybe?"). Because much of the language in the explanation came from the teacher's question, we cannot be sure how much ownership they have with this explanation; at this point, the students seem to be looking for the answer that the teacher would consider correct.

After Daniel reads his explanation, the teacher signals that she is satisfied with that explanation because she responds "yeah" and doesn't problem them further on it. Instead, she switches to asking Daniel if he knows what the phenomenon is called. Not surprisingly, when the teacher moves to focus on the vocabulary word, Daniel frames the activity as trying to figure out what word she is looking for. He first says he doesn't know what it is called, then guesses evaporation. The teacher's response "Well, *is* this evaporation?" indicates to Daniel that his guess was incorrect, so he switches to condensation. The teacher's reaction to condensation ("Hmmm, where did you get that word?") confirms that he was correct, and he sticks with that answer for the remainder of the interaction.

Because of the leading nature of the teacher's questions, we cannot say whether it "makes sense" to Daniel that this phenomenon is called condensation as she suggests it does in Line 80. It is curious that the teacher even uses the language "makes sense" here; there is not much sense-making to be done in selecting the correct vocabulary word. She has used the phrase "makes sense" previously (Lines 33 and 37), when it actually made more sense (especially in Line 33, when she was talking about the water going through the glass). Her use of this phrase suggests she thinks it is important for idea to make sense to students, although she seems to use it without always thinking about what it means, as is the case in this bit. Note also that in Lines 62-80, Daniel is the only one doing the talking; Casey is still standing there, but he does not say anything (and the teacher does not direct any questions toward him). In fact, in Line 80, she suggests that they see if other people in the class agree that it is condensation, without first checking with Casey about what he thinks. However, she may be assuming that the two of them agree, since they had been working on the sheet together, but the sheet presumably only had the explanation Daniel cited in Line 63, not the word condensation.

Next, the teacher has Daniel reread his explanation and begins probing the students on factors that would influence condensation.

81. Teacher: We'll see if that does make sense. Okay, "I think it's just water vapor that turns back to-"
82. Daniel: Liquid water.
83. Teacher: into liquid- "to liquid." What do you think might influence the water vapor changing? A change in what?
(another student?) How wet it is (inaudible).
84. Teacher: What is the- these things are what?
85. Daniel: Change in surface.
86. Teacher: Well, a surface might have something to do with it. That's a great idea, Daniel. Just a second, Malik.
87. Teacher: What else about these things, Casey? These things are what? What's different? Remember you were talking about those glasses over there.
88. Daniel: This is metal and this is plastic (pointing to closed soda can and clear cup)

Here, the teacher again says they'll see if it "makes sense" that the phenomenon is called condensation. Then the teacher asks the students what factors would influence the condensation. Daniel continues to be the only one answering her questions in this segment. He starts by noticing differences between the two containers they have on their desk – a clear plastic cup (glass) and a closed soda can. However, he's not given space to explain how the surface might matter, so we don't know if he actually has a story for how surface might influence condensation or if he's just playing "spot the differences." Daniel's move makes perfect sense in this moment: the teacher seems to be looking for a particular causal factor, so Daniel starts naming potential factors. However, without further explanation from Daniel, we can't tell the sophistication of his reasoning.

In Line 87, the teacher asks Casey specifically to comment on the differences between the glasses. Daniel is again the one to respond and guesses that the type of surface (metal vs. plastic) matter, but the teacher redirects again to Casey's earlier idea:

89. Teacher:	Don't- yeah, yeah, that's true. That's true, but you were saying that the glasses over there don't get this on it.
90. Casey:	Mm-hm.
91. Teacher:	What's different about this glass? It's- has- it's- it has what?
92. Casey:	Ice and-
93. Teacher:	It has ice. The ice changes the what?
94. Casey:	Temperature.
95. Daniel:	And I think we also (inaudible).
96. Teacher:	It changes-
97. Casey:	If we used a regular glass of water, it would still do the same thing.
98. Teacher:	Do you think it would do it as fast-
99. Casey:	No.
100. Teacher:	without the ice?
101. Casey:	No.
102. Teacher:	Do you want to try that? Do you want to go get a glass? Go get another glass and let's try that out.

The teacher's move to get Casey back into the conversation is nice for several reasons. First, she likely noticed that Daniel was the only one participating in the conversation, and she wanted to make sure both students were involved. Second, and more importantly, she brings his *idea* back into the conversation. This is evidence that she noticed his idea earlier, and thought it was important to incorporate the students' ideas as she moved toward her conceptual goal for the lesson. However, recall that Casey's point was that the *water* was the important difference, not the *ice*. In Line 92 Casey says "ice and-" but the teacher cuts him off to focus on the ice. With the teacher's probing, Casey recognizes that ice would cause a difference in temperature; however, Casey doesn't initially say that temperature would make a difference to the condensation. In fact, Casey interrupts the teacher's leading questions to say that even if there was no ice in the water it would still do the "same thing."

In his move in Line 97, Casey is engaging in a productive practice of inquiry, something Windschitl (2004) might call "model-based reasoning" which "takes inquiry to be an empirical investigation to test or develop a model or theory, or to compare theories" (p. 504). Specifically, Casey bases his prediction a regular glass would do the same thing on his model that the water comes from inside the glass to get on the outside of the glass – his model has nothing to do with temperature (until the teacher pushes him into it), so temperature shouldn't affect condensation. Therefore, when the teacher suggests a model for which temperature might matter, Casey makes a prediction that contradicts her model and that suggests an experiment that would help sort out which of the two models is correct.

In addition to reasoning about models, I argue that Casey is also emphasizing the importance of controlling for variables in this clip. The teacher is asking him to compare an empty glass to a glass filled with ice water, and there are two variables that differ in those examples: the presence of water and the presence of ice. Casey's story as it currently stands depends solely on the presence of water, and seeing that a glass filled with ice water has condensation and an empty glass doesn't have condensation doesn't sort out whether it's the water or the ice that's causing the condensation. By trying to control for variables in order to sort out the relevant causal factors of a phenomenon, Casey is engaging in another sophisticated part of scientific inquiry (NRC, 1996, 2000, 2007; Sandoval & Riser, 2004)

After Casey goes to get a glass of room temperature water, Daniel observes something on a soda can that challenges Casey's idea that the condensation comes from inside the glass:

103.	Daniel:	(I have proof) that it's not the, um- it's not that- the water.
104.	Teacher:	What is our proof that it's not the water?
105.	Daniel:	Because this has a lid on it. (pointing to unopened can of soda)
106.	Teacher:	Oh!
107.	Daniel:	And so that can't (inaudible).
108.	Teacher:	Great! That is really neat, Daniel, that you're noticing that. That's great!

In this moment, Daniel is engaging in sophisticated inquiry: he is logically reasoning about evidence, showing that the evidence doesn't support Casey's argument, and using that evidence to strengthen his own argument (NRC, 2007). This type of reasoning is markedly different than what Daniel was doing earlier; here, he is using evidence to figure out what is going on, suggesting a shift in how he is framing the activity.

Finally, I want to comment on Casey's ideas in this five-minute clip and what we can claim about his students' knowledge at the end of the clip. Casey began by saying that condensation came from the water in the glass - can we say that Casey had a misconception that condensation comes from inside the glass but now he knows that condensation comes from the air? Or that he learned that cold water makes condensation happen faster? When the teacher asks Casey if room temperature would develop condensation as fast, Casey answers no, which is the obvious “correct answer” to the question. So, in this moment Casey expresses an idea he knows the teacher wants to hear, even though it contradicts what he said in his previous utterance, that room temperature water would do the same thing as ice water. In sum, I do not think we have evidence that Casey now “knows” that temperature affects condensation, or that he had a coherent misconception of condensation to begin with. Instead, I argue that Casey engages in sophisticated scientific reasoning when his goal is to figure out condensation works, and when this is his goal, he articulates a sensible, fairly coherent mechanism; however, when he is motivated more by pleasing the teacher, he says things that are inconsistent with this mechanism.

Discussion

Before I highlight the important points that come out of this analysis, I invite the reader to revisit the interpretation of the episode she was asked to do before reading my analysis. What did you notice in the episode? What did you think of how the students were engaging in the activity? What was different from my analysis, and what was similar? Were you surprised at anything I did mention or didn’t mention? I expect there was more disagreement in the analysis of the clip than there was in the initial description of science teaching and learning because with the clip, there is actually *something* to disagree about. This intuition is based on my informal interactions with educators and was in fact the *motivation* for the study that was the basis for Chapter 3.

Let's revisit the two main purposes of this chapter. First, I hope that this has provided the reader with an overview of the video clip that was used in the interviews I will analyze in Chapter 3. Second, this chapter allows us to see the benefit in using real classroom video when trying to articulate what we think good science teaching and learning looks like. When policy makers and educators rely on vague descriptions of scientific inquiry, they ignore the complexity and nuance of real students in real classrooms. Furthermore, they assume that educators are generally in agreement about what these reforms mean. In the next chapter, we will see that this is not the case. Watching classroom video has another important benefit: observers can pause, rewind, and replay any segment of the episode. While this is not a luxury when watching a live classroom, it makes it possible for a group of observers to dig deeply into what they see in an episode, allowing for these nuanced points to be discussed.

Note that analyzing a classroom episode involves more than just describing what happened. Even in a 5-minute video clip of just two students and one teacher, there are virtually limitless things that an observer could comment on. Analyzing a video requires making choices about what is worth highlighting and more importantly, *how* those features are valued. For example, two viewers could note that the students used scientific vocabulary in this clip, but they could have very different opinions about the value of using that vocabulary. We will see many examples of these differences in Chapter 3. Furthermore, even the *approach* to discussing a classroom episode can vary widely by observer. In this chapter, I have attempted to provide evidence for my claims, and explicitly state when my claims are merely speculative. Different observers might take different things as evidence, or may not provide evidence at all. We will also see examples of this in Chapter 3.

Finally, I want to emphasize that there are many contextual factors that likely influence what people see in classrooms and how they interpret what they see. These factors could be institutional, such as state standards and testing, or more individual, such as comfort level with content or previous interactions with a teacher. In Chapter 4, I will explore the influence of a district-mandated observation rubric on a science coach's observation of a lesson.

Chapter 3: Exploring the many ways of attending to one classroom episode.

Introduction

Many researchers assert that educators must develop a shared instructional vision in order for schools to be effective (e.g., Bintz & Landes, 2009; Byers & Fitzgerald, 2002; Cobb, Zhao, & Dean, 2009; Elmore, 2000; Galucci, 2008; Nelson, 1999; NRC, 2000). But, what does that really mean? And how do we know if educators have a shared instructional vision? Instructional leadership literature mostly treats vision as an ill-defined component of leadership (i.e., that they have a focus on instruction) with little detail as to what they think good instruction is (Cobb & Smith 2008). While leaders in some schools and districts have successfully reformed instruction, science education reform efforts across the United States have been largely unsuccessful (NRC, 2012). Part of the reason, argue Byers and Fitzgerald (2003), is that "administrators have not understood them" (p. 87). Nelson (1999) explains that leaders are crucial for successful educational reform because "they enact, on a daily basis, a set of ideas about the nature of learning and teaching, thereby influencing the intellectual culture of schools in particular ways" (p. 22). In addition to not understanding the nature of reforms, educators also likely disagree on what counts as evidence of success, as detailed in Chapter 1 of this dissertation.

Indeed, many of the teachers in our inquiry-based professional development program have expressed their concern with their administrators' lack of understanding of science education reform. For example, Sam[4], a 7th grade science

[4] All names are pseudonyms.

teacher in Eastern County Public Schools (ECPS), explained at a teacher meeting, "I think administrators have a whole different decision-making paradigm they're functioning on that has nothing to do with inquiry at all." Sam went on to say that his principal came to their science team meeting to say that they should do more "touch and feel" (hands-on) activities in science class. Sam doesn't think hands-on activities are synonymous with high-quality science lessons, but his principal does, and that creates a tension for Sam in deciding what to do in his science classes.

Of course a principal can't know everything about every school subject, so school districts often distribute this responsibility to discipline-specific instructional specialists. ECPS partners with a large, NSF-funded professional development project which has a goal of increasing math and science interest and achievement among minority students. There are three "science coaches" funded by the project who observe participating teachers' science lessons, and part of the coaches' job is to help teachers prepare for the formal observation with their principal. However, coaches and principals cannot be assumed to align in how they evaluate science lessons. For example, one of the science coaches recounted a recent experience with a principal:

> Valerie: I think in terms of science [the principals are] looking at different things than we're looking at. Sometimes principals realize that a misconception is being expressed in the class, and I don't think the principal understands why we're letting it continue, especially at the start of a lesson when we're trying to pull them out to figure out what we need to teach to get rid of the misconception. I think the principal, and I've seen it on paper, [she wrote on the observation rubric] "a student said a wrong answer and you didn't correct him", and I was going "nooooo!" … but um, I'm not a lesson expert, I can't go and tell a principal, well you were wrong, you shouldn't have told that teacher that.

From Valerie's perspective, she and the principal had significantly different ideas about what students and teachers should be doing in a science classroom. Valerie valued student discussion of ideas, even when those ideas are "incorrect," a foundation of reform-oriented science teaching. The principal, on the other hand, wanted the teacher to correct a student's "wrong answer," which is not in line with reform practices and does not promote students' engagement in scientific inquiry.

Teachers in our project also frequently express frustration with the people who come to their classroom to evaluate them. The school district uses the Depth of Knowledge chart[5] as a framework for question quality, a chart that has four levels of questions: Recall, Skill/Concept, Strategic Thinking, and Extended Thinking. Each level has a number of corresponding terms that can be used to create questions at that level. For example, a recall (Level 1) question could start with who, what, when, or where, and a strategic (Level 3) question could start with compare, investigate, or critique. The following is an excerpt from a conversation between two teachers at a teacher meeting, after a teacher had brought up the issue of question quality:

> Rachel: Sometimes… you know, when some people come in to evaluate you because "synthesize" says certain words, if you don't say that word, then they don't think it's a higher level.
>
> Cynthia: Exactly! …The same thing for that teacher who's looking to implement the higher order thinking questions, they're thinking just because you used one of those verbs from Bloom's[6], that you're hitting application, or you're hitting synthesis, or you're hitting whatever, just because you used that one word. I had a teacher last year who that was his weakness[7]. So I would sit with him and he would say help me come up with questions, and like all the

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[5] See Appendix B: Depth of Knowledge chart

[6] "Bloom's Taxonomy" is another popular classification of question sophistication, with 7 levels instead of 4, but with similar terms.

[7] Cynthia was a teacher leader who mentored other teachers at her school

> questions just contained the verb, but they weren't really higher order thinking skills. It's like what? That's still recall.
>
> Rachel: And then like a recall question, like what is the color after blue in the rainbow, right, because you said what, that's recall, right, but if you say something like "what is energy?" which is not a recall question, people see what, and they say "oh that's recall, that's recall" (pretending to write on a clipboard)

In this exchange, Rachel and Cynthia explain that observers often focus too much on the verbs in the question classification chart and not enough on the substance of the question. Cynthia points out that a question could use on of the “higher level” words without actually being high-level, and Rachel notes the inverse: a question beginning with “what,” ostensibly a “low-level” word could actually be a high-level question. Rachel and Cynthia’s reflections show they have a more sophisticated view of question quality than the observers they are referring to: they think more about the *function* of a question and the type of student response it requires. When Rachel and Cynthia are evaluated on only the terminology used in their questions, they realize that their practice is not being fairly judged, and furthermore, this superficial feedback does not help them improve their practice.

The preceding episodes are examples of an overall theme we have seen in the professional development project: many teachers feel they cannot teach science the way they want to because their administrators have different views of what students should be doing in science class. In this chapter, I seek to answer the following research question:

> To what extent are teachers, science coaches, and principals aligned in how they interpret a classroom science episode?

Before answering this question, I will first use the literature to argue that we should be looking more closely at what leaders think students should be doing in science class. I will argue that the best way to do this is to have them reason about a real classroom episode. Next, I will analyze data from 12 administrators, science coaches, and science teachers, exploring the many nuanced ways that these educators reasoned about a video of a 3rd grade science lesson. I will highlight patterns and themes that came up in the data and compare the ways of thinking to the science education reforms presented in Chapter 2. Finally, I provide conclusions and implications of this work.

Literature

Leadership content knowledge

For decades, educational researchers have argued that instructional leadership is key to the success of a school or district (e.g., Cobb, Zhao, & Dean, 2009; Dufour & Eaker, 1998; Elmore, 2000; Hallinger & Murphy, 1987). For many researchers, a critical aspect of successful instructional leadership in a school or district is that all the leaders have a shared instructional vision (e.g., Bintz & Landes, 2009; Byers & Fitzgerald, 2002; Galucci, 2008; Nelson, 1999; NRC, 2000). However, much of the research on instructional leadership ignores individual leaders' views of the disciplines and instead focuses on generic strategies that effective leaders use in their daily practice (Burch & Spillane, 2005; Stein & Nelson, 2003).

In many ways, today's instructional leadership literature is similar to the state of teacher education literature in the 1980s: it includes lists of practices and behaviors that leaders should engage in to be effective instructional leaders. In 1986, Shulman challenged much of the teacher education literature at the time that promoted such "black box" thinking. He argued that researchers cannot simply give teachers a list of "best practices" or tell teachers how much time to spend on each topic. Instead, researchers must begin to pay attention to teachers' knowledge about and understanding of the content and how it is learned and taught. Shulman called this knowledge "pedagogical content knowledge," a construct that changed the course of education research.

Shulman's (1986) criticism of teacher education research is certainly applicable to instructional leadership research, a parallel that Stein and Nelson emphasized in 2003. They argue that "most of the research in educational administration continues to focus on what effective leaders 'do,' not on how they think about what they do" (p. 2). Furthermore, Stein and Nelson note that the small amount research that has explored leaders' cognition (e.g., Hallinger, Leithwood, & Murphy, 1993), has not explored leaders' beliefs and knowledge about specific disciplines. Consequently, Stein and Nelson (2003) introduced the notion of "leadership content knowledge" which includes knowledge about each subject, knowledge about how students learn that subject, knowledge about how to best teach that subject, and knowledge about how to facilitate teacher and/or principal learning. In other words, leaders must have solid pedagogical content knowledge before working with teachers to help improve their practice. Stein and Nelson emphasize that subject matter knowledge remains important for even the highest-level leaders:

> Notice that as we move away from the classroom, knowledge about subject matter does not disappear, and what administrators need to know does not

> become more generic. The needed knowledge remains anchored in knowledge of the subject and how students learn it. (p. 48-49)

If deep subject matter knowledge is required for effective instructional leadership as Stein and Nelson claim, then researchers must work to understand the nature and substance of leaders' knowledge and beliefs about disciplines and their pedagogy. Researchers need to dig deeper, to unpack the vague terms and phrases that many leaders use to characterize for example mathematics and science teaching.

Leaders' understandings of math and science reforms

Price, Ball, and Luks (1995) found that most elementary school principals and district leaders didn't have deep knowledge about mathematics pedagogy, and many talked about mathematics instruction broadly, referring to "hands-on learning" and "problem-solving." Price, Ball, and Luks argue that these phrases, popular in mathematics education reform, don't mean much in terms of actual classroom practice. Their conclusion about the superficiality of how many leaders talk about mathematics education reform could be written about science education reform today:

> Taken seriously, the mathematics reforms point to fundamental revisions in views of knowledge, of learning, and of the relationship of teachers and students in classrooms. Without dramatically different local policymaking about resources available, however, the rhetoric of mathematics reform has little chance to comprise more than superficial shifts in the surface features of classrooms and a splash of new slogans. Doing so would require administrators to have opportunities to learn about -- not just be updated -- the substance of the mathematics reforms and about what it might take to realize these ideas in classrooms. (p. 37)

Here, Price, Ball, and Luks argue that instructional leaders must know *more* than just the buzzwords associated with educational reform. If leaders only have a superficial understanding of education reform, they cannot effectively support teachers to transform their instruction. Instead, they must develop a deep understanding of mathematics as a discipline, mathematics pedagogy, and what mathematics learning looks like in the classroom.

Much like Price, Ball, and Luks' call to leaders in 1995, many science education researchers have argued that leaders and teachers should work toward developing a sophisticated vision of school science in order for science education reforms to be successful (e.g., Bintz & Landes, 2009; Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003; NRC, 2000). Science reforms, like mathematics reforms, have included such vague terms as "hands-on," "problem-based," and "scientific inquiry," which many leaders use without unpacking exactly what they mean for the classroom. Abrams, Southerland, and Evans (2008) argue that it is crucial for practitioners (and researchers) to work toward a coherent vision of scientific inquiry in the classroom, because "[p]lacing such a nebulous construct at the center of the science education reform effort with such scant support for teacher thinking about these constructs calls into question the eventual success of these reforms" (p. xii). Indeed, science education researchers themselves are still working toward a consensus of what students should be doing in the science classroom (e.g., Abrams, Southerland, & Evans, 2008; Duschl & Grandy, 2008; Flick & Lederman, 2006). With so much ambiguity about what science reforms mean for the classroom, it is not enough for science instructional leaders to ask teachers to "do more inquiry." Instead, leaders and teachers should constantly discuss their vision for students in the science classroom, looking at student work and classroom video to ground their discussion in actual evidence from students and teachers (Bintz & Landes, 2009; Loucks-Horsley et al., 2003)

Of course, many instructional leaders are responsible for supporting and evaluating the teaching and learning of all subjects; therefore, it might be unreasonable to expect one leader to be an expert in every discipline and its pedagogy. Some have argued that schools and districts can be more effective with a model of distributed leadership, where leadership tasks (such as teacher evaluation and teacher professional development) are either divided between or shared among leaders (Elmore, 2000; Spillane, 2003). However, many school districts (inducing the one in this study) still rely on a principal or assistant principal to conduct all of the formal evaluations at a school. Furthermore, even if some instructional tasks are distributed, leaders don't work on separate islands: they are constantly interacting around matters of classroom practice. Thus, a principal who has delegated science supervision to another person will still be collaborating with that person to make instructionally relevant decisions (e.g., textbook selection, teacher hiring/firing, or budget decisions).

Instructional leaders' decision-making takes place within a complex school system involving multiple entities. As Hallinger, Leithwood, and Murphy (1993) explain,"[school leaders'] work is often characterized by brief encounters with many different people, numerous interruptions, partial information, and conflicting expectations from multiple constituencies" (p. 1). It is in these encounters where leaders' assumptions are typically unstated and misalignments go unseen. Indeed, it is precisely because people often don't realize they are misaligned in their ways of thinking that multiple leaders' cognition *must* be considered when analyzing how groups make decisions (Kerchner, 1993). Because of unseen misalignments, a group of people could think they are working together on solving one single clear problem, but the reality is often much more complex.

The dynamic nature of instructional vision

The terms "leadership content knowledge", "understanding", and "instructional views" imply a rather static view of cognition. But increasingly, the dynamic, context-sensitive aspects of cognition are seen to play an important role in individual's in-the-moment reasoning and decision-making. Indeed, some researchers have begun to investigate the dynamic nature of educators' understandings as they pertain to observing classrooms. For example, Sherin and van Es (2009) use the notion of *professional vision*, adapted from Goodwin (1994), to characterize what teachers attend to in complex classroom environments. Their work is based on the goal of current mathematical reforms that call for teachers to attend to students' mathematical thinking so that teachers can base their instructional moves on that thinking.

Sherin and van Es explain that professional vision consists of two processes: "selective attention" and "knowledge-based reasoning" (p. 22). Selective attention involves what the teacher decides to pay attention to in the classroom, and knowledge-based reasoning involves how the teacher "reasons about what is noticed based on his or her knowledge and understanding" (p. 22). This knowledge could include knowledge about the discipline, the curriculum, or the students' understanding. Sherin and van Es explain that selective attention and knowledge-based reasoning are constantly interacting:

> [T]he kinds of interactions that a teacher notices will likely influence how the teacher reasons about those events. In addition, a teacher's knowledge and expectations can be expected to drive what stands out to the teacher in any given situation. (p. 22)

Here, Sherin and van Es bring up an important point that is worth emphasizing: a teacher's knowledge and expectations influences what she notices in a classroom, which in turn influences how she reasons about the situation.

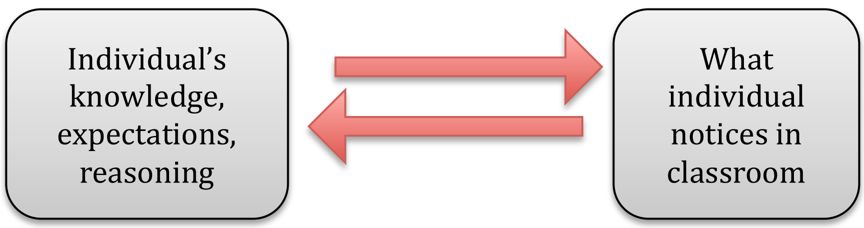

Figure 3-1: Knowledge-based reasoning and selective attention

This conceptualization of teachers' understandings could also be applied to leaders who observe classrooms: how an observer is thinking and reasoning about a discipline and its pedagogy influences what she sees in the classroom, which in turn influences how she is thinking and reasoning about the classroom and the discipline. This way of thinking about leaders' knowledge adds a layer of nuance to Stein and Nelson's (2003) leadership content knowledge: a leaders' understanding isn't a coherent body of knowledge but instead is constantly influencing and is influenced by what she notices in a teacher's practice. So, to understand a leader's work with teachers, it's not enough to list the leadership content knowledge that leader has;

instead, we must understand what she attends to in the classroom, how she reasons about it, and what knowledge and beliefs are coming into play in various contexts.

Teacher noticing and attention has been studied by a number of science and mathematics education researchers. While much of the research on teacher attention has focused on noticing as a skill that teachers either have or don't have (e.g., Franke, Carpenter, Levi & Fennema, 2001; Kagan & Tippins, 1991; Star & Strickland, 2008), an emerging line of research has found teacher attention to be highly variable depending on the context (Berland & Hammer, 2012; Elby, Lau, Hammer, & Hovan; Lau, 2010; Lineback & Goldberg, 2010; Richards, Gillespie, Levin, & Elby, in preparation; Rop, 2002). Researchers have attributed shifts in attention to shifts in how the teacher *frames* the activity of teaching. Framing is a construct adapted from sociolinguistics and anthropology that describes how a person approaches the situations they find themselves in. A person's framing of a situation is usually tacit and is the answer to the question, "what is it that's going on here?" (Goffman, 1986; Hammer, Elby, Scherr, & Redish, 2005). Contextual factors drive an individual's framing of an activity, and this in turn influences what they attend to in the situation.

In this chapter, I will explore how a variety of educators, both teachers and leaders, attended to and reasoned about a science classroom episode. I will show that much of the variability in attention can be attributed to variability in how participants were framing the activity of watching the classroom episode. In the next section I outline my research context and methods.

Research Context and Methods

Overview

In this study, I explored the extent to which a group of educators are aligned in how they interpret the same classroom science episode. In each interview, I showed the participant a five-minute video of a science lesson and asked the participant to reflect on the clip. In what follows, I will detail the research context and describe how I selected my participants. Then, I provide a summary of the video clip that was used in the interview and explain the interview protocol in detail. Finally, I describe my analytical methods.

Context

In this study, I interviewed teachers, science coaches, and principals in Eastern County Public Schools (ECPS). The teachers and coaches are part of a large science teacher professional development project that is a partnership between several educational institutions in Eastern County including a Large Research University (LRU). Fifteen of the teachers are part of the Inquiry Professional Development Project (IPDP), the LRU-based sub-strand of the project. During my study, I was part of the team who facilitated the IPDP. The goal of our sub-strand was to promote scientific inquiry in our teachers' classrooms, with the hypothesis that students who engage in authentic scientific inquiry in school will be more likely to pursue science in the future.

The professional development project consists of activities both in the summer and throughout the school year, all of which we videotape for research purposes[8]. In the summer, we facilitate a two-week workshop in which the teachers engage in three main types of activities:

(1) minimally-guided scientific inquiry of their own
(2) discussions about video clips of students doing scientific inquiry
(3) discussions around various issues of teaching (e.g., lesson planning, assessment of inquiry, test prep, online resources)

During the school year, research team members regularly visit teachers and videotape their classes. Additionally, teachers attend bi-weekly small-group meetings in which teachers watch and discuss videos from each other's classrooms, engage in mini-inquiry questions, and troubleshoot problems of practice.

The IPDP is part of a larger professional development project in ECPS in which over one hundred science teachers participate. The other sub-strands consist of two-week content-based summer workshops (e.g., physics or environmental science), and the goal of those workshops is to increase the content knowledge of the teachers. All teachers in the larger project are assigned one of three science coaches and have the opportunity to attend workshops facilitated by the coaches that occur about once a month. These workshops are focused on strategies to incorporate inquiry into the classroom and are intended to supplement the summer workshops.

[8] Videotaped activities are permitted under IRB Protocol: 08-0583 – Studying the effectiveness of elementary and middle school science education outreach programs

Participant selection

In this study, I seek to compare how different types of educators interpreted the same clip. I chose to interview science teachers, science coaches, principals, and assistant principals because these are educators who work together to improve science teaching and learning. I expected that because my participants have such a wide variety of roles, I would see significant differences in how they interpreted the clip.

I started my study by interviewing all four science coaches (Valerie, Donna, Erica, and Sonya) in the professional development project in ECPS. I was especially interested in interviewing these leaders because they are science specialists whose primary role is to observe science teachers and help them improve their teaching. I also wanted to interview teachers, so I asked five teachers (Lynn, Will, Rachel, Deborah, and Denise) in our professional development project to be in my study. These are all teachers who are observed by one of the science coaches. Finally, I also interviewed school administrators because they are the ones who observe and evaluate teachers. I wanted to interview the administrators of the teachers in my study because they work with each other directly. I asked the teachers in my study for their administrators' contact information and emailed them directly. I was able to recruit the principal (Anthony) and assistant principal (Carol) at Lynn and Denise's school, the Assistant Principal (Tom) at Will's school, and a principal (Sheila) not connected to any of the teachers in my study.

Summary of video clip used in the interview

The clip that I used in the interviews is from a 3rd grade class in Pennsylvania[9]. I purposefully chose a clip from outside ECPS so that there is essentially no chance participants will know the teacher or the students. The lesson begins with a review of what the students learned about evaporation the day before, and then moves to an activity to explore condensation with the students. To introduce the activity, the teacher explains that the night before she got a glass of cranberry juice with ice in it and put it on a napkin on the table. Later, she noticed that the napkin was wet, and she wondered where the water came from. She asks the students to do an experiment to figure out where the water came from – each group gets a glass of ice water (that she has put red food coloring in to simulate cranberry juice) and a napkin. She asks the students to observe what happens and try to figure out where the water is coming from. While the students are doing the activity, the teacher circulates around the room and asks students probing questions.

In the first clip, the teacher stops at a table with two boys, and she asks them where the water came from. Daniel says it's from the air, but Casey says no, it has to come from the water inside the glass because otherwise all glasses would have to be wet all the time (and he points to some empty glasses that are dry). The teacher presses Casey, asking how it could have gotten from the inside to the outside of the glass. Casey responds by saying the water in the glass is taken up by the air and then goes back down the side of the glass, and that both him and Daniel are right. The teacher then asks Casey what it's called when water changes into a gas, and he

[9] Clip used with permission from BSCS (2011). *Videocases for Science Teaching Analysis* (ViSTA). vista.bscs.org,

answers water vapor. The teacher keeps asking about water vapor – What makes you think there might be water vapor in the air? … Do you think it makes sense that it's water vapor? … So do you think that the water vapor is changing back into a liquid, maybe? – and the students follow her leading questions, concluding that the liquid on the glass must be from the water vapor in the air. Daniel asks if they should write that down, and she says, “well if that’s what you think is going on, then yeah. You’re doing some really great thinking!”

The teacher goes to talk to some other groups, and then comes back to Daniel and Casey, which is where the second clip starts. She asks them to read what they’ve written down, which is “We think that it’s water vapor that turns into liquid water.” The teacher then asks the students what that’s called, and offers both evaporation and condensation before settling on condensation (with much teacher probing). The teacher then asks what might influence the condensation, and after a few guesses, they reach the intended answer “ice,” but Casey asserts that non-ice water would do the same thing as ice water. Ms. D tells Casey to go get a glass of water and try it out, and while he’s gone, Daniel notices that a closed coke can has condensation on it, which proves it can’t be coming from inside the glass. My own analysis of the clip is available in Chapter 2, and Appendix A contains a complete transcript for the clip.

Data Collection and Analysis

I videotaped and transcribed each interview. The interviews were semi-structured; I asked the participants the same general list of questions, but I asked follow-up questions depending on what the participant said. In the interview, I first described the context of the video I was going to show, essentially reading the first paragraph of the previous section.

Before showing the video clip, I told each participant "I am going to show you 2 ½ minutes of the clip and ask you to comment on what the students are doing in the clip." After showing the clip, I asked the following questions:

> Is this the kind of thing you'd like to see students doing in science classrooms? Why, or why not?
> What about it are you seeing that you like?
> In what ways would you like to see the students improve in their engagement with science?
> Is there anything else you noticed or would like to comment on?

As the participant responded, I asked follow up questions when I wanted the participant to be more specific (e.g., What student remark are you referring to? or What about that would make it better?) After we finished discussing the first clip, I showed the second part of the clip and asked the participant the same questions.

To characterize the differences in how participants attended to and interpreted the classroom episode, I analyzed the interview data using methods borrowed from Marton's (1986) phenomenograpy and Glaser and Strauss' (1967) grounded theory. I read through the transcribed interviews, with the goal of trying to understand how the participants viewed and understood the activities in each part of the episode, a central goal in phenomenography (Marton, 1986). I employed bottom-up coding by identifying and coding all of the salient topics that came up during the interview. I iteratively refined and expanded on the coding scheme as I read more interviews, similar to the "constant comparison" method in Glaser and Strauss' grounded theory. I used the individual codes to create broader categories, for example, *administrators*, *time pressure*, and *state standards* were all included in the *institutional constraints* category.

In my analysis, I will be making claims about how participants interpret different parts of the focal episode. I will not be making any claims about how participants think about classrooms *in general* because educators' views and attention are dynamic and context-dependent, as detailed earlier in this chapter. Instead, I recognize that participants' comments in their interviews are specific to the interview context and give evidence of only what a participant is attending to in the moment. Throughout my analysis and discussion, I highlight patterns in the *ways* participants are attending to the video. I do not make claims about how an individual attends to science lessons in general, or even this video as a whole, because all participants exhibited variability in how they attended within the interview.[10] Instead, I attempted to highlight the moments when participants attended in certain ways. In the discussion, I will summarize the patterns I found in how people attended; again, this section does not include statements such as "Rachel always attended to X" but instead things like "Sometimes participants attended in this way, for example, when Rachel attended to X." I considered the content of participants' speech when determining what they were attending to. Attending to the substance of student thinking required that participants identified and/or interpreted a student idea in the episode.

[10] Variability *within an individual* will be explored in Chapter 4.

Analysis

What kinds of things do educators attend to in the focal clip?

In this section, I will walk through the clip used in the interview, highlighting participants' reactions, interpretations, and reflections corresponding to each part of the episode. Specifically, I show the many different ways that participants engaged in watching the clip: what they noticed, what evidence they used to make claims, and what types of claims they made. I will show that not only did participants disagree about what was happening in the clip, but they actually framed the observation activity in different ways. I will explain how their engagement with the clip suggests that participants value different things in the science classroom, and in the discussion section I will explain why this has instructionally-relevant consequences.

Note that in this section, I move through the clip chronologically, sharing and commenting on participants' reflections to each part of the clip. One benefit of this organization is that the reader can follow the action of the clip more easily and compare participants' reactions to the same part of the episode. However, because the analysis is not organized thematically or topically, it may be more difficult for the reader to keep track of the patterns in the data. For this reason, I will summarize the analysis and comment on the patterns that emerged in the discussion section.

<u>Focal Clip: Part 1</u>

The clip begins with the teacher directing the two students' attention to a cup filled with ice water that is sitting on a napkin in the middle of their desk.

1. Teacher: So, guys, I have a question for you. I want you to look at this with me. I want you to look at this. Where is this water coming from on the outside?

2. Daniel: From the air?
3. Casey: (shaking head no) I think it's from in there (pointing inside glass) - because the-
4. Teacher: Okay, Casey thinks it's from in here. Let's talk- let's talk a minute about why you think it's from in there, Casey.
5. Casey: Because where-- I don't think there is as much- enough moisture to make it come from here. And like the glass over here or the glasses over there don't have any water on them, unless they've been like washed. They don't get it like this one did. And if it came from the air. It would have to- all glasses would be wet when-
6. Teacher: If it came from the air, all glasses would have to be wet.
7. Casey: All the time.
8. Teacher: All the time. Huh!
9. Daniel: Um, I think it's actually steam.
10. Teacher: Well, where's the steam?
11. Daniel: I don't know.
12. Teacher: How- where is the steam?
13. Daniel: In the air.
14. Teacher: You think there might be steam in the air?
15. Daniel: Mmm hmm.

Participants attended to and interpreted each part of the episode in very different ways. When judging the quality of the teacher's questions, for example, some participants noticed the *function* that the questions served, while others attended more to the wording of the questions. In an interview with Anthony, a principal at Oak Leaf Elementary School, he mentioned that he saw different levels of questions in the episode. I asked him if he saw examples of high level questions, and he responded:

> Anthony: Yes, yes. Um, I did see higher level questions, um, why do you think it happened, um, please explain your rationale for that, and um, those sort of things, and honestly, she didn't ask a lot of questions, so her activity to me was perfect, I thought she could have just stepped back a little bit more and let the students do it. But I do think she incorporated higher, um order questionings to where she had the students to explain, where do you think the water is coming from? So the students had to draw a conclusion based off the evidence that they had. This wasn't a total simple recall, this wasn't a yes or no answer.

In this response, Anthony is looking at what the questions are making the students do – they had to do more than "simple recall," they had to use evidence to "draw a conclusion." Anthony gives two examples of the higher level questions he saw: Why do you think it happened? Where do you think the water is coming from? Anthony explains that these are higher level because the students had to use evidence to draw a conclusion. Anthony contrasts these higher questions with the "yes or no" question, "Do you think it came from the sky?" This is a lower level question because it just requires a yes or no answer, which doesn't require any explanation. Here, Anthony is recognizing that different questions can have different roles and functions, and to him in this moment, the teacher is asking higher-level questions due to the cognitive activity the students must engage in to answer them.

The principal at Maple Leaf Middle School, Sheila, had a similar characterization of the teacher's questions:

> Sheila: I liked the fact that she was using higher order questioning, there was no low questioning where she was only um, eliciting one-word responses from students. The students had to think through the process and they had to give her more than one word to answer the questions, and they had to think about it, well the water didn't jump on the outside, didn't jump from the inside to the outside, where did the water come from. They had to actually think through that process in order to respond to her.

Like Anthony, Sheila attended to the type of answers the students had to give to determine the quality of the teacher's questions. She wasn't "eliciting one-word responses" but instead her questions required the students to "think through the process" of how the water got to the outside of the glass.

While Anthony and Sheila were happy that the teacher's questions were getting the students to think deeply, some other participants attended more to the substance of the students' ideas, noting that the students seemed to have some interesting ideas that the teacher didn't fully flesh out. For example, Rachel, a 6th grade science teacher at Redwood Elementary School, was pleased with the teacher's question "what's causing that to happen" because it "at least make the students try to think about the mechanism." However, Rachel zeroed in on a student idea in the beginning of the episode that she would have liked to hear more about:

> Rachel: Um, and then also when the young, when the young man said steam, it was kind of like, okay so you think, where's it coming from, and then he didn't get a chance to really, and then she went back to the other young man, is it coming directly from out of there? You know
>
> Colleen: So you're saying that he, that she didn't quite give him enough chance to like really elaborate on steam
>
> Rachel: Yeah, I don't think she valued his reasoning

Rachel noticed Daniel's "steam" idea and commented that he didn't get an opportunity to explain it, because the teacher quickly switched back to the other student. This suggests that Rachel didn't think the teacher did enough to get the student to explain his idea in the moment.

Valerie, a science coach in ECPS, also wanted to hear more about Daniel's "steam" idea. After discussing the first clip for ten minutes, I asked Valerie if she had any final comments on the first clip. She responded:

> Valerie: I'd be interested to see what they think about HOW the water, if they know why the water changed from one state to another. Um, she kind of, when she said, if it came from the air, all the glasses would have to be wet, and then kind of let that go. And the one kid says I think it's actually steam. I'm not sure if he's thinking about heat in steam, because it's kind of hidden in there, but what actually made the water change state, they didn't discuss. So I would have liked to have gone in that direction, but, I'm not sure if it comes next

Colleen: So right now they're just talking about where it came from

Valerie: Where it came from

Colleen: without talking about

Valerie: how it got there.

In this reflection, Valerie noticed that so far, the students have only talked about where the water came from, but not why or how it got there. She's attending to the substance of their explanation more than Anthony or Sheila did - it's not enough for Valerie that the students are giving more than yes/no answers. She wants to know more about what they're thinking. She also acknowledges that she has to interpret what the students said – she's not sure if Daniel is thinking about heat, but it's "hidden in there."

With these interpretations, Valerie is framing the activity of watching the episode in a different way than either Anthony or Sheila. She's looking for underlying meaning, trying to figure out what they're actually saying, and wondering what more is behind what they're saying. Note that from this data alone, we cannot be sure if Valerie would be satisfied with a more mechanistic but wrong answer, so it is unclear whether she is focusing primarily on mechanism or on just the correct mechanism. More data would be needed to tease this apart.

While Anthony, Sheila, Rachel, and Valerie looked to what the students were doing to judge the quality of the teacher's questions in this episode, some participants took a different approach. For example, Carol, the assistant principal at Oak Leaf Elementary School (where Anthony is the principal) identified the teacher's questions as being too "literal":

> Carol: Mmm, they were answering questions. However, I did notice that the teacher was asking literal questions
>
> Colleen: Okay
>
> Carol: She was asking what, why, when, basically that was all, why, where, the 3 W's and the H, which are literal questions. Now if she had said describe, if she would say compare, those would have been more critical thinking kinds of questions. But she did ask questions and then she did solicit answers from the students. She didn't tell them whether they were right or wrong, she had them you know just thinking about, now why is this happening, how is this happening, uh, why, where, you know, so they could answer what, when, where, why, how, uh…
>
> Colleen: And what makes those literal questions?
>
> Carol: Because literal questions is exactly what you observe, you don't have to draw inferences, it's based on what is there. So if she said, what, like they're looking at this, what, why is this here, and they had to come up with why, but now if she would have said describe what's here, or if she had used a word like uh, uh, construct, or even contrast what's happening here and what's happening there, or if she would have said analyze this, it's the terminology that she used. Literal questions are usually who, what, when, where, why, what is the 5 Ws and 1 H…. you know, literal comprehension is not bad in itself, it's just the lowest level of comprehension, so they did, you know, basic skills, which, you know, they had something to build on.

Here, Carol is evaluating the degree of "critical thinking" the students are engaged in by looking for specific words in the teacher's questions. Specifically, she describes "literal questions" which she identifies by the question stems (who, what, when, where, why, how). Carol asserts these types of questions don't require students to draw any inferences: they ask about "exactly what you observe." This assertion implies Carol thinks good questions get students to draw inferences; however, her examples don't support this stated goal. She gives an example of a literal question: why is this here? Carol contrasts this literal question with other questions using the "critical thinking" stems she mentioned earlier: describe what's here; contrast what's happening here and what's happening there; analyze this. She concludes her explanation by reiterating that the difference in question quality is the "terminology."

In watching the clip, Carol is focused more on first-word terminology of the questions rather than the substance of the question itself. Not only does Carol tell me that the terminology is the determining factor in question quality, but the examples she gives highlight that she is not thinking deeply about the substance of the questions in this moment. Carol's example of a literal question, "why is this here," requires mechanistic reasoning to answer, while her example of a higher level question, "describe what's here," is a simple observation question. Thus, her example of a higher question meets her own qualifications of a literal question: something that doesn't require inferences but is instead just what you observe. Carol's apparent inconsistency could be explained one of two ways: either she has a stable, non-canonical understanding of the word "inference," or her understanding of "inference" is context-dependent. From this data, we can't tell which it is, but we can say that Carol is not attending closely to what the students are saying in the clip, and in this moment, she means something non-canonical when she uses the word "inference."

In participants' reflections so far, we can already begin to see the great variety in how people are engaging with the episode. Participants have conflicting views on what's happening so far because they are framing the activity of watching the clip in different ways and using different evidence to make claims. As we saw, Anthony and Sheila framed the observation task as looking for the amount of student talking. They used the evidence of the students sharing their ideas and giving more than yes or no answers to say that they are engaging in deep thinking. Rachel and Valerie framed the observation task as wanting to understand student thinking: they noticed a specific student idea, that the water on the outside of the glass could be steam, and wanted to know more about it. Rachel liked the teacher's questions because they asked about mechanism, but Rachel and Valerie both thought the teacher should be probing the students more on their ideas because the "steam" idea isn't fully fleshed out yet. Valerie guesses as to what the student might mean ("I'm not sure if he's thinking about heat in steam, because it's kind of hidden in there"), recognizing that it's just a guess and she can't know from the evidence given. She would like the students to think much more deeply about the mechanism that is actually happening in condensation. Finally, we saw that Carol's framing led her to look at just what the teacher was saying when she used specific teacher words as evidence for teacher questions that promote critical thinking.

<u>Focal Clip: Part 2</u>

Now we will return to the clip to look for more patterns in how participants attended to the episode. After Daniel said he thinks "it might be steam," the teacher didn't press him any farther and instead redirected her attention to Casey. In Lines 3-5, Casey had explained why he thinks the condensation must be coming from the water inside the glass. The teacher decides to press him on that point:

16. Teacher:	So, Casey, my question for you is, if you think it's coming from inside the glass, how does it get from there to the outside?
17. Casey:	I think it's both. I think that him and me are kind of right.
18. Teacher:	You think you're both kind of right?
19. Casey:	The air takes it up and then it kind of makes it come back down onto this.
20. Teacher:	Okay, so let's think about that a minute. You think the air takes it up. What do we call that when- when it

	changes from liquid?
21. Casey:	Water vapor.
22. Teacher:	It changes it to-
23. Casey:	Water vapor.
24. Teacher:	water vapor. So do you think there's water vapor in the air around here?
25. Daniel:	Yeah.
26. Casey:	Yeah.
27. Teacher:	Yeah? What makes you think there might be water vapor in the air?
28. Casey:	Well, because there's mostly water vapor everywhere.
29. Teacher:	So you think there's a lot- there's water vapor everywhere.
30. Daniel:	So is it water vapor?
31. Teacher:	Well, Daniel, that's what we're trying to figure out. Does it- do you think it comes directly from inside out to here?
32. Daniel	No.
33. Teacher:	That- that doesn't- does that make sense?
34. Casey:	It has to go up and then-
35. Teacher:	It has to go up and then come-
36. Daniel:	(back down the outside?)
37. Teacher:	-down to here. Do you think it makes sense that it's water vapor?
38. Daniel:	Yeah.
39. Casey:	Cause there's also water in here. (pointing to the inside of the glass, above the water level, where it's also wet)

After showing the clip to Sonya, a science coach, I asked her if this is the kind of thing she'd want to see students doing in science class. She responded:

> Sonya: Exactly. Exactly, that is what you want to see, unfortunately we've gotten to such a point where we feel like we have to cover all of this material, but what we don't realize is if we teach them how to think, they'll cover it on their own… so when the young guy was like I think it's coming from the air and he was like wait, I think you might be kind of right there, I mean you saw him saying that might actually make sense, you know, we keep knowledge that makes sense, or we're able to access knowledge that makes sense to us. And so he did that, so what if I said to them, it comes from the air? I did them no service in giving them the answer, you know, oh I've got a halo on my head because I'm helping kids, but I did not help that child because I told him the answer and he didn't work it out on his own, so he'll probably never access it again past the test, so um, yes, that is the type of thing that you would hope to see, and that's lovely down in the, that's elementary level, but with that, that could happen all the way through and all the way up. Um, that particular

> dialogue. They, I don't want to say they geeked out, they learned off of each other, yeah she asked some questions you know, okay that's fine, but they, their thought processes, and look at them, they're fine, they're logical.

Here, Sonya makes several claims about what the students are doing in this episode as well as some more general normative statements about this type of teaching. She asserts that if we “teach them how to think, they’ll cover it on their own,” and gives an example from this episode, suggesting she thinks Daniel and Casey were “covering the material” on their own. Sonya’s focus on covering the material suggests that her framing of the observation task might include looking for correctness. She also states that Daniel said it makes more sense that the condensation is coming from the air, contrasting what happened with a hypothetical teacher who “told him the answer” that the condensation comes from the air, suggesting she thought the students constructed the answer for themselves in this episode. Sonya acknowledged that “yeah, [the teacher] asked some questions you know, okay that’s fine,” said in a somewhat dismissive tone that indicates she didn’t think the teacher’s questions played much of a role, and it was really the students’ “thought processes” that were front and center in this video.

Sonya’s interpretation is quite interesting because in the episode, it was the teacher who essentially told Daniel that it doesn’t make sense that the water comes directly from the glass (“That, that doesn’t – does that make sense?” in Line 33). Then, she did ask him if it makes sense that it’s water vapor, and he answered yes, but her tone in asking the question made it clear that was the answer she was looking for. Sonya is putting a lot of stock in the literal language that the students are using (e.g., Daniel responding “yes” when she asked if it made sense that it’s water vapor) without attending to other communicative cues and discursive meaning as the conversation progresses. She is also attending to correctness: Sonya praises the students for "covering the material" which is a very different thing than commenting on how they're engaging in scientific practices or how interesting their ideas are, which some other participants noticed.

Will, a science teacher at Evergreen Middle School, also noticed that the students were constructing knowledge, and thought the teacher did a good job of facilitating that process. Immediately after the first clip stopped, Will shared his amazement over the clip:

> Colleen: (stopping clip) Okay
>
> Will: Wow
>
> Colleen: So what did you notice about what the students are doing in that clip?
>
> Will: They were um, they were use-, excuse me, they were trying to come up with some, what we call it, what do they call those statements, um, hmm, causal arguments, for what's going on, which is great, which is spontaneous, they were running off, the person on the right, the younger guy, was, he was really trying to make sense of what he was seeing, and the teacher was there, which was, which is a good thing, so the directing, okay well let's look at this, well how do you think that happened, what do you think, and so those sort of questions now challenge the child to really look at their causal argument when they start to clarify um, clarify what's going on.

Like Sonya, Will was struck by the students' construction of ideas in the clip. He described what they were doing as "trying to come up with some… causal arguments," which is language we have used in our teacher workshops (although usually referred to as causal stories). We will return to the causal arguments in the next bit. Will also notes that one of the students was "mak[ing] sense of what he was seeing" with some teacher guidance. Will states that the teacher's guidance was "a good thing" because it directed the students to the flesh out their causal arguments more and "clarify what's going on." So far, Will is primarily using the teacher's questions ("how do you think that happened") for evidence of his claim that students are coming up with causal arguments, but later we see that Will was also attending closely to the students' ideas.

Later I asked Will to elaborate on the causal stories he was talking about eariler:

> Colleen: And so what was the causal story that you saw in there, were there multiple versions of the causal story, or?
>
> Will: Well one was there was steam, you know, that was coming up from somewhere, so that would put water in the air, that's something, I'm understanding that the steam eventually, you have to have something, some water somewhere that's in the air, so that's one casual story. Where that came from wasn't quite clear to me, although I might have missed it, and then the first guy who talked was discussing, he um, if I remember correctly, he was saying that, the uh, also I think that was when she mentioned evaporation with him, and he was, he was really working a lot of the terminology that was going on there, because she was saying, do you really think it's coming from, and he was able to say, well it must be somewhere around the glass, and then there was, I'm just trying to remember, I'd have to probably look at it again, but um, in each case, they had plausible causal stories that honed in on what was going on, that's what I was seeing.

Will admitted he couldn't remember all of the details of the students' ideas, but he specifically mentions Daniel's steam idea and spends some time trying to understand his causal story. Will's language indicates that he was engaging in an interpretive act when he was trying to figure out what Daniel meant when he talked about steam. Specifically, he switches from referring to Daniel's idea to his understanding of Daniel's idea: "Well one was there was steam… that's something, I'm understanding that the steam eventually, you have to have something, some water somewhere that's in the air" In this utterance, Will shows that he values trying to figure out what the students are saying; in fact, he suggests that if he watched the episode again, he'd have a better understanding of the students' causal stories.

Focal Clip: Part 3

Returning to the clip, the teacher continues to direct the students' attention to the concept of water vapor:

40. Teacher:	Do you think water vapor- okay, so we know that water can change from liquid to-
41. Daniel:	Solid.
42. Teacher:	to- to-
43. Daniel:	No wait, solid and water vapor.
44. Teacher:	and to water vapor. So we know that the liquid can change into a gas. My question for you is, can the gas change back into a liquid?
45. Daniel:	Yes, because I think this is water vapor.
46. Teacher:	So do you think that the water vapor is changing back into a liquid, maybe?
47. Daniel:	Yeah.
48. Casey:	Because we can see it then.
49. Daniel:	Yeah.
50. Casey:	We- we can't see it right away. But then it kind of-
51. Teacher:	Can you- can you see some evidence that the-
52. Casey:	Yeah.
53. Teacher:	that it's- that something has changed back into a liquid here?
54. Daniel:	Yeah.
55. Teacher:	Yeah.
56. Daniel:	Should we write that down?
57. Teacher:	(to another student who approaches the table) Well, that's okay. Just put down what you have now. That's okay.
58. Daniel:	Shall we- shall we write that down?
59. Teacher:	Well, I- if that- if that's what you think is going on-
60. Daniel:	Yeah.
61. Teacher:	Yeah, yeah, go ahead and write that, guys. I think you're really doing some great thinking here.

This snippet marks the end of the first 2 ½ minute clip, which is when I actually stopped the video and asked the participants to comment. Participants interpreted the nature and effect of the teacher's guidance in this bit in various ways. In my interview with Donna, one of the first things she said was that she liked the way she was getting the students thinking. I asked her to name an example of this, and she referred to the transcript and picked out the following bit:

> Donna: Let's see... Okay, like right here, "Do you think water vapor, okay so we know that water can change from liquid to..." the student says "solid" and the teacher said "to, to" "no wait, solid and water vapor." So he had to go back and like think about what he was saying because she was probing him to bring, to give more, so that's what I saw her doing. And a lot of times teachers don't allow that wait time, it's like you gave me your answer, let's move on, she was able to sit there and get more and more out of the kids even though she didn't let them just come up with one answer and walk away.

In this reflection, Donna cites the teacher move in Lines 40 and 42 as a good thing – the teacher's probing required Daniel to "go back and like think about what he was saying" and "give more." Interestingly, the teacher's move was not an explicit request for the student to explain more; all she did was stop in the middle of her sentence about water vapor and say "to, to," waiting for him to finish her sentence. Donna contrasts the teacher's move with a hypothetical teacher who doesn't give any "wait time," suggesting that she approved of the teacher's wait time in this bit. Donna praises her for getting the students to explain their ideas more.

To Donna, the evidence for the student "giv[ing] more" in this part of the episode is simply that he said more words when he added "water vapor" to his answer. This is not a deeper explanation or a different kind of answer; it is just two vocabulary words instead of one. It just so happens that the additional vocabulary word is the "correct answer" that the teacher is looking for, so it is likely that Donna is mainly attending to correctness in this reflection, although she could just be focusing on how much the students are saying. Either way, she is framing the activity of watching the clip here in a markedly different way than Will was in the last snippet

– while Will was trying to *figure out what the students meant*, Donna is listening for other things, including how much the students are speaking and possibly correctness of ideas.[11]

While Donna was generally pleased with the teacher's guidance in this clip, she also had a suggestion for the teacher. When I asked Donna how she'd want to see the students improve in their engagement with science, she responded that the teacher could:

> Donna: … Maybe tweak the questions up a little higher, using some more of the Depth of Knowledge, like we use here in the county…maybe she should have elaborated a little more on why he said solid [in Line 41], and then maybe give him an opportunity to maybe come up with water vapor on his own. So maybe that's an area where she could have probed him more on maybe, why did you choose solid, why do you think solid, and then I think he would have eventually been like, so solid and water vapor.

In this section, Donna suggests that the teacher could "tweak the questions up a little higher" and refers to the "Depth of Knowledge Chart" that the county uses (see Appendix B). Because Donna is recommending the teacher increase the level of her questioning, we know that she thinks her current level of questioning is relatively low.

I asked Donna to give an example of a higher level question the teacher could

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[11] Throughout this analysis, the reader may get the sense that I am saying that attending to student thinking is the only important thing, and attending to anything else is at odds with attending to student thinking. Indeed, this was what I thought when I began teaching this year, as discussed in the introduction to this dissertation. However, as I have realized, there are often situations where attending to other things can be in service of a broader goal of building a class around student thinking. For example, in this instance, an observer must first notice that the students are talking at all. However, other modes of attention can detract from attending to student thinking. For example, if an observer is looking for correctness, she will likely miss the substance of what the students are saying.

have asked, and she explained:

> Donna: Okay, let's see... I'm trying to think of the terms myself... because most people still look at that paper. But let's just use the word, analyze is the first one that comes to my head. Um... you know, how would you.... I'm trying to think… Analyze doesn't really go with it... I can get the sheet, if you prefer, cause um, I don't have them memorized, I admit that, I still have to refer, when I see it, I know how to use it, but I don't have the terms memorized, because they went from Bloom's Taxonomy, Bloom's Wheel, now to the Depth of Knowledge, so I gotta get that in my head, but it's still very similar, but using some words like analyze, critique, compare, um, distinguish. Like maybe she could have said, well how are you distinguishing your glass to the glasses at the other table, she could say distinguish. Or how do you distinguish between solid and water vapor, you know, using those terms like that is probably how she could tweak the questions a little bit more.

When I asked Donna to give an example of a higher-level question, she first named one of the higher-level terms she remembered from the chart ("analyze"). However, she couldn't think of a question that could start with analyze ("I'm trying to think… analyze doesn't really go with it"), so she offered to go get the chart for me to look at. Donna pointed out that the county used to use Bloom's Taxonomy, but they've changed to Depth of Knowledge, so she's not as familiar with it even though "it's still very similar." She then remembered some of the other words on the chart: analyze (level 4), critique (Level 3), compare (Level 2), distinguish (Level 2), and then thought of two questions that the teacher could ask using the term distinguish ("How are you distinguishing your glass to the glasses at the other table" or "How do you distinguish between solid and water vapor"). Note that the question examples she gives are both a Level 2 from the DOK chart (where level 4 is the "highest level"), but states that those examples could be used to increase the level of the teacher's questioning. This is evidence that to Donna in this moment, framing the observation task as looking any of the DOK terms, even though she is advocating for using higher-level terms.

This example from Donna illustrates the significant impact contextual factors have on how a person's framing. It is not surprising that Donna is focusing on the Depth of Knowledge chart because it is widely used in ECPS. Donna has learned from colleagues and superiors in the county that questions using the DOK terms promote critical thinking. Furthermore, she reports that she is encouraged to use it in observations. So, when she is looking at a science episode, it is likely that the DOK chart is easily "cued up" as she is trying to make sense of what she sees. In other words, Donna's framing of the observation task seems to be highly influenced by the DOK chart as a contextual factor. In the next chapter, I will explore the influence of one particular observation tool in more detail.

Returning to the data, Will also thought the teacher did a good job of guiding the students:

> Will: … so you know, so there were a lot of things they were just going-, the had it, but they just had to keep working at it, and with the prompting from the teacher, so to direct their inquiry along, to see where this actual water vapor is coming from… Um, but it was good, the kids actually came to an impasse, the little third grader said, well I just don't know where, what's going on there, but wasn't discouraged because then the teacher said, well remember this, or uh, what do you think this is happening, what's happening here, so um, the gist of it is children had an opportunity to speak what was on their mind, and then talk back and forth, it was a whole, you know, 3 of them, dialoguing, to come up with some sort of causal story for what's going on there. And I think that's um, that was the heart of what we like to get at, and I think, so that was good.

Here, Will acknowledges that the teacher is doing some "prompting" but thinks it is in the service of the students' inquiry. He notes that when the student admitted he didn't know where the condensation is coming from (referring to Line 11), the teacher reminded them what they know (referring to Line 40 and 44). To Will in this moment, the teacher's questions gave the students "an opportunity to speak what was on their mind" which helped them to construct the causal story together. Will then asserts that the interaction between the students and teacher is "the heart of what we like to get at."

While Will and Donna were happy with the teacher's guidance in this clip, other participants thought she was being too leading. For example, Erica, an ECPS science coach, reflected that the teacher didn't give the students enough wait time:

> Erica: Um, I would have liked to see more wait time from the teacher, um, it seemed as if, I don't know if she wanted to move onto another group or what, but I think more wait time would have allowed the students, because she said, well we know that this that and the other, so I don't know, was that for the camera, or was that for the teacher, for the students, because if the students know that, then I would like to see her use a different method to try and get them to say that themselves… So, they had that idea, but I didn't, I don't think they were really allowed to articulate that because a few times, she kind of interjected as they were kind of, you know, saying what it is they felt was going on. So um, that was the only thing that I saw that I didn't like. But the investigation, she started off really well because she was just waiting and just listening to what they said. But, I think that sometimes we get excited as teachers, and we're like, we want to bring it on home, and we see them, you know, at third base, and we're like, okay, let's bring it on in, bring it on in, so rather than doing that, maybe we give them a little bit more time to actually say what it is they wanted to say. Because the student that's on the side that she was sitting with was ready, I think he was ready to get it out, um, the other student seemed like he was trying to, he would have listened to the young man, I would have liked to hear the young man explain it to him, rather than the teacher.

Here, Erica explains that the teacher's lack of wait time prevented the students from being able to share their ideas. She gives an example of the teacher's pushiness in Line 40 and 44 which Erica describes as "well we know this that and the other." Recall that Will cited this same teacher move as helping the students create a causal story, but here, Erica suggests this move is actually getting in the way of the students "say[ing] what it is they wanted to say." Erica gives two possible reasons for the teacher's move in Line 40 and 44: she might have "wanted to move onto another group" or it might have been "for the camera." In doing this, Erica is adding on a layer of interpretation not seen in Will's reflection – she is considering possible motivations that might be behind the teacher's behaviors. In this instance, Erica is framing her engagement with the clip as *trying to figure out why the teacher behaved in the way she did*.

From Erica's response, we can also get information about what lens she is using to think about student ideas. She wants the teacher to give the students more wait time – what is she hoping to see the students do in that wait time? She says that instead of the teacher recounting "what we know," she would have liked to see the teacher "get the students to say it themselves," suggesting she wanted to see the students come up with the correct answer. Later in her reflection, Erica compares teacher questioning to playing baseball – when we see that the students are close to the answer, we get excited and "want to bring it on home" which might cause us to be more leading than we'd like. She offers an alternative of giving the students "a little bit more time to say what they wanted to say." This might sound like Erica is interested in whatever the students have to say, but she followed that with saying she thought that Daniel was "was ready to get it out" and she "would have liked to hear the young man explain it to him, rather than the teacher." These comments suggest that Erica was primarily interested in what the students had to say because she thought they were on the verge of saying the correct answer.

Like Erica, Lynn also thought the teacher was being too leading, but unlike Erica, Lynn took issue with the fact that the teacher was leading them to a “correct observation”:

> Lynn: I felt like she was pushing them to an answer a lot faster than they were ready to go, like she says, well we know water can, we know this, so that, I, it kind of, and then he said should we write that down, and she said well you should write down what you observe, but she had actually been leading them to a correct observation, which at that point I guess I... I think I would have gone a little bit more, when he said steam, too, so what happens when you see steam, and see if they could go, on the two things they were observing, that one is steam, and one was this is not happening on everything else, but only happening on that glass, and see if maybe they would have pulled out the components of what was actually going, what was different about that glass, and you know, that kind of stuff.

Here, Lynn refers to two specific student ideas: Casey’s idea that it is steam, and Daniel’s idea that it doesn’t happen on all glasses. Lynn wants to know more about these ideas, and she thinks they may have been able to “pull out the components of what was actually going [on].” In this statement, Lynn suggests she is looking for students to get to the correct answer, but juxtaposed with her concern that the teacher was “leading them to a correct observation,” we see that Lynn may be feeling a tension between wanting the students to get the correct answer and wanting them to share their ideas. Even with this potential correctness goal, we see Lynn do something quite different from Will and Erica: she refers to specific student ideas and wants to know more about them, while Will and Erica focused more on general discussion dynamics. Therefore, we know that her Lynn is at least partly framing the observation task as *trying to figure out what students mean*.

I next asked Lynn why she thought the students weren't ready to go along with the teacher in this clip. She explained that she thought the students didn't have time to really think through their observations:

> Lynn: Um, I guess, because I felt that way with her, I felt like she was jumping into stuff before I was even getting what they were saying, and then when the little guy keeps saying, well is that what we should write down, should we write that down, so to me, they were looking to her for an answer at that point rather than really thinking through those initial observations they had, I don't know. Just my general feeling was like she was not maybe listening, she was listening some, but when he made that comment, I would have jumped on that comment I think, of course you know, in hindsight, I think I would have jumped on that comment when he said, or otherwise it would be with all the glasses, and then say, so what's different, what do you see about this glass, you know, and then try to pull the steam thing together, we could have taken their two observations and see if could, anyway.

Here, Lynn again mentions that she wasn't even "getting what they were saying" because the teacher was moving too fast. She also thinks that the students were just looking to the teacher for an answer, and her evidence for this claim is that Casey kept asking "well is that what we should write down?" Lynn is attributing an epistemological stance to the students – to Lynn, the students are not engaging in an authentic inquiry discussion but instead just trying to figure out what the teacher wants them to write down. Lynn continues by referring again to Daniel's idea that if condensation came from the air then all glasses would have to be wet. She speculates that if she were the teacher, she would have "jumped on that comment" and asked him what's different between the glass in front of them and the glasses elsewhere. This question is quite leading, and Lynn is likely thinking about how she could get Daniel to the "correct answer" that water *and ice* is necessary for condensation. So again, Lynn says she wants to hear the students' ideas but also seems to have a "correct answer" in mind.

After talking more about the first clip, I asked Lynn if there was anything else she'd like to comment on before moving on to the second clip:

> Lynn: I don't think so. And I don't mean to sound critical and stuff, because you never know what's been going on, but sometimes I feel like, and maybe it's because I see it in myself, like I start putting words in kids' mouths, because I know where I want to go, but I don't, that's not necessarily where they want to go, so I'm sort of interpreting it in that way, and uh, I'm trying harder to not do that, because a lot of times they're going in a different direction, but equally valid, more valid direction, like I felt that he was getting to a really cool idea with that, and it was sort of getting, that observation was not given the due that it probably should have been given for it to develop a little bit better, so. that's all, yeah

Like Erica, Lynn empathizes with the teacher in this moment. She says "you never know what's been going on," indicating that Lynn realizes there is context and motivations behind decisions that we're not seeing. Lynn realizes that she also sometimes "put[s] words in kids' mouths" and interprets students' ideas to align with a particular content goal. However, she is trying to curtail that tendency because she knows that students are often "going in a different direction, but equally valid, more valid direction." Here, Lynn is explicit about her tension between leading students to the correct answer and wanting to follow students' ideas even if they are not what she had in mind. She starts by saying the students' direction is "equally valid" as her content goal, but then corrects herself and says the students' direction is "more valid." Lynn's focus here on listening to and following students ideas' (regardless of correctness) stands in contrast to Erica's desire to see the students get to the correct answer themselves.

Rachel also wished she could have heard more of the students' ideas in the clip. Like Erica and Lynn, Rachel thought the teacher was too leading:

> Rachel: Yes, I think, also I think when she said water vapor, I don't think the students were necessarily 100% comfortable with the word water vapor
>
> Colleen: What makes you think that?
>
> Rachel: Because um, when they were describing what they were seeing before, it was a fluid, like idea coming out, but then they had to keep saying, what, or, or the water vapor, because she planted it, or said water vapor in, and like the student said, should I write that down? *Yeah, water vapor, if that's what you think, yeah* (in teacher's voice). But then when he was saying steam, it wasn't, *Yeah, write that down if that's what you think* (teacher's voice), so.
>
> Colleen: (laughing) Mmhmm.

Here, Rachel says that the teacher "planted" the word water vapor, and she doesn't think the students were comfortable using it. The students started by discussing their own ideas about what they were seeing, but then the teacher encouraged them to say water vapor. Then, when the student asked if he should write down water vapor, the teacher said to write it down "if that's what you think." Rachel said this in a sing-songy, mocking tone, indicating she thought the teacher was being overly encouraging to the students about this idea instead of wanting them to write down what they really think. But with Daniel's steam idea, Rachel noted that the teacher didn't encourage him to write down that idea.

Rachel continued talking about the teacher's response to Daniel's steam idea, quoting the teacher's question "where's [the steam] coming from?" matching the teacher's [incredulous] tone.

Rachel continues by reflecting on what the teacher valued in the clip:

> Rachel: Um, and then also when the young, when the young man said steam, it was kind of like, okay so you think, where's it coming from, and then he didn't get a chance to really, and then she went back to the other young man, is it coming directly from out of there? You know
>
> Colleen: So you're saying that he, that she didn't quite give him enough chance to like really elaborate on steam
>
> Rachel: Yeah, I don't think she valued his reasoning, but then when he said water vapor, then she valued that, and even encouraged him to write it down.
>
> Colleen: And how exactly can you tell that she valued one over the other?
>
> Rachel: Cause she told him that he could write it down, and then she was like, oh, yeah, yeah, whereas she was like-

In this exchange, Rachel is making claims about what the teacher values in the episode. Her evidence for what the teacher values is twofold: one, she notes that the teacher only wants the students to write down the correct term, “water vapor,” and two, Rachel comments on the *way* in which the teacher responded to the correct idea in Lines 58 – 61. When Daniel asked the teacher if he should write down “water vapor,” she responded “if that’s what you think is going on, yeah” When Daniel answered “yeah,” the teacher used a very energetic and positive tone to say “yeah, yeah, go ahead and write that guys,” which is what Rachel is quoting in this clip. Rachel continues to mock her tone when citing this line, indicating her dissatisfaction with how the teacher responded to Daniel.

Rachel continues:

> Rachel: I know teachers, we put on these faces and we try to act like confused, but if you're confused, you ask questions, and it's like, where's it coming from, and then it was like, back to you, you know, it was like the news, back to you John.
>
> Colleen: laughing

> Rachel: So it's like one idea was closer to what she wanted, and she tried to like, harness that idea, what are you thinking, tease it out, whereas the other one, and then there was a possibility they could have connected, they were just saying different words at the time, and then the word water vapor, both of them were like, I wasn't really saying water vapor, I don't know if water vapor is it, I think it's the air, this is this, but we'll just say water vapor, because clearly, that's what you want, you know, kids know how to play school.

Like Lynn, Rachel identifies with the teacher, recognizing that “we put on these faces” sometimes, but Rachel suggests an alternative: if you’re confused about a student’s idea, ask the student real questions about the idea. Rachel goes on to explain why the teacher might have been so leading: Casey’s idea seemed to be closer to what the teacher was looking for, while Daniel’s steam idea wasn’t connected, according to the teacher. Rachel points out that Daniel’s idea may have been connected to Casey’s idea, but they weren’t given a chance to explore that. Instead, the students picked up on the fact that the teacher wanted them to talk about water vapor, so they used the term water vapor in their explanation without fully understanding what it is. Rachel calls this behavior “playing school.”

In this moment, Rachel is framing the observation task very differently than other participants: she is thinking about how the *students* are framing what’s happening in the classroom. This move shows that Rachel isn’t just relying on what students are *saying* as evidence of what they’re *thinking*. Instead, she is recognizing that in watching a classroom episode, you must engage in a process of interpretation to make claims about what the students are thinking and doing, and this interpretation is informed by many sources of evidence.

While Rachel didn’t find value in the students’ use of the term “water vapor,” Sheila shared that she actually liked that the students were using science vocabulary terms. After showing her the first clip, I asked Sheila what she noticed about what the students were doing in the clip. She replied with a list of behaviors that she liked, including that they were "using their vocabulary, steam, vapor, um, I thought that was excellent." A few minutes later, I asked her to elaborate on this:

> Colleen: Mmmhmm, um, you mentioned that you liked that they were using vocabulary words, like steam, and
>
> Sheila: And vapor, mmmhmm.
>
> Colleen: And what do you like about that?
>
> Sheila: That, when you're using that vocabulary, that means, to me, you have a deeper understanding of the concept, we're no longer using the basic terms of how to explain something, we're able to talk the terminology, so for instance, when they're listening to the news, and the weather man is talking about vapors and air and those things, their visual may go back to that particular concept and they'll be able to understand what the weatherman is trying to explain to them, versus you know, the basic terms, and not only that, they'll be able to explain it to someone else.

Here, Sheila reiterates that she liked that the students were using vocabulary words. To Sheila, using vocabulary means "you have a deeper understanding of the concept," because you're not having to rely on the "basic terms" to explain something. Sheila notes that the students will be able to understand the weatherman better because they know terms like water vapor.

Sonya also was pleased with the students' use of vocabulary in the clip:

> Sonya: I also like, and I might be combining the clips, but they were able to say it in different ways.
>
> Colleen: Mmmhmm, so what were some of those different ways?
>
> Sonya: So um, first it was the air, then our vocabulary got a little bit more specific and we started talking about water vapor, so I could actually see the transition and look at that, that's in one class, that's not in years, it's not in grade levels, and even in uses of the vocabulary, vocabulary words, that's the

> transition piece that I, that you could see, you could actually see levels right here, you know of them moving up the levels.

In this reflection, Sonya is saying that the students are “moving up the levels” because they are using more specific vocabulary. It is unclear exactly what she means by “moving up the levels,” but she clearly thinks it’s a good thing – “look at that, that’s in one class, that’s not in years.” Sonya’s and Sheila’s claims about student understanding are in stark contrast to Rachel’s: Rachel saw the students’ use of vocab to be evidence of the students “playing school,” while Sonya and Sheila uses their use of “water vapor” to be evidence of the level of student understanding of the concept. This difference in interpretation highlights how participants are framing the activity of watching and interpreting the clip very differently. Sheila and Sonya are making claims about student understanding based on the words students are using, while Rachel and Lynn use the students’ words as part of a larger body of evidence. Furthermore, Lynn’s and Rachel’s claims are not just about what students understand or don’t understand; Lynn and Rachel are also thinking about how the students are framing the condensation activity.

Focal Clip: Part 4

Next, we return to the clip to learn more about how participants interpreted the students’ use of vocabulary in the episode. After discussing the first clip in the interview, I showed participants the second 2 ½ minute clip. This clip picks up several minutes after the end of the first clip. The teacher circulated around the room while Casey and Daniel have had time to record their thoughts on a worksheet. The teacher returns to Casey and Daniel to ask them about what they have written:

62. Teacher: Okay, Daniel, are you done drawing what's going on

here? Okay, I need you guys to see if you can give me an explanation of what's going on here and what it's called, okay? "We think that..." what?

63. Daniel: It's just water vapor that turns back to liquid water.
64. Teacher: Yeah, do you- there's a word for that. Do you have any idea what it might be called?
65. Daniel: No.
66. Teacher: Any idea what it might be called?
67. Daniel: Evaporation.
68. Teacher: Well, is this evaporation?
69. Daniel: Condensation.
70. Teacher: Hm, where did you get that word?
71. Daniel: I just heard it before.
72. Teacher: You heard it before, you guessed. Well, is it- it- is this evaporation?
73. Daniel: No.
74. Teacher: if water vapor turns back into liquid?
75. Daniel: No.
76. Teacher: Okay, so do you think it might be called condensation?
77. Daniel: Yeah.
78. Teacher: Well, both evaporation and condensation are going on a lot of times when it- with rain, with clouds. So, what do you think this one might be called?
79. Daniel: Condensation.
80. Teacher: Well, let's- let's come back and talk about it as a group and see if other people think that- that that makes sense, too.

While showing Carol the second clip, she asked me to pause the clip at about this point. She then said:

> Carol: See, when she asks those questions, he can say yes or no. So, is this condensation? No Is this con-? Yes. See, if you don't ask the questions right, you can easy yes or no. If you say describe, or analyze, or construct, or explain, explain to me what you would have to do to- then you can solicit more from the students.

Here, Carol says that it is “easy” for the students to answer these questions because they are “yes or no” questions. She asserts better questions would include “describe, or analyze, or construct, or explain” – these are the critical thinking stems she cites elsewhere in her interview – because they would “solicit more from the students.”

With this characterization of the teacher's questions, Carol is attending to the stem of the question as evidence of quality. A question that begins with "Is this-" is an easy yes or no question, while a question that begins with the stems she cites would require inference and critical thinking. Much like before, Carol attends mostly to the teacher's utterances when evaluating sophistication of students' responses.

Many participants commented on the role of vocabulary in this clip. For example, Will was impressed with the students' use of vocabulary:

> Will: Secondly, they actually said that you know, said that liquid came out of, liquid came on the glass, so there must have been liquid that came from the air onto the glass, so they c-, they were able to put a word to that that they had, cause I think he heard, he had heard the word somewhere, so he had condensation. So he's connected a word with an actual phenomenon that he's actually seen, so that really bolsters his vocabulary and understanding of it.

Here, Will likes the students' use of the word condensation, because they've already seen the phenomenon that it describes, and they have already articulated their causal story that "there must have been liquid that came from the air onto the glass". For Will, the student's connecting the word condensation to the process at this point in the activity "bolsters his vocabulary and understanding" of the process. This is similar to how Sheila and Sonya thought the students' use of the term "water vapor" was evidence of increased understanding in the last clip, although here, Will emphasizes the connection of the word with seeing the "actual phenomenon." Taken together, the use of the word "condensation" with the fact that the students have observed the process is evidence for Will of "bolster[ed]" understanding of the concept.

Other participants, however, were not as happy with the students' use of vocabulary at this point in the lesson. For example, Lynn explained that she was confused by the focus on vocabulary in this part of the clip:

Lynn: I'm a little confused about the vocabulary thing because it sounds like, do they know those words condensation and evaporation?

Colleen: They've talked about evaporation previously, I don't know if they've used the word condensation

Lynn: Okay, so, um...

Colleen: And what confuses you, or what-

Lynn: Well, I guess I'm not sure why she would be focusing on the vocabulary at this point, because that doesn't seem to relevant right now, that it seems like she, you know, it doesn't do us a lot of good to call it condensation when we're trying to figure out what the mechanism is that's going on there, so I was um, just a little bit surprised that she was leading him into, could this be cond- because I guess I would be focusing a little bit more on what the heck is going on, and then she did seem to go to that when she talked to the other little boy when she said would this be happening with another glass of water without the ice in it and stuff, and then he made the observation, , but I'm also not sure, when he said there's a lid on this one, he said it wasn't happening to that one cause there's a lid on it, so it, still sounds like the whole mechanism they're- yeah I guess I'd be focusing a little bit more on the mechanism and not even worry about the word condensation and all that kind of stuff at that point, you know… but I'm not sure the ideas, the ideas don't seem to be coming from the kids so much as they do from her.

Colleen: And what makes you say that?

Lynn: I'm not sure, um, I guess cause when she's saying, and would you call this condensation, it's like well I don't think that's what he was really thinking about, was the term for it right then, he wanted to talk about what was going on.

In this reflection, Lynn is baffled by why the teacher is focusing on vocabulary at this point in the activity, because vocabulary isn't "relevant" yet. The students are still trying to figure out "what the heck is going on," and attaching a word to the phenomenon at the point doesn't help their understanding at all. Lynn cites evidence that the students haven't figured out the mechanism yet: "when he said there's a lid on this one [soda can], he said it wasn't happening to that one cause there's a lid on it[12], so it, it still sounds like the whole mechanism they're-." Lynn doesn't finish this sentence, but she uses that idea to lead into her decision to focus more on the mechanism, suggesting that she thinks their current explanation isn't sufficient to warrant bringing in vocabulary. The focus on vocabulary in this moment certainly isn't helping the students understand the phenomenon, and could even be hindering their understanding since they don't have the space to continue discussing what is actually going on in the phenomenon.

Lynn's attention here is similar to Rachel's attention earlier to how the students are engaging in the activity at hand. Specifically, Lynn is noticing that the Daniel wanted to talk about what was going on in the demonstration, and that the teacher's probing is pushing him away from that sense-making. The students respond to the teacher's questions about vocabulary, but Lynn doesn't think the vocabulary words have much meaning for the students in this moment; in fact, for Lynn, the students' use of vocabulary in this clip is actually evidence that they are *not* engaging in an authentic activity here.

After watching the second clip, Rachel noted that at one point, Daniel seemed to be saying it was evaporation, and then the teacher said it was condensation, so Daniel changed his answer to condensation. I asked Rachel what she thought about that part:

> Colleen: So you mentioned when they were talking about condensation or evaporation or condensation, what did you think about that part, toward the beginning?

[12] My interpretation of Casey's idea was that the soda can has a lid on it but *does* get condensation on the outside of it, "proving" that the water can't be coming from inside of the can or glass

> Rachel: I thought it was just vocabulary words that they haven't owned, they were (inaud) she's like, and he said I think Daniel said, I think it's condensation, she's like, what is condensation? where did you hear that word from? and then that's it, there wasn't anything else for it, so it's like if that's it, and you can't explain condensation or something, how is that your answer that you're sticking with as like the reason why, but then what condensation is, is not evaporation, so they had the lid on the top of the can, it's not, so that right there, it's like if we could take away the vocabulary words, they'd probably be more, and able to talk, they probably would have been more like, into their reasoning of what they think is happening, but I think the words kind of stifled their ideas, to a sense, you know, sometimes you have to feel like you're right, so maybe they felt like they were right with using those words. And then um, I don't know about Casey, I think Casey wasn't still sure about what he was, he was thinking again, because I think the words came in and kind of stifled their process.

Here, Rachel asserts that the students haven't "owned" the vocabulary words, and her evidence is that the students can't explain what condensation is. This claim is similar to Lynn's argument that "it doesn't do us a lot of good" to use the word condensation if we don't understand the mechanism yet, but Rachel is making a more explicit point about what students are saying versus what they're thinking. Specifically, Rachel is attending to how the students are engaging with the teacher in this clip – yes, Daniel is saying the process is called condensation, but he doesn't really know what he's saying; he's just saying it because it's obvious that's what the teacher is looking for.

Rachel goes on to say that if the vocabulary words were removed from the conversation, the students would actually be able to reason more freely about what is going on. To Rachel, the words actually seemed to "stifle" their ideas, because when you're using vocabulary words you're more focused on being right than reasoning about what you actually think. Again, Rachel has a level of attention and analysis of the clip that is different than most participants: she is thinking about the student utterances as only one piece of evidence of their understanding. This mode of attention is evidence of Rachel framing the observation task in a particular way: Rachel knows that she must think about how the students are experiencing this interaction and consider many other pieces of evidence to interpret the clip and make claims about student understanding.

Donna was also unhappy with the extent to which the teacher was guiding the students in the second clip:

> Donna: Mmm, I still like the probing on how she questions them, but I started seeing her give more of the answer, not necessarily give the answer, but kind of let the kids know that's not right, the way she would "question" them.
>
> Colleen: What is an example of that that you saw?
>
> Donna: … I mean I guess it depends on interpretation, like she says, any idea what it might be called, Daniel said evaporation, and she said, well, is this evaporation? So that kind of might make a kid be like, maybe it's not evaporation, so it depends on, there's so many factors, it's how you question, the way you say it, I think she should have just asked it without making it be geared toward not being correct, so that automatically let the student know, that's not the right answer, that's what I got from that. And then, let me make sure it was the same child, then he changed his answer, so again, maybe time restraints, but if he said evaporation and the teacher knows that wasn't correct, again, I think that's where she should have pulled out and asked him why he thought evaporation instead of just kind of probing him, letting him know in about so many words that's not right.

In this reflection, Donna explains that she thinks the teacher gave away the answer while she was "questioning" them. The example she gave was from lines 66 – 69, when Daniel incorrectly guessed that the process was called evaporation, and the teacher responded, "well is this evaporation?" Donna notes that her question let Daniel know that his first guess wasn't correct, and he then changes his answer to condensation. Donna identifies some of the non-verbal cues that students might use to read the teacher – "how you question, the way you say it" – which can alert a student that their answer was incorrect. Donna then checks the transcript to make sure it was the same student who then changed his answer, which seems to confirm for her that the teacher's probing caused the student to know he was incorrect.

In this reflection, Donna is doing several sophisticated things. Like Rachel, she recognizes that a student saying something doesn't necessarily mean they understand it because there are other interactional and contextual dynamics at play. Donna's explanation of Daniel switching his answer seems to be another example of Rachel's assertion that the students are "playing school." Like several other participants, Donna also speculates about contextual factors that could be influencing the teacher's decisions – she may be operating under time constraints that would lead her to push the students more than she would if she had more time.

Next, I will discuss patterns and themes that came up during the interviews.

Discussion

In this section, I will summarize some of the important differences in *what* people saw when they watched the clip. I will also discuss the differences in *how* people framed the activity of interpreting the clip: what features of the episode they noticed, what *types* of claims they made, and what they took as evidence for their claims.

Differences in participants' interpretations of the clip

In this section, I will summarize some of the most significant differences in how participants interpreted the clip. The headings below represent topics that emerged frequently in the interviews, and that involved clear patterns of disagreement.

Students' use of vocabulary

All participants attended to the students' use of vocabulary words; what differed was whether they thought it was a positive thing. Some participants saw the students' use of vocabulary as *evidence* of student learning. For example, Sheila said the students' use of the word water vapor shows they have a "deeper understanding of the concept." Will also liked the students' use of vocabulary, but for a slightly different reason: instead of being *evidence* of a deeper understanding, he saw vocabulary use as something that actually *furthered* their understanding of the phenomenon of condensation. Other participants expressed that they thought the vocabulary was actually inhibiting their science learning. For example, Lynn shared that she was confused by the teacher's use of vocabulary and that she would be focusing more on "what the heck was going on" before introducing vocabulary words. Rachel was even more explicit about her [disapproval] of the use of vocabulary: she said that Daniel's use of the word condensation was actually "stifl[ing]" his ideas and reasoning process.

Quality of Questions

One topic that came up often during all of the interviews was question quality. Participants had significantly different ideas about what constitutes high quality questioning in a science classroom, and whether the teacher in the video was asking high quality questions. It is no surprise that teachers, science coaches, and administrators brought up issues of questioning because it shows up in many reform documents (e.g., NRC, 2012) as well as district evaluation instruments such as Danielson's (2013) Framework for Teaching[13]. In discussing the classroom episode, many participants used language similar to the FFT and reform documents to describe what they think good questioning is. However, participants had conflicting opinions about whether the teacher in the episode is engaging in high quality questioning.

Some participants focused primarily on the terminology of the questions when assessing their quality. For example, Donna judged questions to be high quality when their stem word came from the Depth of Knowledge framework. Similarly, Carol considered "who, what, when, why, and how" questions to be low quality ("literal questions") and questions starting with "describe" or "compare" to be high quality ("critical thinking question"). In these judgments, both Donna and Carol are attending to the wording of the question to determine whether the question was high or low quality. While Donna and Carol attended to primarily the wording of the questions to determine question quality, other participants focused more on the function of the question or the type of response required by the question. Because participants considered different things to be evidence of the quality of questions, some participants disagreed over whether certain questions were high quality (and for different reasons). For example, there was significant disagreement as to whether the question *Why is the phenomenon happening?* was high- or low-quality: Carol thought it was low-quality because it started with the word *why*; Sheila thought it was high-quality because it required more than a one-word response; and Rachel thought it was high-quality because it demanded a mechanistic explanation from the students.

[13] See Appendix C for Danielson's (2013) Framework For Teaching

Teacher guidance

Science education reforms charge the teacher to use less direct instruction and be more focused on the students' thinking. Teachers are to create an environment where students are constructing their own scientific explanations, and the teacher is there to support the students in doing this (NRC, 2000). The National Science Education Standards (NRC, 1996) state that "Emphasizing active science learning means shifting emphasis away from teachers presenting information and covering science topics (p. 20) and shifting more toward "inquiry-oriented investigations" where students interact more with their peers than their teacher. The teacher should not be giving the students the answer but instead encouraging students to construct answers for themselves.

Consistent with education reforms, most participants in my study asserted that a teacher should not just give the students the answer in science class; instead, teachers should be asking questions to find out what students think about the scientific phenomenon. However, educators disagreed strongly as to whether the teacher in the clip was giving the students the answer or effectively soliciting student thinking. Some participants shared that the teacher was doing a good job of giving the students time and space to share their ideas without the teacher giving them the answer. For example, Will said he liked how the teacher was getting the students to share their ideas and come up with causal stories. Similarly, Sonya liked that the teacher gave the students space to "cover [the material] on their own" and contrasted this teacher to a hypothetical one who just tells the students the answer. Donna had mixed feelings about the teacher's guidance: in one part of the episode, she thought the teacher did a good job of giving the students space to share their ideas, whereas in another part, she commented that the teacher was essentially giving the students the correct answer without letting them think on their own. Lynn and Rachel both thought the teacher was being too leading throughout the entire 5-minute episode.

Differences in how participants attended to the episode

Not only did participants have different interpretations of what happened in the clip, but they were actually *attending to different things* as they observed the episode. In some moments, participants primarily attended to correctness of ideas. For example, when Sonya praised the students for "covering the material" she was attending to the fact that the students' ideas were in line with the correct answer. Other times, participants focused on who was doing the talking and when. For example, Erica noticed that the teacher was doing a lot of the talking and wanted to see the students discussing and questioning more. We also saw some participants look for particular words or terms, for example when Carol and Donna looked for specific questioning stems.

Throughout the interviews, sometimes participants focused more on the teacher, seemingly approaching the task as an evaluative one. For example, Sheila noticed that the teacher used higher-order questioning and praised her for that. Similarly, Carol noticed the teacher used "literal questions" and criticized her for that. While Sheila and Carol disagreed about whether the teacher's questions were good ones, the way they approached the task of reflecting on the clip in these examples is similar: they were attending to the wording of the teacher's questions and making judgments from that; neither one attended to the substance of the students' responses to make those judgments.

While some participants attended mostly to the teacher, others attended more to the substance of students' ideas, interpreting the ideas when they were understandable and trying to figure out what the student meant when an idea was less clear. For example, when Valerie heard Daniel's idea about steam, she reflected "I'm not sure if he's thinking about the heat in steam, because it's kind of hidden in there." This suggests an underlying assumption that what students say must be interpreted, and sometimes what a student says doesn't necessarily correspond directly to what a student is thinking. Some participants attended not only to the substance of student thinking but also to how the students were approaching the activity. In other words, was the activity an authentic inquiry task for the students, or were they simply trying to guess the answer the teacher was looking for? For example, Rachel said she thought Daniel was "playing school" in the activity, which she concluded due to her attention to how Daniel responded to the teacher's questions.

Conclusion

Before making concluding remarks, I'd like to share one more piece of data from an interview with a principal in ECPS. At the end of my interview with Sheila, I started to wrap up the interview by expressing my appreciation for her participation in the interview. Sheila's response caught me off guard:

> Colleen: Well, thank you so much for sharing your thoughts with me, it's really great to hear just all the different perspectives
>
> Sheila: You keep getting different ones? Nothing in common?

> Colleen: Well I mean there's definitely stuff in common, but you know, people, when you watch a video, there's lots of different things that you could say about it, and it's just so interesting to see-
>
> Sheila: But is there somebody who said they didn't like it?
>
> Colleen: Oh, most people think that um, for the most part-
>
> Sheila: It's excellent!

Sheila was genuinely shocked to hear that other participants had different perspectives. In her mind, the episode was such a perfect example of good science teaching and learning that she could not believe that anyone wouldn't agree with her.

This anecdote highlights one of the driving motivations for this dissertation, and suggests serious implications for practice. The primary problem with vague notions of instruction vision isn't that leaders don't agree on what should be happening in the classroom, but it's that *they don't realize they don't agree*. In order to make any progress toward more sophisticated science teaching and learning in schools, educators must first realize that misalignments in vision exist. To do this, educators can't just talk about teaching and learning in the abstract, but they *must* ground their discussions in artifacts of classroom practice such as video or student work. When educators engage in discussions around classroom artifacts, misalignments are likely to emerge not only in their interpretations of the artifact but also how they are *framing* the activity of interpretation, as we saw in the data. To achieve science education reforms that require teachers to attend to the substance of student thinking, teachers *and* leaders must shift how they approach classroom observation.

Chapter 4: Exploring the variability in how one science coach attends to science classroom interactions

Introduction

As we saw in Chapter 3, leaders and teachers can see many different things when they look at the same classroom. An obvious question that follows is: how can we get educators more aligned in how they observe and evaluate classrooms, and aligned in a sophisticated way? Policymakers have tried many ways to align what is happening in classrooms in the U.S. In 2001, No Child Left Behind set up goals for states to create rigorous standards and standardized tests, but the specifics were left up to the states. The most recent reform push, the Common Core State Standards (CCSS), calls for standards alignment among all states. As of March 2013, the CCSS have been adopted by 45 states and the District of Columbia. The proponents of the CCSS assert that alignment of expectations for students will "promote equity" and will allow states to collaborate on curriculum development and assessment systems.

In conjunction with the current push to align the expectations for content standards, policymakers are also seeking ways to align teachers' practice. Indeed, many see these as related goals. One widely used teacher evaluation system is Danielson's (2013) Framework for Teaching (FFT)[14], which explicitly connects teacher evaluation with the CCSS. Danielson argues that in order for the ambitious goals set forth in the CCSS to come to fruition in the classroom, teachers will need to learn new pedagogical skills, which for some will be a "major departure" from what they are used to (p. 5). A tool like the FFT, asserts Danielson, will help teachers learn

[14] See Appendix C for the complete FFT rubric

the skills they need to effectively implement the CCSS in the classroom. Danielson describes how the FFT is aligned to the goals of the CCSS:

> But educators who are familiar with the Framework for Teaching will recognize much in the philosophy of the CCSS that is similar to the underlying concepts of the Framework. After all, the centerpiece of the Framework is student engagement, which is defined not as "busy" or "on task," but as "intellectually active." Learning activities for students may be "hands-on," but they should always be "minds-on." Furthermore, the hallmark of distinguished-level practice in the Framework is that teachers have been able to create a community of learners, in which students assume a large part of the responsibility for the success of a lesson; they make suggestions, initiate improvements, monitor their own learning against clear standards, and serve as resources to one another. (p. 5-6)

With the widespread adoption of the CCSS and the growth in the use of the FFT, the impact this framework (and other similar frameworks) could have on teaching and learning is significant. The stated goal of the FFT is to improve teachers' instructional practice, and in order for an evaluation system to achieve that goal, Danielson asserts that certain characteristics must be present. The system should have "a consistent definition of good teaching" and "*everyone* in the system—teachers, mentors, coaches, and supervisors— must possess a shared understanding of this definition" (Danielson, 2011, p. 36, emphasis in original).

Danielson argues that this is crucial because if everyone uses the same language to describe good teaching, the discussions that happen between teachers and leaders after a classroom observations can be much more productive. Finally, an effective teacher evaluation system must employ "skilled evaluators" who can recognize what evidence applies to which evaluation categories and accurately interpret the evidence to determine the level of the teacher's performance. Danielson emphasizes that "evaluators must be able to assess teachers accurately so teachers accept the judgments as valid and the public has confidence in the result" (p. 37). In sum, Danielson calls for alignment around what counts as good teaching.

So what does Danielson define good teaching to be? The FFT rubric is extensive, and the framework in its entirety can be found in Appendix C. For the purposes of this chapter, I will highlight two categories: Quality of Questions and Discussion. Later in the chapter I will detail the process by which an observer uses this rubric to score a lesson; here I am focusing primarily on the substance of the rubric. Table 4-1 shows the four levels of evidence that correspond to the two categories in question.

Element	Level 1 Evidence	Level 2 Evidence	Level 3 Evidence	Level 4 Evidence
Quality of Questions	Teacher's questions are virtually all of poor quality, with low cognitive challenge and single correct responses, and they are asked in rapid succession.	Teacher's questions are a combination of low and high quality, posed in rapid succession. Only some invite a thoughtful response.	Most of the teacher's questions are of high quality. Adequate time is provided for students to respond.	Teacher's questions are of uniformly high quality, with adequate time for students to respond. Students formulate many questions.
Discussion	Interaction between teacher and students is predominantly recitation style, with the teacher mediating all questions and answers.	Teacher makes some attempt to engage students in genuine discussion rather than recitation, with uneven results.	Teacher creates a genuine discussion among students, stepping aside when appropriate.	Students assume considerable responsibility for the success of the discussion, initiating topics and making unsolicited contributions.

Table 4-1: Quality of Questions and Discussion categories from Danielson's (2013) Framework for Teaching

Focusing first on the *Quality of Questions* row, we see that the evidence includes several dimensions: Quality of teacher's questions (low vs. high); type of answers generated (single correct responses vs. thoughtful response); amount of time for students to respond (questions asked in rapid succession vs. students have adequate time to respond); and student initiative in asking questions (present only in Level 4 Evidence, but nothing about the quality of their questions). The *Discussion* category has similar dimensions: interaction between teacher and student (teacher-student vs. student-student); quality of discussion (recitation vs. genuine); and student initiative (teacher-driven vs. student-driven).

Note that the rubric is content-neutral – there are no science-specific aspects to the categories – even though it is easy to imagine how high quality questions could be different in science (mechanistic, testable, etc.) and literature (meaning, motivations, interpretations, etc). Indeed, The Danielson Group (2011) recognizes the content neutrality of the FFT and justifies it in the following way:

> The Framework for Teaching describes good teaching in all subjects and levels, K-12. That is, it applies to all contexts and settings, for example, art, music, computer, etc. Teachers use the same teaching skills within their own environments: they set instructional goals for students, design coherent instruction, establish a safe classroom environment with clear routines and procedures, engage students in learning etc. So a separate Framework is not needed. Naturally, the manner in which teachers do these things varies with the context, but the components of the framework for teaching apply to them all. (http://www.danielsongroup.org/article.aspx?page=FAQFft)

While The Danielson Group recognizes that context will affect exactly *how* teacher implements the FFT standards, they assert that the framework applies to all contexts, because good "teaching skills" are the same in all classes.

As we will see in this chapter, boiling down the complex practice of teaching into a set of discipline-neutral skills is problematic if our goal is to teach students sophisticated disciplinary practices. By leaving the disciplines out of the rubric used to observe and evaluate teachers, the conversations happening between teachers and supervisors are focused away from students' engagement in disciplinary practices, as will be illustrated in this chapter. Attending to disciplinary substance while teaching is crucial for learning, an idea that has been present in the literature for at least two decades (e.g., Ball, 1993), and has recently been emphasized in the context of formative assessment (Coffey, Hammer, Levin, & Grant, 2011).

While the FFT rubric is being used to align supervisors' observations and evaluations of teachers, I ask what is being lost in this pursuit of alignment. My goal in this chapter is to highlight this attentional shift away from students' engagement in scientific practices in real episodes from one science supervisor's work with a teacher. In the next section, I briefly review the literature on attention and noticing in the classroom, highlighting pieces that explore "shifts" in and influences on attention on various dimensions. Next, I describe the context and methods for this study. I then present data showing Valerie's ability to attend to scientific practices in some contexts and contrast that with an episode from Valerie's observation cycle with teacher Deborah. I will show that Valerie is extremely capable of attending to student thinking and engagement of scientific practices in some contexts, but that the FFT draws her attention away from doing so. In other words, Valerie's shift in attention away from student thinking isn't a matter of her not being *able* to do so but a matter of contextual factors pulling her attention in other directions. Finally, I discuss the different ways that Valerie framed the task of classroom observation and conclude with the implications of these results on instructional practice

Literature

Attending to the disciplinary substance of student thinking

Many researchers (e.g., Jacobs, Lamb, Philipp, Schappelle, & Burke, 2007; van Es & Sherin, 2008) and policy documents (e.g., NCTM, 2000; NRC, 1996) call for teachers to attend closely to their students' thinking in order to cultivate an authentic, inquiry-oriented classroom. In science and math education research, teachers are encouraged to attend to the substance of students' ideas as well as students' engagement in disciplinary practices (Ball, 1993; Coffey, Hammer, Levin, & Grant, 2011). While attending to student thinking is crucial for meaningful student learning, teachers often do not engage in this practice in their classroom (Levin, 2008) or when watching classroom video (van Es & Sherin, 2008).

To support teachers' engagement in these sophisticated practices, Stein and Nelson (2003) argue that *leaders* must have deep mathematical content knowledge and pedagogical knowledge. They call this knowledge "Leadership Content Knowledge" and in 2005, Nelson and Sassi thoroughly explored this construct by analyzing the knowledge used by many leaders in various episodes from their daily practice. Nelson and Sassi argue that deep subject matter knowledge and pedagogical knowledge allow leaders to attend to the most important mathematical aspects of a classroom that lead to teacher growth. Specifically, they claim that leaders' attention to and engagement with the students' mathematical ideas in the classroom are central to supporting and improving teachers' practice. Nelson and Sassi explain:

> We argue that ideas about mathematics, learning, and teaching influence both *what* administrators are able to perceive about instruction in their schools and *how* they choose to take action… [W]hen observing in classrooms

> administrators make subtle decisions about what is important to attend to in order to judge the adequacy of the instruction… Decisions about which facts matter also help shape the related practical activities in which administrators engage: the notes they make about what they observe, what they say when they consult with the teacher, what recommendations for further actions they make. (p. viii)

Nelson and Sassi emphasize that the judgments administrators make are all based on interpretations of the situation due to the "mutability, indeterminacy, and particularity" (p. viii) of the complex classroom environment. Because of the interpretive nature of observation, administrators' judgments of classrooms are inextricably tied to what aspects of a classroom they attend to and how exactly they attend to those features.

Context-dependence of attention

Before we review the education research on attention we look to the field of psychology, which will provide us a framework for thinking about how attention can be variable depending on context. Simons and Chabris (1999) have studied selective attention, a phenomenon where a person can fail to physically see certain things in his field of vision when he is focused on looking for something else. In their experiments, Simons and Chabris asked participants to watch a video of students playing basketball and count the number of times the players passed the ball to each other. Some participants were asked to keep track of the total number of passes ("easy task"), while others were asked to keep track of the number of bounce passes verses the number of air passes ("hard task"). In the video, a person in a gorilla suit walks into the middle of the basketball court, beats his chest, and walks off screen. Simons and Chabris found that about half of all participants did not notice the gorilla, with significantly less “hard task” participants noticing the gorilla than “easy task” participants.

The results from the gorilla experiment suggest that the more a person is asked to look for or keep track of in an observation, the more likely that person won’t notice other features of the situation. In other words, observers can reach a “cognitive overload” when focusing their attention on one aspect of a scene, which can cause the observer to be blind to other aspects of a scene, even if they would notice those features in a different context (i.e., if they weren’t asked to count the basketball passes). In a typical classroom, there are essentially an infinite number of things to attend to, and it is likely that attention can be focused in many different ways by many different contextual factors. In the next two sections, I will consider the variability in teachers’ attention and the many possible contextual factors that focus that attention.

Teachers’ variable attention in the classroom

While research on administrators’ attention in the classroom is largely nonexistent, teacher attention has been studied by a number of science and mathematics education researchers. While much of the research on teacher attention has focused on noticing as a skill that teachers either have or don’t have (e.g., Franke, Carpenter, Levi & Fennema, 2001; Kagan & Tippins, 1991; Star & Strickland, 2008), an emerging line of research has found teacher attention to be highly variable depending on the context (Berland & Hammer, 2012; Elby, Lau, Hammer, & Hovan; Lau, 2010; Lineback & Goldberg, 2010; Richards, Gillespie, Levin, & Elby, in preparation; Rop, 2002). Researchers have attributed shifts in attention to shifts in how the teacher *frames* the activity of teaching. Framing is a construct adapted from linguistic and anthropology that describes how a person approaches the situations they find themselves in. A person's framing of a situation is usually tacit and is the answer to the question, "what is it that's going on here?" (Hammer, Elby, Scherr, & Redish, 2005). Contextual factors drive an individual's framing of an activity, and this in turn influences what they attend to in the situation. Russ and Luna (2013) describe how researchers can use locally stable patterns of a teacher's attention to infer how she is framing the activity of teaching.

Variability in attention and framing has been found to happen at different grain sizes. Richards, Gillespie, Levin, and Elby (in preparation) found that a high school physics teacher attended closely to the substance of students' thinking when he framed the lesson as one about "science" and not when he framed it as "engineering." Rop (2002) presented a case study of a science teacher who attended closely to students' questions only when he had finished the "lesson" for the day and had extra time in the class period. While Richards et al. and Rop found their focal teachers' attention to be stable within each class activity, other researchers have found significant variability in attention within a single discussion. For example, Lineback and Goldberg (2010) identified three primary modes of attention – content, student interaction and discussion, and the substance of students' ideas - that occurred within a single discussion. Similarly, Elby, Lau, Hammer, and Hovan (in preparation) found one teacher to shift between "constructivist" and "transmissionist" epistemological orientations within a single lesson. These shifts in epistemological framing were evidenced by shifts in how the teacher attended to the students' ideas in the classroom.

Taken together, these studies suggest that improving educators' attention to student thinking isn't a matter of teaching them a new skill, but instead requires educators to shift their framing of classroom activity to one that requires or invites attending to student thinking. In this chapter, we will see a science instructional leader who is *able* to attend closely to the substance of student thinking at times, but does not always do so due to the institutional context in which she works. In the next section, I will consider how institutional constraints can influence attention.

Selective attention and institutional constraints

Sherin and van Es (2009) provide a framework that helps us consider the dynamic nature of educators' understandings as they pertain to observing classrooms. They use the notion of *professional vision*, adapted from Goodwin (1994), to characterize what teachers attend to in complex classroom environments. Sherin and van Es explain that professional vision consists of two processes: "selective attention" and "knowledge-based reasoning" (p. 22). Selective attention involves what the teacher decides to pay attention to in the classroom, and knowledge-based reasoning involves how the teacher "reasons about what is noticed based on his or her knowledge and understanding" (p. 22). This knowledge could include knowledge about the discipline, the curriculum, or the students' understanding.

Sherin and van Es explain that selective attention and knowledge-based reasoning are constantly interacting:

> [T]he kinds of interactions that a teacher notices will likely influence how the teacher reasons about those events. In addition, a teacher's knowledge and expectations can be expected to drive what stands out to the teacher in any given situation. (p. 22)

Here, Sherin and van Es bring up an important point that is worth emphasizing: a teacher's knowledge and expectations influences what she notices in a classroom, which in turn influences how she reasons about the situation. Not only can attention be influenced by a teacher's knowledge and expectations, it can also be influenced by institutional constraints (Levin, 2008). Levin takes a sociocultural stance on teacher's attention, noting "an individual's cognition cannot be disentangled from the sociocultural context in which it exists and interacts" (p. 106). Levin argues that teachers' attention cannot be explained fully by looking at teachers' content or pedagogical content knowledge; instead, Levin analyzes influences from contextual factors such as high-stakes testing, state standards, district curriculum, school community, and students' expectations of school. He determined that teachers' attention is highly driven by salient contextual factors; presumably, this would be true for administrators and other instructional leaders given the many institutional tensions that leaders experience every day.

One such contextual factor might the any observation tools that leaders are asked to use. When an instructional leader is observing a classroom, an observation tool acts as a lens that influences what the leader notices in the classroom. Reflexively, an observation tool also influences how a leader reasons about what she notices. In this way, an observation tool adds another layer to Sherin and van Es's (2009) concept of selective attention and knowledge-based reasoning as two dynamically interacting processes.

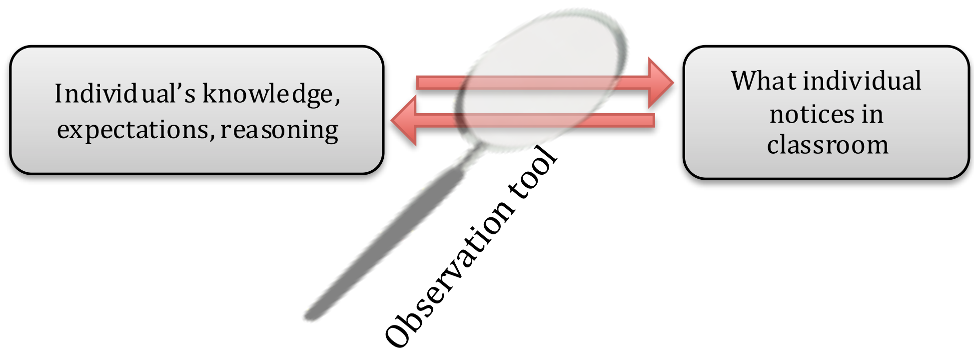

Figure 4-2: An observation tool's influence on attention and reasoning

A typical classroom is generally much more complex than people passing a basketball, with more people, lots of talking, and sophisticated disciplinary concepts and reasoning, so there is even more competition the observer's attention. Therefore, any object or framework that focuses an observer's attention is going to inherently cause the observer to miss a lot of the complexity of the classroom

Leaders' use of tools in classroom observations

While observation tools are an important aspect of many instructional leaders' practice, very few researchers have studied leaders' use of tools. Coldren and Spillane (2007) define tools as "externalized representations of ideas and intentions used by practitioners in their practice [or] mechanisms that enable leaders to make connections to teaching practice" (p. 372). In other words, tools are a key link between leaders and teachers. Coldren and Spillane argue that "the role of tools in instructional leadership practice is conspicuously absent from the empirical literature on leadership in schools" (p. 372). One exception is found in Nelson and Sassi's (2005) book on instructional leadership in mathematics. In their book, Nelson and Sassi present case studies of elementary school principals, focusing on the mathematical content knowledge, pedagogical content knowledge, and leadership content knowledge that is required to engage in episodes of administrative practice.

One of Nelson and Sassi's (2005) focal episodes describes a principal's use of an observation tool and the extra effort it took her to turn her teacher observations into something more meaningful. Ms. Diggins, an elementary school principal, was required to use a district-mandated form to observe and evaluate teachers. The form was "cognitively oriented" but was not subject-matter specific, with components such as "Helps all students learn by having them solve their own problems and make their own discoveries" and "Asks questions that stimulate students' critical, independent, and creative thinking" (p. 91). Ms. Diggins did not find this form helpful because she had learned the importance of attending to students' mathematical thinking, which this form didn't give space for. Ms. Diggins found a way to satisfy the form requirements *in addition* to noticing the students' mathematical thinking by writing a three-to-four page narrative after each observation to describe student ideas and teacher responses in much greater detail. Nelson and Sassi reflect on the unique kind of attention Ms. Diggins used to construct the narrative that wasn't needed for the district form:

> Ms. Diggins's essay shows that she was paying attention to subtly different aspects of this class than the district-prescribed form suggested… In calling the principal's attention to whether or not students were "solving their own problems," "making their own discoveries," engaged in "critical, independent, and creative thinking," and "taking increased responsibility for their own learning," this district form focused on the development of general cognitive abilities and metacognitive skills… However, Ms. Diggins attended to more than this… She also attended to the content of students' mathematical thinking, as we saw in the example above when she captured the student dialogue. (p. 94)

Ms. Diggins's behavior in this episode is analogous to the people who successfully complete the "hard" basketball counting task *and* see the gorilla in the gorilla experiment. Ms. Diggins knew that she needed to fill out the observation form and look for the mathematically important aspects of the lesson, and she was skilled at doing both. If Ms. Diggins did not supplement the district form with her own detailed narrative, all of the in-the-moment noticing of students' mathematical thinking likely would have been lost; this loss would have led to a much less substantive conversation in the post-observation conference with Mr. Davis. With the addendum, she was able to discuss the students' thinking in detail with Mr. Davis, modeling and supporting the practices central to effective constructivist teaching.

The extra effort that Ms. Diggins exerted in this episode highlights at least two different ways that a district-mandated form could limit observers' attention to student thinking. First, an observer may not notice student thinking *in the moment*, especially when given something like the basketball counting task or a district observation form. Second, even if an observer *does* notice student thinking, she must put in significant extra work to record what she noticed, since the district form doesn't support that practice. Ms. Diggins is an example of someone who was not deterred by either of these potential obstacles, but it is easy to see how this is likely the exception, not the rule.

While Ms. Diggins still attended to the students' thinking in her classroom observation, in this chapter I will present a case of Valerie, a science coach whose attention was more influenced by the district observation tool. I will show the significant variability in Valerie's attention in her administrative practice. Danielson

(2013) promotes her rubric to facilitate alignment in observations and evaluations of teachers. In this chapter, I ask "alignment at the expense of what, at the expense of what else?" I will show that the influence of the FFT leads Valerie to focus less on the substance of students' ideas and engagement in scientific practices and more on superficial participation patterns.

Research Context and Methods

Overview

In this study, I focus on Valerie, a science coach in Eastern County Public Schools (ECPS). Because I was interested in the variability in leaders' attention in the classroom, I wanted to study Valerie's attention in different contexts. Consequently, the data in this chapter comes from two main sources: an interview I did with Valerie at the beginning of the 2011-2012 school year, and data collected from an "observation cycle" she conducted with Deborah, a teacher in the Inquiry Professional Development Project (IPDP). In this section, I will detail the research context and the methodological approach I took with this study.

Context

Valerie is a science coach in ECPS who works exclusively with teachers who are part of the NSF-funded science teaching professional development project that is a partnership between several educational institutions in Eastern County, including a Large Research University (LRU). There are over 100 4^{th} – 8^{th} grade ECPS teachers in the project, and each is matched up to one of three coaches. Fifteen of the teachers are part of the Inquiry Professional Development Project (IPDP), the LRU-based sub-strand of the project. During my study, I was part of the team who facilitated the IPDP. The goal of our sub-strand was to promote scientific inquiry in our teachers' classrooms, with the hypothesis that students who engage in authentic scientific inquiry in school will be more likely to pursue science in the future.

Participant Selection

I chose to study Valerie for a number of reasons. First and foremost, I chose Valerie because I knew her from the Inquiry Professional Development Project and I knew that she valued students' engagement in scientific inquiry. I had seen her attend to student thinking in the context of our project, and I knew she was thoughtful and skilled in seeing the science in students' ideas. It was important for my focal participant to be good at attending to student thinking because I wanted to investigate the influence of contextual factors on that attention. I expected that certain institutional contexts would inhibit attention to student thinking; it was crucial for my participant to be good at attending to student thinking in some contexts so I could see that shift.

Valerie is assigned to several teachers in the IPDP; one of her teachers is Deborah, a 4th grade science and math teacher. Each science coach conducts two observation cycles each year with each teacher. An observation cycle consists of three parts. First, the teacher completes a 'Pre-Observation Map,'[15] and the teacher and coach meet to discuss the upcoming lesson. Next, the coach observes the lesson, where she scripts as much of the lesson as possible. After the observation, the coach uses the scripted lesson to pick out evidence for the various FFT rubric rows and

[15] See Appendix D for a sample pre-observation map.

sends the rubric with evidence (but no scores) to the teacher, asking the teacher to score herself using the evidence. Finally, the teacher and coach meet in a post-observation conference, where the coach shares her rubric scores for the teacher and they discuss places where the teacher and coach differed and categories in which the teacher could improve.

Data Collection and Analysis

The first part of the analysis explores Valerie's attention during an interview in which I asked her to reflect on a classroom episode. In the interview, I showed Valerie a five-minute video of a science lesson[16] and used the semi-structured interview protocol below to guide the interview. In the interview, I first described the context of the video and told Valerie I would ask her to comment on what the students are doing in the clip. After showing the clip, I asked the following questions:

> Is this the kind of thing you'd like to see students doing in science classrooms? Why, or why not?
>
> What about it are you seeing that you like?
>
> In what ways would you like to see the students improve in their engagement with science?
>
> Is there anything else you noticed or would like to comment on?

As Valerie responded, I asked follow up questions when I wanted Valerie to be more specific (e.g., What student remark are you referring to? or What about that would make it better?) After we finished discussing the first clip, I showed the second part of the clip and asked Valerie the same set of questions.

[16] The details of the video clip can be found in Chapter 2 and the transcript in its entirety can be found in Appendix A.

The second part of the analysis in this chapter explores Valerie's attention during an observation cycle with Deborah. I accompanied Valerie to the pre-observation conference and post-observation conference with Deborah. I videotaped both conferences. I was not able to accompany Valerie on the classroom observation itself; instead, Jen Richards, a fellow LRU graduate student, accompanied Valerie to that lesson. The lesson was videotaped by both Jen and Valerie; Valerie wore a wireless microphone to record her interactions with the students during the lesson. Jen recorded detailed field notes about the lesson and made a photocopy of Valerie's notes from the lesson. Finally, I interviewed Valerie ten weeks after the post-observation conference to find out more about how she planned for and conducted the entire observation cycle.

My goal in analyzing the data was to look for patterns in what and how Valerie attended to the classroom episodes. Evidence of attending took two main forms. In both interviews and the post-observation, I considered the content of Valerie's speech when determining what she was attending to. In the post-observation conference, I also used the rubric that Valerie used to record evidence from Deborah's lesson as evidence of her attention during the class. To characterize how Valerie attended to the classroom episodes, I analyzed the data using methods inspired by Marton's (1986) phenomenograpy and Glaser and Strauss' (1967) grounded theory. My goal in analyzing the data was to understand how Valerie viewed and understood the activities in the episode, a central goal in phenomenography (Marton, 1986).

During the data collection process, I used tentative conclusions from the post-observation conference to inform my later interviews with Valerie. This served as a way of confirming the findings by collecting new information in a different context (Miles & Huberman, 1984). I employed bottom-up coding by identifying and coding salient topics that came up during the interview and teacher conference data. I iteratively refined and expanded on the coding scheme as I read more interviews, similar to the "constant comparison" method in Glaser and Strauss' grounded theory. I used the individual codes to create broader categories, for example, *focusing on participation patterns* and *focusing on the teacher's questions* were both included in the broader category of *getting through the rubric.*

Attending to the substance of student thinking required that Valerie identified and/or interpreted a student idea in the episode. I determined Valerie to be focusing on *getting through the rubric* when she cited the rubric directly, used language from the rubric, or discussed rubric scoring. I considered Valerie to be focusing on *parsing participation patterns* when she talked about the number of students talking or who was talking when. For example, I determined Valerie to be focusing on participation patterns in her statement "So the reason I chose these snippets is because it goes from teacher to students, and at times another student would make a comment, another student would make a comment."

Variability in Valerie's attention

Valerie's attention to students' ideas and students' engagement in scientific practices

As we will see in a later section, Valerie's attention is pulled away from the substance of students' ideas and engagement in scientific practices when she is using the FFT rubric to evaluate science lessons. If that was the only data presented in this chapter, the reader might question Valerie's *ability* to attend to student thinking or her *belief* that it is a valuable thing to do. In this section, I argue that is not the case.

Valerie is able to attend to students' thinking and engagement in scientific practices, often in a deep, sophisticated way. She does this in multiple contexts, both in an interview with me and in informal reflection about her own teacher visits. In this section, I will start by analyzing Valerie's attention in watching the video clip from the interview. I will show that she notices specific students' ideas, sometimes trying to figure out exactly what the students mean. When not attending to the substance of ideas, she often is noticing the students' engagement in scientific practices such as arguing with evidence and reasoning mechanistically.

At the end of this section, I will show an example of Valerie attending to the substance of students' ideas in another context – when she is informally discussing a classroom she visited recently. We now turn to her interview about the video clip.

After watching the first video clip, I asked Valerie if this is the kind of thing she'd want to see students doing in science class. She responded:

> Valerie: Absolutely. Um, I like the idea that they are thinking, although the questions at this point are coming from the teacher and not from the student, I like the fact that they are making attempts to provide evidence for their own ideas, in response to her questions, and the fact that the student that was standing, I didn't catch his name, combined his idea, he said I think that we're

> both right, he was able to explain his partner's idea with his idea for it to make sense for himself.
>
> Colleen: Um, so what was an example of them providing evidence for what they were thinking?
>
> Valerie: When he pointed to the outside of the glass, and he agreed that there was something changing here because there was something that wasn't there before, um referring to the water droplets that were on the outside of the glass.
>
> Colleen: And that was evidence for what idea that he had?
>
> Valerie: He had um, the idea that something went up, and that there was water vapor everywhere, so he thought that water vapor on the outside of the glass was changing back, that's what he said, into water.

Right away, Valerie starts by talking about the students' ideas. She likes that the students are trying to "provide evidence for their own ideas," such as pointing to the water on the glass as evidence that something is changing back into water. Valerie specifically noticed and praised Casey for explaining Daniel's idea and combining it with his own idea, and "made sense" of the ideas together.

During the first part of the interview, Valerie continued to notice that the students had generative ideas and were engaging in productive scientific practices:

> Colleen: Are there other things that you'd like to see change, either things that students are doing or that the teacher was doing, or things that you want them to improve on?
>
> Valerie: I think I would like to see, now that they have this idea, their new idea that they built, I would like to see them compare what they thought before to what they now think. So what were they thinking before the teacher came over, excuse me, and what are they now thinking when she's there, so that they can compare the two ideas that they had, I would like to see them actually get that down on paper so that they can look at it later. Because that kind of thinking could help them to, if they decided to share to their group, help bring another group, students over to their side by evidence as to why their original idea couldn't be the case. So I would like to see some kind of formal way of recording those, even if it's just a messy chart, with a list of ideas or picture, um, in that sense.

Colleen: Other things you'd like them to improve on?

Valerie: And this was a small group of students, it was two students, but obviously if there were others, I would like to see more of that, um, connecting of ideas, you know, from one student to another, well what did you think about it, how does that idea work with his idea, to see more conversation between the students and less talking by the teacher. Cause she at that point was only working with two students, but there are plenty of others in the room, so I was curious to know what's going on in the other groups, what questions they're asking each other, if any.

In this reflection, Valerie doesn't refer to specific students' ideas, but does emphasize the importance of students keeping track of their ideas and sharing their ideas with other students. Valerie thinks that keeping track of ideas is important because it helps facilitate sense-making and coherence seeking between groups of students. Valerie wishes to see more talking between students and less of the teacher, because then the students would be able to connect their ideas.

At the end of discussing the first clip, after asking what she liked, and didn't like, I asked Valerie if she had anything else she wanted to add:

Valerie: I'd be interested to see what they think about HOW the water, if they know why the water changed from one state to another. Um, she kind of, when she said, if it came from the air, all the glasses would have to be wet, and then kind of let that go. And the one kid says I think it's actually steam. I'm not sure if he's thinking about heat in steam, because it's kind of hidden in there, but what actually made the water change state, they didn't discuss. So I would have liked to have gone in that direction, but, I'm not sure if it comes next

Colleen: So right now they're just talking about where it came from

Valerie: Where it came from

Colleen: without talking about

Valerie: how it got there.

Here, Valerie is noticing a specific idea that Daniel had – that the condensation is actually steam – and shares that she wants to know more about this idea. Specifically, Valerie notices that so far in their discussion, the students haven't included much mechanism in their explanations; they've been talking about where the water came from without talking about how or why it formed on the outside of the glass. In this moment, Valerie is thinking that a good scientific explanation includes mechanism, so a good scientific question is one that promotes mechanistic thinking (i.e., how did the water get there? why did the water change states?) While earlier in the interview, Valerie discussed general scientific practices (comparing, asking questions, etc), here, Valerie is naming a specific scientific practice that the values – mechanistic reasoning – and commenting on the quality of their reasoning so far.

In this snippet, Valerie is also recognizing that when you observe students, there is a degree of interpretation that must happen. Specifically, she realizes that what a student *says* doesn't necessarily map exactly to what a student is *thinking*. Valerie notes that Daniels says he thinks it's "steam" but she's not sure exactly what he is thinking about. She suggests he could be thinking about "the heat in steam, because it's kind of hidden in there." Recognizing that there is meaning "hidden" in what students are saying is a necessary prerequisite for educators to attend and respond to student thinking in meaningful ways. Recall from the literature review that this is the cornerstone of responsive teaching that is fundamental to significant student learning.

The "steam" bit is not the only instance of Valerie engaging in the important activity of *trying to figure out what a student means*. She does it again later in the interview. After watching the second clip, Valerie noticed another specific student idea: Daniel's mention of the unopened soda can. I asked Valerie what Daniel's can idea was. She responded:

> I'm not sure if he was saying it is happening or it's not happening on the can, but he was referring to the situation, it being different because it was a lid on this one, I think he was saying that the water didn't necessarily have to come from the inside here because there's a lid on here, so the water can't escape out of here to form on the outside of the glass, so it must be coming from the air, although I don't think he quite stated it that way. But the fact that he compared it to something else is something that I like to see students doing.

In this instance, Valerie explains Daniel's mechanistic chain of reasoning for the condensation coming from the air: the soda can was closed, which meant there was no way for the liquid to come from inside the can to get on the outside of the can, so the water must be coming from the air. Valerie says she's not sure if he thought condensation was or wasn't happening on the can, but her recollection of Daniel's reasoning supports the idea that it *is* happening on the can – if he didn't think there was condensation on the can, his reasoning wouldn't make sense. Here, Valerie is again trying to *make sense* of what Daniel is saying.

Valerie then shifts away from talking about Daniel's specific idea and notes that she likes that he is *comparing* two things. Indeed, it is this comparison that allows him to sort out the mechanism by which water gets to the outside of the glass, but she minimizes this benefit by making a general statement about comparison – "the fact that he compared it to something else is something that I like to see students doing." So, in this moment Valerie shifts from attending to mechanistic ideas to attending to general scientific practices.

So far, the examples I have shown of Valerie attending to student thinking or their engagement in scientific practices have all been from a single interview in which I asked Valerie to reflect on a video of a classroom episode. This particular activity is only an approximation of what she does in her job when she observes teachers' classes; perhaps this video interview allowed her the time and space to notice student ideas, whereas a real classroom would not. Plus, she is in an interview context where her interviewer is asking her specifically about the student ideas in the video, so one might think she only does this with prompting. However, I also have evidence from her actual coaching practice that she notices student ideas on her own, as we will see next.

Jen, a fellow graduate student, visited a teacher's class when Valerie was also there. Jen recorded the following field notes about what Valerie said to her after the lesson:

> Valerie told me about something a kid said in another visit that almost brought her to tears -- I think they were talking about why a leaf floated in a container of water, and one kid offered that when the leaf does photosynthesis, it gives off oxygen, so maybe there's air in the leaf that caused it to float.

In this reflection, Valerie remembers a student idea that was clearly not "correct" – the oxygen given off during photosynthesis has nothing to do with leaves floating – but it "brought her to tears." Jen's sense was that Valerie was so excited about this comment because the student was making the correct connection that photosynthesis produces oxygen, but that she also thought it was interesting that he connected it to floating.

Both in the interview context and in the classroom, Valerie demonstrates that she can and does often attend to aspects of students' ideas and their engagement in scientific practices. Sometimes she attends more closely to the specific substance of a student's idea, such as Daniel's soda can idea, and other times she attends more generally to the fact that they have idea, or the ways they are engaging with science. Valerie notices and values when the students provide evidence for their ideas, compare across situations, and reason mechanistically. She also demonstrates genuine appreciation and interest in students' ideas, such as when she was almost "brought to tears" from the photosynthesis idea in the other class.

Up until this point, the FFT rubric discussed in the introduction of this chapter has not been mentioned. When I conducted the initial interview with Valerie, I did not know about the FFT, so of course I did not bring it up. She didn't mention it either until I shifted gears in the interview and asked her what she would do if she was a coach observing this teacher, which is what we will turn to in the next section.

Valerie's description of the FFT and observation cycle

Halfway through the initial interview with Valerie - after watching and discussing the 5-minute video clip - I asked what she would talk to the teacher about in a post-observation conference. When I asked Valerie this, I knew nothing about the FFT, which the coaches and administrators in ECPS use to observe and evaluate teachers. I briefly described the FFT in the introduction of this chapter; in this section, I will present Valerie's description of how she uses the rubric in post-observation conferences. Through her description of the FFT, we will begin to see what types of things it focuses attention on. Later in this chapter we will see her use the FFT in a real observation cycle with a teacher.

In the interview, Valerie explained that she would first talk to the teacher about any rubric area in which the teacher scored a 1 or 2 (out of 4). Valerie explained what Quality of Questions means:

> Valerie: So for example if the teacher was asking virtually all low quality questions, that would look like, what color is the sky, what color is grass, what color is this table, you know that quick, rapid response, but level 4 evidence would look like teachers asking uniformly high quality questions, like where did the water on the outside of the glass come from, that's a question that requires much more thought than what color is the sky?

Here, Valerie gives examples of what low and high quality questions are, in relation to the FFT rubric. In this moment, low quality questions are ones that require quick responses, whereas high quality questions are ones that require much more thought.

The example that Valerie gives for a high quality question, “where did the water on the outside of the glass come from,” is the same question that she earlier suggested was not sufficient for the most sophisticated explanations in science. Recall that earlier, Valerie wanted to know what the students thought about how and why the water got on the outside of the glass, mechanistic questions that are above and beyond just talking about where the water came from. So, in this instance, when Valerie is telling me about “level 4 evidence,” she doesn’t mention those questions that she earlier thought were more valuable.

It is important to emphasize that in this part of the interview, Valerie is explaining the rubric to me, which doesn’t necessarily translate to what she would do in an actual post-observation conference. I know nothing about the rubric, so she is giving me an overview of what the rubric entails. While the artificial context of this interview doesn’t necessarily align with how she would approach an actual conference with a teacher, we can still gather some information about what she considers low and high level questions in this moment. Also, the interview context here is similar to the interview context earlier, when she told me that "where did the water come from" was not a sophisticated question. Therefore, even from this interview context, we can see how the rubric influences the way Valerie approaches question quality.

Valerie continues by describing how she would score a lesson on the Question Quality category, and transitions into talking about the Discussion category:

> Valerie: So in the students dealing with those questions, for level 4, most of the student, teachers' questions are high level, with adequate time to respond would actually be like a 3. The difference in a 3 and 4, is that in a 4, students are formulating their own questions, so in that classroom, students are asking each other questions, so in the case where I said I would be curious to see this group challenging that group, asking them questions, so that would be level 4. If I were in a classroom where the teacher was standing at the front of the room and the teacher asked a question, a student answered, a teacher asked a question, and other student answered, that would be a level 1 discussion, primarily recitation between the teacher and the student, whereas in a level 4 classroom, students assume considerable responsibility, that's the classroom where you see this student Kevin saying, "well I had the same idea Sarah, but you said something about the water in the air, how does the water in the air get down to the sides of the glass?" So that student is asking questions, asking another student without the teacher interfering. At times the teacher may have to step in, but those students are very comfortable using the stems, I'm confused with, I'm not sure I understand, well I agree with you but I think, those stems that help to further their discussion without teacher interference.

On first glance, this looks fairly similar to earlier in the interview, when Valerie was focused more on the students' having of ideas – in both instances, Valerie is arguing that the students should be talking more and the teacher should be talking less. However, in her first reflection, Valerie was more focused on the students' thinking: students should be talking more to each other because they should be connecting their ideas. Here, Valerie is talking more about participation patterns among the students and teacher: in a classroom with low-level discussion, the talk alternates between the teacher and students, but in a high-level discussion, the students are asking each other questions. In addition, in a high-level discussion, students are using the “stems” which refers to the “accountable talk” framework that is widely used in ECPS.

In this moment, Valerie is focusing more on students talking to each other using the stems, and less focused on the substance of the students’ ideas. Certainly, students talking to each other and using the accountable talk stems could facilitate students’ mechanistic sense-making; indeed, Valerie gives a hypothetical example of Kevin asking Sarah to spell out her mechanism for water getting to the outside of the glass. In this moment, we can’t tell whether Valerie is emphasizing accountable talk stems in the service of mechanistic reasoning or as an end in itself. Furthermore, it is likely that Valerie is focusing on certain parts of the rubric because she knows I know nothing about it – for example, of course she has to explicate the “stems” to me because I presumably know nothing about them. So, we must keep in mind that my presence is likely influencing what she is deciding to focus her attention on in this moment, when she is in the middle of explaining the rubric to me.

Valerie continued by talking about how she would approach a post-conference where a teacher scored low in one of the rubric categories:

> Valerie: So if there were a teacher that I were observing and the teacher received 1s and 2s in a particular area, those would be the area that we would discuss most at the post-observation, and we would talk about ways to change the activity. For example, if a teacher has, let's see, if a teacher is having trouble engaging everyone in the lesson, say she tried to do a whole group discussion, my suggestion might be for the next lesson to do a turn and talk. So instead of all 30 students responding, they turn and they talk to their partner, we have more opportunities for individuals to get to share their ideas. So hopefully that teacher would be monitoring student learning which is another category on the back, by walking around and listening to that pair that was dealing with the glasses.

Here, Valerie offers an example of what she might tell a teacher who is "having trouble engaging everyone in the lesson" which most likely refers to the "discussion" category on the rubric that she was talking about in the moments leading up to this snippet. She says she would suggest that the teacher have the students do a "turn and talk" instead of doing a whole class discussion. The turn and talk would allow all students to share their ideas and would allow the teacher to monitor student learning" by "walking around and listening" to all students.

While Valerie does say this strategy would allow all students to share their ideas, in this moment, it's more about the fact that every student would get to talk and less about the substance or utility of the ideas themselves. Furthermore, doing a turn-and-talk would allow each student to share, but wouldn't facilitate broader sense-making or consensus-building, since each idea is only heard by 1 other person. However, to Valerie in this moment, simply because more students get to talk during a "turn and talk," this makes for a better discussion than a whole-class discussion, where less students get to talk. Unlike earlier, when Valerie was focusing on the value of the ideas themselves, here she is focusing more on participation patterns.

Valerie continues telling me about how she uses the rubric in the observation cycle. She explains that when she visits the class, she writes down a script of what she hears, and later picks out "evidence" from the script to put in a rubric they give to teachers. Using the evidence Valerie provides, the teacher scores herself on the rubric, without seeing Valerie's scores. Then, at the post-conference, Valerie and the teacher compare their scores. I asked Valerie some clarification questions about the process:

> Colleen: So does the teacher see the one that you fill out with the evidence?
>
> Valerie: Yeah they get my exact copy with the evidence, and that's the one that they're applying scores to.
>
> Colleen: And then do you use, um, and then do you use the evidence to talk about in your post conference?
>
> Valerie: Mmmhmm, so I bring a copy of the one with their scores on it and my scores together, and we look at them at the same time, and we compare their scores to my scores. Most of the time what I find is that the teachers score themselves lower than I would score them because they aren't as familiar with opportunities that count. Like a teacher who does turn and talk doesn't consider every student being engaged because they think of it as more whole group discussion. But students talking in pairs (inaud) discussion. SO we kind of, those are the kinds of things we discuss in the post.

Here, Valerie notes that the teachers often score themselves lower on the rubric than Valerie. The reason for this, Valerie explains, is that the teachers "aren't as familiar with opportunities that count," for example, the turn and talk strategy which "counts" for every student being engaged. In this moment, the turn and talk strategy is valuable because it engages all students in discussion and therefore is reflected in a higher score on the rubric.

So far, we have seen initial evidence of how the FFT rubric pulls Valerie's attention in a classroom observation. When Valerie is discussing the rubric, she seems to have an overarching framing of *getting through the rubric*: her primary focus is on how she would score the lesson on each category of the rubric. Of course this is not surprising: she is describing the rubric, so she is looking for evidence that she would use on the rubric. We can also see finer-grained levels of framing and attention in this interview that fall within Valerie's focus on *getting through the rubric*. For example, Valerie focuses closely on participation patterns when discussing the *Discussion* rubric row. From this initial interview, we cannot make definitive conclusions but we can keep these modes of attention in mind as we analyze Valerie's attention in other contexts. What we care about the most is how the rubric influences Valerie's attention in actual classroom practice, so now we will look to see how she uses it in an observation cycle with Deborah.

Valerie's use of the FFT in a real classroom observation

In the previous sections Valerie is discussing a video clip, removed from the context of a real classroom observation. We next turn to an actual episode from Valerie's coaching practice. I accompanied Valerie on portions of two separate observations cycles with Deborah, a 5th grade science and math teacher in ECPS who is a participant in the Inquiry Professional Development Project (IPDP).

The first classroom observation was on October 6, 2011. I studied the video data and field notes recorded by Jen Richards. I accompanied Valerie to the post-observation conference with Deborah on November 21, 2011, where I took notes and videotaped the conversation. After the post-observation conference, I interviewed Valerie about the observation process on February 3, 2012. In this section, I will first briefly describe the class that Valerie observed. Then, I will present data from the post-observation conference, showing how the rubric directed Valerie's attention away from students' ideas and engagement in scientific practices. Finally, I will show data from the interview I conducted with Valerie about the post-observation conference, further confirming the influence of the rubric on the observation cycle.

Summary of Focal Lesson

The following text is taken from the field notes written by Jen Richards after she visited Deborah's class on October 6, 2011:

> This visit was part teacher visit for me and part data collection for Colleen, so the data and write-up look a little different than usual in that I was trying to get a sense of what Deborah, Valerie, and the kids were all doing. When Valerie came, she set up two video cameras of her own (and would be happy to share the footage), as well as an iPad that she carries around with her as she talks to kids and a camera on her phone that she uses to take pictures of their work… Valerie told me about something a kid said in another visit that almost brought her to tears -- I think they were talking about why a leaf floated in a container of water, and one kid offered that when the leaf does photosynthesis, it gives off oxygen, so maybe there's air in the leaf that caused it to float.
>
> When the kids came in, Deborah gave each group plastic bags with pictures inside and had them draw a line down the middle of their white boards. Groups were to put pictures of nonrenewable resources on one side of the line and pictures of renewable resources on the other side… and when Deborah brought everyone back together, she highlighted a picture that seemed to give kids trouble -- a picture of a forest. One group had put the picture of the forest right on the line because forests have trees, and trees can grow back, but it takes them a long time to do so.
>
> Then Deborah moved onto her big question for the day -- essentially how they could have a trash-free lunch at school. She gave kids a bit of time to think, then talk in small groups and list their ideas on chart paper. Both Deborah and Valerie were moving around talking to small groups. When Deborah opened up the floor for whole-class discussion, there were lots of interesting back-and-forths between the kids. For instance, one group said something that I couldn't quite hear about conserving electricity and gas, and Devon asked how that connected to the idea of a trash-free lunch. On the whole, kids seemed very willing to share their thoughts and argue with each other a bit (and I noticed Deborah sort of took herself out of the picture when kids were addressing each other directly). The ideas were largely along the lines of what you'd expect (e.g., reuse water bottles, bring silverware from home), but the level of passion in the room was notable with kids jumping out of their seats, holding up sticky notes for Deborah to see ("I have a question"), etc. Tomorrow, they will create more tangible plans from their ideas, and they all want to present their plans to the principal to see if any can be implemented.

There are a few things worth noting about how Valerie observed this lesson. First, Valerie chooses to collect a lot of data during her observations: she videotaped the lesson as a whole, carried around an iPad to videotape specific bits she found interesting, and took pictures of student work. The other science coaches in ECPS do not typically videotape when they visit classrooms, but Valerie often does. She later mentioned that she uses the videotape to pick out more specific evidence to use in the FFT rubric. She also said she reviewed this particular videotape before her post-observation conference with Deborah to refresh her memory of the lesson, since the conference took place six weeks after the observation.

During the lesson itself, Valerie walked around the room and talked to specific groups about what they were doing. She told me that she likes to interact with students more than the other coaches. As she observed, she also scripted much of the lesson by hand[17].

Between her data collection and interaction with the students, Valerie is well-positioned to attend to the substance of students' ideas. However, as we will see in the following analysis, Valerie largely did not attend to the substance of students' ideas and engagement in scientific practices in spite of this rich corpus of data.

Post-observation conference between Valerie and Deborah

In preparation for the post-observation conference, Valerie filled out the rubric in a manner consistent with how she described in an earlier interview. Specifically, she took the script she wrote during the lesson, picking out parts that correspond to the rubric, and inserted that "evidence" into the appropriate rubric category[18]. Typically, she sends the evidence to the teacher in advance of the conference so the teacher can score herself, and then Valerie and the teacher would compare their scores in the conference. However, Valerie was not able to send the rubric with evidence to Deborah ahead of time, so in this conference, Valerie and

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[17] see Appendix E for Valerie's written notes from the class.
[18] see Appendix F for the rubric with evidence

Deborah read over the evidence together, and Valerie asks Deborah to decide what score she thinks she should receive. Valerie and Deborah went through the entire rubric in this way, but in this section, I will just show the conversation that happened around two of the rubric categories: *Quality of Questions* and Discussion, because those were the categories in which student ideas most often come up.

<u>Quality of Questions Category</u>

In this section, I will detail Valerie and Deborah's conversation about the *Quality of Questions* category. I will show that focusing the conversation around the FFT, Valerie doesn't notice the substance of student thinking and engagement in scientific practices as she did in the interview earlier.

Recall that the Quality of Questions row on the FFT rubric is as follows:

Element	Level 1 Evidence	Level 2 Evidence	Level 3 Evidence	Level 4 Evidence
Quality of Questions	Teacher's questions are virtually all of poor quality, with low cognitive challenge and single correct responses, and they are asked in rapid succession.	Teacher's questions are a combination of low and high quality, posed in rapid succession. Only some invite a thoughtful response.	Most of the teacher's questions are of high quality. Adequate time is provided for students to respond.	Teacher's questions are of uniformly high quality, with adequate time for students to respond. Students formulate many questions.

Table 4-2: *Quality of Questions* category

The following chart is an excerpt of the document Valerie brought to the conference; it shows the "evidence" Valerie recorded for each element of the rubric.

Element	Support and Evidence	
Quality of Questions	Coach Observation	Students are asked to sort items into two categories.; <<Big question>> (on screen): Since we've been learning about protecting our resources, I wonder if there is a way we can start at our school and possibly have a trash-free lunch; T: If we are trying to have a trash-free lunch here at [school], what could we do?; Student (S): We have a question. (A student asks another group to explain how electricity and water bottles solve the problem of a trash-free lunch.); S: What can we use solar energy for?

Table 4-3: Evidence for *Quality of Questions* category

Valerie and Deborah looked at this chart together at the conference. The "score" columns were not filled in at first; after Valerie read through the evidence with Deborah, she asked Deborah what score she thought she earned and then Valerie shared her own score.

Valerie started the conversation about *Quality of Questions* by reading the evidence out loud:

> Valerie: So for quality of questions, (reading from rubric) "students are asked to sort items into two categories, and the big question for that day was, since we've been learning about protecting our resources, I wonder if there's a way we can start at our school, and possibly have a trash free lunch, if we're trying to have a trash free lunch here at [school], what could we do? Later in the lesson a student says, we have a question, referring to their group, they were asking another group to explain how electricity and the water bottles were solving the issue of the trash free lunch, and then another student later asked, what can we use solar energy for" And with the type of activity that they were doing, it's difficult to catch every question from the teacher, so um, I tried as much as possible to get the main question, and any questions that the students asked.

Here, Valerie cites three questions from the class – the overall question given by the teacher and two questions that came from the students. The first student question (about electricity and water bottles) refers to a lively debate among the students as to whether electricity should be considered when they are planning how to have a trash-free lunch. After reading the evidence, Valerie made a meta-comment about how it was difficult to "catch" every question from the teacher, likely due to the fact that the students were working mostly in groups, with the teacher moving around the room. Valerie also said she tried to get "any questions that the students asked." After Valerie read the evidence, Deborah responded:

> Deborah: Yeah, definitely, that, when I heard that, I said wow, what made you think of bottles and electricity? But, they were just thinking, and they were just going, going, so I kind of just let it ride out, so because, if I see the conversation getting wayyyy off, then I'll interject, and I'll ask the question, okay but my original statement was, blah blah blah, so let's get back to the original statement. But I kind of didn't do that too much here, because even though there's no connection between electricity and water bottles, there's probably water bottles in trash, so I was hoping somebody would say, okay, well we're not talking about electricity, we're talking about the problem we had with all the water bottles and recycling the trash, so that's what I was kind of hoping would happen (laughing)

Deborah's response shows she also noticed the "water bottles and electricity" comment. She starts her reflection by wondering what made the students think of that particular idea. She shared that when she heard that idea in the class, she thought "woooooow," which was long and highly emphasized, suggesting it really struck her as interesting in the moment and that it really stuck with her. Deborah then tells Valerie that she let the discussion go on because it wasn't "wayyyy off" topic yet, and she hoped the students would bring it back to the more focused question of the trash-free lunch. Deborah claims "there's no connection between electricity and water bottles," without considering that the students may be thinking there is a connection.

Deborah's mention of this idea provides an opportunity to – and could even be a bid to – discuss with Valerie the merits of this idea. Instead of discussing the student ideas in this moment, Valerie says they can talk about it later (which they do not). She then directs Deborah's attention to the *Quality of Questions* section on the FFT rubric:

> Valerie: A little bit came out of that later, and we can talk about that when we get to that section. So what's your thinking about the quality of questions? So level 1 says virtually all poor quality, low level and level 4 says uniformly high quality, adequate time to respond, and students formulate many questions.

> Deborah: Um, I don't know, I think the question started out good, but... I think it was a....

Here, Valerie reads from the rubric and asks Deborah what she thinks about the quality of the questions in the lesson. Deborah's response had a noticeably different tone than her previous reflection on the "water bottles and electricity" comment. She was less animated, hesitated, and didn't refer to any specifics from the class. She starts to answer what level she thinks the questions were ("I think it was a….") but didn't give a number right away. Valerie stepped in, assuring Deborah it's hard to decide on a score:

> Valerie: It's a very challenging section, for this particular class
>
> Deborah: Mmmhmm.... I think I probably should have narrowed that question down.
>
> Valerie: When you say narrow it down, what do you mean?
>
> Deborah: I mean I, when I talk about a trash free lunch, I probably should have focused in on either food items or the items that we eat our lunch on, or the things that people bring in, like the bagged lunch, I probably should have focused in more on one particular area, and then it probably would have elicited more focused responses.

It is unclear why Valerie thinks "this particular class" is hard to score for the *Quality of Questions* category, but she may be trying to reassure Deborah that it's okay to be unsure about the score, and encourage her to guess a score without worrying about whether it's the "correct" one. However, instead of offering a score, Deborah tells Valerie that she could have improved the overarching question by narrowing it down. Valerie asks Deborah what she means by that. Deborah replied that if the questions specified food items or food containers, the students' discussion would have been "more focused."

> Valerie then defended Deborah's original, broader question:
>
> Valerie: Um, the, I think the question allowed students to let you know what they thought a trash free lunch was, because we didn't discuss what trash free lunch means
>
> Deborah: Right, we had discussed that earlier that day, but it was in another class, what a trash free lunch was, we were going over the Camp Schmidt packet, so we were going over that, and in the packet, we had to discuss what a trash free lunch is, so with the other class we did, but with this class, (shaking head no).

In this reflection, Valerie points out that the broader question allowed Deborah to find out "what they thought a trash free lunch was." This defense of the question shows that Valerie valued the students' different interpretations as a way to discover their background knowledge on the topic. Valerie then steers the conversation back to the rubric, this time asking Deborah a yes-or-no question:

> Valerie: So in thinking about that question, where level 4 says the teacher's questions are uniformly high, with adequate time to respond, and students formulate many questions, would you think that that, does this evidence shows that level?
>
> Deborah: Uh uh.
>
> Valerie: Okay, what about um, most of the questions are high, with adequate time for students to respond
>
> Deborah: I would say a 3
>
> Valerie: Okay you would say a 3, thinking students had plenty of time to respond, they had lots of group opportunities,
>
> Deborah: Right and, the question posed I think a lot of insightful thought and response, so, I would say a 3.

In this exchange, Valerie repeats the qualities of a level 4 score, and asks Deborah if she thinks her lesson is at that level. Note that initially, Valerie asked Deborah "what's your thinking for quality of questions?" which prompted a narrative response from Deborah (without offering a score) whereas here, Valerie shifts to asking a yes-or-no question about the rubric score. Valerie knows she needs to make it through the entire rubric, so it is likely that here she is trying to focus Deborah's attention more on selecting a rubric score and less on time-consuming reflection.

When Valerie asks if the lesson showed evidence of level 4 questions, Deborah says no, so Valerie moves down to level 3 and asks Deborah if she thinks level 3 reflects her lesson. Deborah says yes, and Valerie restates Level 3, confirming that Deborah agrees with this, which she does. The characteristics of high-quality questions that Valerie is citing from the rubric include 3 things: the teachers' questions are "uniformly high," the students have "adequate time" to respond, and the students are asking questions, although Valerie only mentions the first two in this bit. Interestingly, when Deborah confirms that she thinks the quality of questions is a level 3, the reason she gives is that her question led to "a lot of insightful thought and response." So for Deborah in this moment, the quality of questions was more about the quality of the students' responses, which was not something that Valerie mentioned, likely because it is not part of the rubric. Deborah's response could be seen as a bid to discuss more of the substance of the students' responses, but Valerie doesn't take up this bid, as I will show next.

After Deborah shared what she score she thought her lesson deserved, Valerie confirmed that she agreed with that score:

> Valerie: Okay. I agree with that. I also said a 3. The students had lots of opportunity, and because the question was so open without the discussion of the trash free lunch, you did several things there. You brought out their misconceptions and confusions about trash free lunch and energy saving because they had the discussion about electricity, and you also um, gave them the opportunity to share their ideas without limiting them. So I do think it was

> a high level question. The lower level questions came in when you were walking around to groups. Your questions were mainly, um, to (inaud), what is your thinking, what have you recorded, that kind of question, instead of asking questions that dug a little deeper into why they thought a particular idea was one that they could carry out in the class. And also, I leaned more toward 3 than 2 because students were actually formulating questions on their own. They, I mean that group was challenging that other group about that electricity idea
>
> Deborah: Yeah they wouldn't let that go. We haven't seen, watched that tape yet, we're going to watch it tomorrow
>
> Valerie: Oh, okay. I just finished watching the tape again today.

Up until this point, Valerie was mostly just finding out what Deborah thought about the lesson, but here, Valerie offers her own judgment of the lesson. Specifically, she gives more detailed reasoning behind why she thinks the lesson is a level 3 in the *Quality of Questions* category. She elaborates on her earlier point that the broad nature of the original question allowed Deborah to find out their "misconceptions and confusions" about what they thought a "trash-free lunch" means. Valerie also praised Deborah for allowing them to share their ideas without "limiting them." Both of these reasons led Valerie to think the original question was a "high level question."

Valerie goes on to share that she also heard Deborah ask lower-level questions (although these weren't recorded in the evidence column of the FFT) such as "what is your thinking?" and "what have you recorded?" Valerie explains that higher-level questions would have encouraged the students to "[dig] a little deeper" into *why* they were thinking what they were thinking. This implies that in this moment, Valerie doesn't think that the question "what is your thinking?" is one that gets the students to dig deeper, even though students would likely be sharing their reasoning in answering this question.

Finally, Valerie explains that the reason she scored the lesson a 3 rather than a 2 was because the students were asking questions. She does refer again to the question about electricity, but the important thing is *that* they were asking questions and challenging each other, without comment on the quality or the substance of the questions. While she does note that the students were engaging in argumentation here, there is no mention on whether or how it was *scientific* argumentation. Note that the students' question about electricity will come up again in the *Discussion* category, and as you will see, Valerie will use the question as evidence for a very different (and somewhat contradictory) claim than what she's making here.

Discussion Category

After discussing the first three rubric rows (Expectations for Learning, Directions and Procedures, and Quality of Questions), Valerie and Deborah moved on to the Discussion category. Recall the Discussion row on the rubric is as follows:

Element	Level 1 Evidence	Level 2 Evidence	Level 3 Evidence	Level 4 Evidence
Discussion	Interaction between teacher and students is predominantly recitation style, with the teacher mediating all questions and answers.	Teacher makes some attempt to engage students in genuine discussion rather than recitation, with uneven results.	Teacher creates a genuine discussion among students, stepping aside when appropriate.	Students assume considerable responsibility for the success of the discussion, initiating topics and making unsolicited contributions.

Table 4-4: *Discussion* category

The following chart shows the section of the document that Valerie and Deborah were looking at together:

Element	Support and Evidence	
Discussion	Coach Observation	A small group of students are discussing whether or not trees are renewable or nonrenewable.; T: [When I was walking around, I saw one picture that seemed to be a thorn in everybody's side.] This group placed a picture on the line. S: We put forest in the middle because [it has trees in it and it takes a long time to grow back.] T: So what you said is… [if you cut down a forest it will take longer to grow back than one tree].; T: Let's leave that right there for a second. Everyone put the forest on the line.; T is holding up two trays (Chipotle bowl and cafeteria tray). <<Big question>> (on board): Since we're been learning about protecting our resources, I wonder if there is a way we can start at our school and possibly have a trash-free lunch. The teacher asks the students to talk within their groups about this idea. S: The important thing we can do is… (student asks to see the tray up close) S1: We can reuse this tray (Chipotle). S2: and I like the plate, we can just wash it off.; With a small group, T: If we were trying to have a trash-free lunch here at [school name], what could we do? S1: Use paper cups instead of Styrofoam cups because… S2: We can recycle the stuff we use… like recycle day on Tuesday and Thursday. S3: We can reuse these water bottles.; (Whole group) S1: Always use something that you can recycle. S2: Don't throw away stuff you can reuse. S3: Don't waste any kind of paper.; (Next table) S1: Instead of using trash bins, we can use recycle bins. S2: The second thing we can do is for people who walk right in… [do not get food you know you are not gonna eat.]; S: We can reuse bottles, plates [less electricity and less gas] T: So you're saying that… S: But how do electricity and gas go with the problem of a trash free lunch (question is directed to the group speaking). S: That's actually a good question.; T: Do you want to add on or do you [have another idea?] S: We want to add on… S: If we take all these ideas and put them together, [we can save the Earth].

Table 4-5: Evidence for *Discussion* category

Note that the evidence Valerie recorded for the *Discussion* category is significantly longer than what she recorded for the *Quality of Questions* category that we saw in the previous section. However, we also notice that Valerie sometimes only includes the beginning of the teacher's or students' statements. For example:

> S: The important thing we can do is…
> S1: Use paper cups instead of Styrofoam cups because…
> T: So you're saying that…
> S: We want to add on…

These partial statements resemble the "accountable talk stems" that are used commonly in ECPS to encourage students to connect their ideas in discussions.

Specifically, “I want to add on” and “so you’re saying that” are stems on the accountable talk documents used in the county; thus, it is unsurprising that Valerie noticed these particular phrases. By including only the “stem,” Valerie is leaving out the substance of the statement. For example, we don’t know *why* S1 thinks they should use paper cups instead of Styrofoam cups; we just know *that* S1 has a reason for thinking that. Without access to the substance of S1’s reasoning, Valerie and Deborah will not be able to discuss the students’ ideas as deeply.

In Valerie’s discussion of the *Discussion* category with Deborah, she will explain why she sometimes only includes the first part of a statement, so we will revisit that practice shortly. Valerie begins by describing how she chooses evidence for the rubric:

> Valerie: I'm gonna just flip through this a little bit to remind you what the lesson looked like. So it started out with - you know, when I record, um, evidence, I try to script the entire thing, and because I had video, I had more than I normally have for lessons, which is very difficult to pick and choose. But what I do is I go through and I choose parts of the discussion that um, lend themselves to the rubric, so that um, I use those phrases as evidence.

Here, Valerie explains that there is a lot of transcript from which to choose the evidence for each rubric category. In this observation, Valerie also videotaped the lesson, which she watched in order to help her fill out the rubric, so she had even more to choose from than typical observations. Because of this large amount of data, it was “very difficult to pick and choose,” but she decided what evidence to include based on what “parts of the discussion… lend themselves to the rubric.” In this reflection, Valerie is aware of and explicit about the fact that the rubric guides her attention and selection of evidence from the lesson.

Valerie continues by reading from the evidence on the rubric, interjecting frequently with explanations of her transcript conventions and interpretations of the evidence:

> Valerie: "A small group of students are discussing whether trees are renewable or nonrenewable." And whenever you see brackets, that means that I'm paraphrasing something that you've said, if it's after a colon, then it's direct, obviously an ellipses, that's the beginning of your statement and I don't have the end. But there may be a reason I chose just the beginning of your statement, so we'll talk about that as we go. So the teacher says "when I was talking around, I saw one picture that seemed to be a thorn in everybody's side", and you talked about the group that placed the picture on the line
>
> Deborah: Mmmhmm (nodding head yes)
>
> Valerie: um, and the students defended their thoughts. "We put forest in the middle because it has trees and it takes a long time to grow back. Teacher says, so what you said is" so there you're eliciting repetition, confirming their idea, "if you cut down a forest it would take longer to grow back than one tree" and they talked a little bit about that, there's a semicolon there, meaning there was a pause in the conversation. They talked a little bit about that, and you went back and said, "well let's leave that right there for a second, everyone put forest on the line," so that shows that that's something they would come back to.
>
> Deborah: Mmmhmm (nodding head yes)

Here, Valerie describes some of the transcription conventions she used, such as putting an ellipses where she has the beginning of a statement and not the end. She explains that “there may be a reason [she] chose just the beginning,” which she’ll talk about as they go through the evidence. Indeed, after the lesson, Jen talked to Valerie about the transcript, and Valerie mentioned that sometimes statements only have the initial phrasing because Valerie “is most interested in is not necessarily the question itself but the starter” (Richards, 2011). By including only the starting phrase of a statement or question, Valerie is communicating that the substance of the question doesn't affect the rubric score and thus shouldn't be a focus of her notes or of the conversation.

Returning to the post-observation conference, Valerie continued reading the evidence for the *Discussion* category. We see that Valerie doesn't always leave off the substance of a student's reasoning. For example, she recorded one group's idea that a forest isn't strictly renewable or nonrenewable, because individual trees can grow back, but an entire forest takes a "long time" to grow back. While Valerie included that idea in the "evidence" for the discussion category, when she read it to Deborah, other than saying the students were "defending their thoughts," she didn't call any special attention to the idea by unpacking the idea herself or asking Deborah what she thought of the idea.

The mention of the forest idea was a missed opportunity to delve deeply into the main idea of the activity – renewable resources – and how students were thinking about that concept. The students' placement of "forest" shows that there's a blurry line between renewable and non-renewable resources, and one can imagine that this idea could have led to a productive discussion about what it means to be renewable. Deborah seemed to think this was an interesting idea to explore in the moment, since she subsequently had every group place their forest card on the center line, but they didn't come back to it in the lesson. The post-observation conference could have been a time for Deborah to think more about how to respond to this idea with Valerie there as an experienced science teaching resource. However, Valerie did not provide the space to discuss the generativity of this idea in detail. Instead, Valerie continued reading the evidence for the Discussion category and never came back to discuss the idea:

> Valerie: So then the teacher's holding two trays, there was a chipotle bowl and a cafeteria tray, and the big question again, (so it's), and the teacher asked the students to talk in their groups about ideas. So the next set of information is little snippets of what the groups were saying to each other. So one student says, "the important thing we can do" and the student asks, paused right in the middle of his statement, and asked to see the tray up close, because they wanted to compare the trays to... okay so here we have student 1 says "we can reuse this tray", referring to the chipotle tray, and student 2 says, "and I like the plate" which for me I was unsure what the plate was referring to
>
> Deborah: The plate was the (inaud) Styrofoam plate thing yeah
>
> Valerie: The Styrofoam plate, okay, "we can just wash it off" and then there's a semicolon. And then we're noticing that there's two students. Um, another group, you asked the question, if we were trying to have a trash free lunch here at [school name], what could we do, that's an, um, an example of a question where you were just asking (what they responded to and not how that connects to, or how that would relate to food...) and a student responded, "use cups instead of Styrofoam cups because…" so because, the student was providing a reason, student 2 "we could recycle the stuff we use like recycle day on Tuesday and Thursday" student 3 "we can reuse these water bottles." So there we had 3 students speaking, and the important thing there, about the three students and I didn't note, was that every person in the group shared a response, whereas in the other group, there were only 2 speaking. (jotting something down).

In this segment, Valerie is reading more of the back and forth between the students during the group discussions. She mentions several student ideas, such as "we can reuse this tray" and wonders what the students were talking about when they said "I like the plate," but she doesn't focus on the substance of their ideas. Instead, she directs Deborah's attention to the number of students speaking in the various groups when she says "And then we're noticing that there's two students" and "there we had 3 students speaking." Valerie goes on to say that "the important thing there… was that every group shared a response, whereas in the other group, there were only 2 speaking." Here, Valerie is completely focused on the participation patterns in the group - who is doing the talking, how many are talking – effectively directing Deborah's attention to who is doing the talking and how many students are participating instead of the substance of what they're saying.

Notably, in this segment, Valerie uses the transcription strategy she mentioned earlier – including just the initial phrase of a sentence – when she quotes the student who says "use cups instead of Styrofoam because…" Valerie interjects there, pointing out to Deborah that "the student was providing a reason" because he said "because," without mentioning what the reason was. To Valerie in this moment, what's important is just the fact that the student was giving a reason for his idea. While this focus could be considered attending to the students' scientific practices (giving reasons for ideas), here the substance of the reason doesn't matter. In the condensation episode, Valerie was attending to the *kind* of reason students were giving, specifically commenting on the level of mechanism present, which doesn't seem to be important to comment on in this bit.

Valerie continues reading the evidence out loud:

> Valerie: So and then in the whole group, a student said, "always use something that you can recycle" another student shared "don't throw away something you can reuse" another student shared "don't waste any kind of paper" The next table, "instead of using trash bins, we could use recycle bins" "the second thing we can do is for people who walk right in" that's the point where they were talking about students who just walk in and waste food, so then again, we're going, as the students are sharing out whole group, more than one student is sharing from a group, go to another group, more than one student is sharing from another group… the teacher (begins) "so you're saying.." and then there's a student, they're challenging him, "how do electricity and gas go with the problem of a trash free lunch?" And the question is directed at the group who is actually speaking. So then a student from that group says, "that's actually a good question" and I paused that there, because the students in that group are now realizing okay maybe we weren't

> really focused on the right thing when we were talking about a trash free lunch, which helps them to understand that we got a little off task with what we were talking about. And they weren't actually able to come up with a reason for why electricity had anything to do with a trash free lunch, but it shows that they're thinking. Um, you asked "do you want to add on?" there's that accountable talk, encouraging its use, and the student repeated "we would like to add on" and he finished his statement and then the student summed it up at the end, "if we take all these ideas and put them together, we can save the earth." (the end of the conversation)

Here, Valerie again focuses on the number of students who are sharing out from each group ("more than one student is sharing from a group") rather than the ideas that the groups are sharing. Then, she recalls the argument that happened between two of the groups: one group said they could use less electricity and gas from reusing water bottles, and another group responds "How do electricity and gas go with the problem of a trash free lunch?" Valerie notes that "the question is directed at the group who is actually speaking" which she will later praise because the students are "challenging each other" without the "teacher interjecting." Valerie does say that the group who mentioned electricity was "thinking," which she thinks is good, but she also thinks they were "not focused on the right thing" and "a little off task with what [they] were talking about." These reflections demonstrate the variability in what Valerie is valuing in this lesson. Recall that in the *Quality of Questioning* category, Valerie used the group's question as evidence for a *higher* score because the students were "formulating questions on their own." This is partially consistent with her praising of the students' "thinking" here, but she also considers the substance of the question here when she deems it "off task." This variability in judgment shows the importance of attention in observing classrooms: depending on what aspects of a classroom you are attending to, you can have significantly different interpretations of an interaction.

Valerie continues by highlighting the accountable talk that the teacher and student used (“Do you want to add on?” “We would like to add on”), noting that the student “finished his statement” without saying what the statement was. Again, Valerie is noticing the language around the ideas rather than the substance of the ideas themselves. Note that the accountable talk language that Valerie attends to has some merit: these phrases encourage students to listen and respond to each others’ ideas. However, there is again a missed opportunity to talk about the students’ scientific thinking.

Valerie then asked Deborah how she would score herself in the Discussion category, given all of this evidence:

> Valerie: So based on the whole group conversation, what was occurring in the small groups, what do you think about that discussion? (Valerie looks at rubric – Deborah also turns to look at rubric)
>
> Deborah: I would actually say that's a 2
>
> Valerie: Okay so why do you say it's a 2?
>
> Deborah: Well, uh, because when I was going around from group to group, I was attempting to have them really focus in on coming up with a possible solution, you know, even to put the ideas in the air, go through their ideas and come up with something that might work. And, um, that didn't happen. A couple of students were just kind of repeating what some of the other students were saying, because I don't think they really had a good idea, they didn't want to come up with, they didn't want to put anything out there. Like okay, I'm not going to say this, that type of thing. So I'm kind of torn between there and here, a 2 and a 3. Because when they would have the discussion, they would throw out, you know, how can your group say so and so, I'm just like, okay, just go for it.
>
> Valerie: Okay so when you said okay, go for it, what is that?
>
> Deborah: That for me, when they know, if they're having a discussion and somebody disagrees, and I can see that they're really, I really just don't agree with that, okay so I just take a seat, and I just slide my chair back

> Valerie: Okay, so would you say that the teacher is stepping aside when appropriate?
>
> Deborah: Yeah
>
> Valerie: Okay, so I scored that a level 3, cause that's what I saw. When you have an opportunity to have students talk as groups, and a discussion is occurring, and more than 1 or 2 students - more than 1 or 2 students are participating in the conversation instead of 1 or 2 students dominating the entire conversation, we actually had groups where students were taking a turn to speak, seat by seat, and also, in whole group, they were challenging each other, discussing with each other, without you interjecting, and that is stepping aside when appropriate. In a level 4 that would be, when students would initiate topics and kind of change it and take it in a different direction, which wasn't really fitting here, but that doesn't make it any less of a discussion, cause you're giving them a great opportunity for students to share their ideas.

In this exchange, Deborah shares that she was concerned that not many students were sharing ideas, but instead she felt that many students were just repeating each other. She had hoped students would come up with a lot of different possible solutions, and they would collectively "go through their ideas and come up with something that might work," but she didn't think that happened. Deborah considered that maybe the discussion was a level 3, because of the fact that the groups argued with each other ("how can your group say so and so?"), but overall, she didn't "think they really had a good idea." Valerie responded by asking Deborah about her move of letting the students just "go for it," suggesting that that move qualifies as the teacher "stepping aside when appropriate," which is directly from the rubric. Valerie then explained why she gave Deborah a 3 in the discussion category, focusing on participation patterns: more than 1 or 2 students were participating in the conversation, multiple students from each group shared, and groups challenged each other. Valerie did not address Deborah's concern about the quality of the student ideas in the class, but instead praised Deborah for "giving them a great opportunity for students to share their ideas." Valerie continued by noting that "it's very easy for them [to share their ideas] because they were very comfortable." In this exchange. Valerie and Deborah seem to be talking "past" each other: Valerie doesn't pick up on Deborah's concern and instead focuses on how much the students are talking.

Throughout the discussion about the *Quality of Questions* and *Discussion* categories, Valerie's attention was primarily on getting through the rubric and deciding on a score for each category. This focus is not surprising; the main purpose of this conference is to come to an agreement with Deborah on how the lesson scored in each category. I will detail Valerie's attention modes in the discussion section. Next, I will present data from an interview I conducted with Valerie after the post-observation conference to show further evidence of Valerie's attention and framing of the conference.

Interview with Valerie about post-observation conference

Ten weeks after the post-observation conference with Deborah, I interviewed Valerie about the observation cycle to find out more about the process she used to conduct the observation and post-observation conference. Specifically, I wanted to learn more about why Valerie engaged in the process the way she did. I also wanted to investigate how "stable" Valerie was in discussing the lesson. I found that much like the post-observation conference, in this interview, Valerie was very deliberate and systematic in her use of the rubric. She used much of the same language as she did in the conference with Deborah and explained the scoring in the same way. In this section, I will present data from the interview and will argue that Valerie is framing her post-observation conference with Deborah in a very particular way. Specifically, she following standard operating procedures and simultaneously trying to give Deborah the highest possible score on the rubric.

In the interview, I started by asking Valerie how she prepared for the conference. Valerie explained that she first takes the transcript from the lesson, types it up, and selects segments to put into the scoring rubric. Similar to what she told Deborah in the post-observation conference, Valerie explained that she finds the segments from the lesson that match up with the different rubric categories. So, for the questioning category, she finds the questions that were asked in the lesson, focusing on parts of the lesson in which "students are asking a lot of questions" because that will give the teacher a higher score. The highest scores for the questioning category also require that most of the teacher's questions are "high quality." I asked Valerie how she determines that:

> Colleen: Um, so I guess talking, thinking a little bit more about that, once you have, you know like a list of questions that the teachers or the students are asking, um, how do you figure out like if they're high quality, you know mix of low and high quality, how do you kind of figure out where on the rubric that fits?
>
> Valerie: Actually what I'll do is I'll go back and I'll look at all of the questions, sometimes I have write symbols, I write a Q next to it so that I know it's a question, so that when I'm trying to decide if they're high or low quality, I'll go back. 1 is fairly easy, that's the low cognitive, that is, what colors are in the rainbow, how many sides to a cube, you know, that quick question that has a one word answer. But the high and low would be, for example, if they used 3 high level questions and 3 low level questions. The thing about level 3 is that the majority of the questions that the teacher asked were higher level questions. And we don't limit it to the questions that were asked in class, we include the questions that were asked on worksheets, because sometimes those question they discuss as a class, so I'll copy and record them. If the number of high quality questions is higher than the number of low quality questions, if it's like 6 to 4, then they'll score in a level 3, because it says that most questions, even so. If 2 or 3 questions are posed by the students that change the direction of the discussion, would definitely score in the 3, because most of the questions are high quality, and they're close to 4 because they have

> students asking questions. But if the students are asking questions and virtually all of the teacher's questions were high level and there was no how many sides to a cube type question, then that would be a level 4.

In this response, Valerie elaborates on how she determines a score based on the distribution of questions: if the majority of the teacher's questions (6 out of 10) are high level, then the teacher would score a 3, and if the students also are asking questions that "change the direction of the discussion," then the teacher would score a 4[19]. I asked Valerie to elaborate on what she sees as being a high level question, and she explained that high quality questions require students to make comparisons, apply something they've learned, create something new, or analyze situations. I then asked Valerie to think about question level in the context of Deborah's lesson. We looked together at the rubric that Valerie filled out for Deborah's lesson, and I asked Valerie if the questions she listed were examples of high level questions. She responded:

> Valerie: So the overarching questions for the day was asking students to develop a trash free lunch, which we- I would consider a high level question, because the students are asked to think about their instruction, their conversations about resources, what's good, what's bad, what we need to do, how trash is affecting us, they're being asked to create a plan for their school. So they're connecting it to something real, based on knowledge that they've previously gained, so we would consider that higher knowledge. They're not just making a list of trash for her, they're saying, okay we have all this trash, what can we do to help our whole school be better for our environment. So that would be considered, um, a higher-level question.

Valerie starts by recalling the "overarching question" that Deborah had posed at the beginning of the lesson – How can we develop a trash free lunch? Valerie thinks this is a high level question because it's asking them to create a plan based on what they've already learned, and it's connected to the real world. Here, she's making a

[19] Note that this characteristic for a Level 4 discussion does require attention to student thinking; to identify a student question that changes the direction of the discussion you must be attending to the substance of the discussion.

claim about the what the students are doing ("they're connecting it to something real") based on what the question is asking them to do ("they're being asked to create a plan for the school"), not based on how they actually respond to the question. In this moment, Valerie is attending to the substance of the teacher's questions without attending to the substance of the students' answers and using the teacher's questions as evidence for "higher level" thinking.

Valerie continues by talking about why she scored a 3 rather than a 4:

> Um, there's a question here about a students, and the reason that this wouldn't have scored a 4 is because there was that big overarching question for that day, and there weren't a lot of other questions being asked, because the type of activity, that's not necessarily a bad thing, it's because the class was truly student-centered that day, and most of the students were doing the talking, so there weren't a lot of teacher questions that the students were responding to, they were still working on the overarching question. But a student did, the students did ask a question to challenge another group. So that was something I recorded, so that definitely solidified the questioning for that day at a 3, even though it was part of a 4, it wasn't enough of a 4 to carry on. And because of the nature of the activity, it was kind of difficult to hear if each group of students was asking questions of each other, but whole group, there wasn't a lot of student questioning, so I wouldn't put it in the 4 category. Had 5 or 6 students come up with that questioning, then it would have fit into a level 4.

In this response, Valerie emphasizes the importance of student questioning. Specifically, she's noting that the lesson was driven by the overarching question, which is "not necessarily a bad thing," but with more student questions, the *Questioning* score would have been higher. She states that the students are mostly "working on the overarching question" which shows Valerie is attending somewhat to the substance of their discussion; otherwise she would not be able to make that claim. Note that here, Valerie is suggesting that if the discussion had diverged *more* from the teacher's overarching question, that would have garnered a higher score in this category. Furthermore, she mentions the group's electricity question as an example of something she would like to see more of. Recall that in the post-observation conference, Valerie expressed contradictory opinions on this particular question. At one point, she liked the question because the students were "formulating questions on their own" and challenging each other, and later in the conference she called the question "off task."

In each of these moments, Valerie is noticing the same student question but valuing it in a different way depending on the context in which it comes up. In the *Quality of Questions* category of the FFT, the highest score requires that a student's question "changes the direction" of a discussion, and within the context of that category, Valerie praises the question for being student-initiated and challenging another group. However, within the context of the *Discussion* category, Valerie judged the question as being "off task." This is a bit surprising because the Level 4 evidence for the *Discussion* category requires that "Students assume considerable responsibility for the success of the discussion, initiating topics and making unsolicited contributions." The electricity question was certainly an "unsolicited contribution" and could be considered an "initiation of a topic." We get more information about how Valerie decided on a score for the *Discussion* category in the next part of the interview:

> Colleen: Okay, um, so, so what about for the discussion, for the quality of the discussion, so there's a whole lot of stuff you, um, included here… can you talk a little bit about how, um, you decided this sort of discussion was a 3?
>
> Valerie: The pieces of this discussion are cut off by semi colons and the reason I chose these snippets is they showed connections, student connections to what each other was saying, um verses being a teacher-student conversation. So section 1 says that the interaction is primarily between teacher and student, so that would be teacher asks a question, student responds, teacher asks a question, student responds. So the reason I chose

> these snippets is because it goes from teacher to students, and at times another student would make a comment, another student would make a comment, and if we step back and look, and see S1 and S2, when the conversation is going back and forth between students and a different student joins the conversation, I count the number of students that respond to that particular question, because it shows that it's not teacher to one student type of conversation, it's teacher to student to student to student to student, and then back to teacher. So this, level 4 says the students assume considerable responsibility for the question for the success, initiating topics and making contributions. Because the discussion pretty much stayed on topic, because they had a focus for the day, students weren't pulling outside information in and changing the direction of the conversation, which sometimes is a good thing and sometimes is bad, so for this lesson they had a focus, so we didn't want to go too far off. But 3 says that the teacher creates a genuine discussion between students, and she did that by having them to work in small groups and talk with each other, so that's a clear 3 for that one.

In explaining her choice of a 3 for the quality of discussion, the first two-thirds of her explanation is solely about the participation patterns in the lesson. She selected evidence from the discussion where the discussion moved from the teacher to a student, to another student. She explains that she “count[s] the number of students that respond” which shows her whether it’s a student-centered conversation.

Valerie then talks about the topic of the discussion: a level 4 discussion would require students to introduce new topics, which didn’t happen in this lesson. Instead, the discussion stayed “on topic” because they had “a focus for the day.” Valerie actually cites language from the *Quality of Questions* category by saying the students didn’t “[change] the direction of the conversation” and notes that “sometimes is a good thing and sometimes is bad.” In this comment, Valerie seems to realize that she has been inconsistent about this in the post-observation conference. Although, of course she may not see this as inconsistent: there may be certain lessons when it’s productive for students to change the course of the discussion and others where it’s not. Valerie emphasizes that “for this lesson they had a focus,” suggesting that when the teacher has a specific goal in mind, Valerie thinks students should not change the direction of the conversation.

Summary of Framings

In this chapter, we have seen Valerie exhibit several different ways of framing the task of classroom observation. In this section, I will briefly summarize the two most salient framings: (1) Focusing on students' ideas and engagement in scientific practices and (2) Focusing on getting through the rubric. These two framings are largely in tension: when Valerie is focusing on getting through the rubric, she does not attend closely to student thinking.

Within the second framing, I will specify two sub-modes: (2a) Focusing on parsing participation patterns and (2b) Focusing on the substance of the teacher's questions. As I will explain, while these frames are locally coherent, they are not mutually exclusive and they do not exist at the same grain size. Instead, some frames (2a and 2b) are nested within frame (2). Furthermore, these are not the *only* ways Valerie attended to classroom interactions, but they were the most prominent and capture most of the talk in my data corpus. I will now summarize each frame using examples from the data.

(1) Focusing on students' ideas and engagement in scientific practices

Behavior consistent with this framing was seen primarily in my initial interview with Valerie. During the interview, Valerie noticed specific students' ideas and often tried to figure out what they meant. For example, Valerie noticed Daniel's idea about the unopened soda can and she spent time trying to figure out what he meant and how that idea supported his explanation. Valerie also attended to how the students were engaging in scientific practices. For example, Valerie was attending to the students' level of mechanistic reasoning when she noticed they were talking about *where* the condensation without considering *how* it got there. This type of attention happened frequently in the initial interview but not in the post-observation conference with Deborah, as we saw in the analysis. Next, I will summarize the attentional framing Valerie exhibited in that conference.

(2) Focusing on getting through the rubric

During the post-observation conference with Deborah, Valerie had an overarching focus on getting through the FFT rubric. The substance and structure of the rubric determined the substance and structure of Valerie's conversation with Deborah. Valerie walked through the categories of the rubric in an extremely methodical fashion: for each category, she first read the description of the levels from the rubric, then read the evidence she recorded, then asked Deborah what score she thought was appropriate, and finally Valerie reported the score she gave the lesson and why.

When Deborah showed interest in discussing a specific student idea, Valerie often acknowledged the idea but quickly redirected Deborah to thinking about the rubric score. For example, Deborah was very interested in talking about the students' "water bottles and electricity" idea, and while Valerie says they can talk about it later, they never do come back to it. Valerie then redirected Deborah to the rubric by asking her what score she thinks should be assigned for the *Quality of Questions* category. This example is evidence that Valerie's focus in the post-observation conference was resilient to perturbations. Because of this resiliency, we can conclude that her framing in the conference was rather coherent and stable. Next, I will examine two of the finer-grained framings that were nested within this overarching framing of the *Discussion* and *Quality of Questions* categories of the FFT.

(2a) Focusing on parsing participation patterns

During the post-observation conference, Valerie exhibited finer-grained framings that were consistent with, and in fact supported the broader goal of getting through the rubric. One of these subroutines is parsing student participation patterns in the lesson. In the FFT rubric, the *Quality of Questions* and *Discussion* categories primarily focus on *who* is doing the talking. Students talking to each other and asking each other questions earns a higher score, while a lower score is assigned if the teacher is controlling the conversation. Therefore, it is no surprise that Valerie spent a lot of time focusing on the participation patterns in the lesson without much attention to the substance of the discussion. For example, in the interview after the post-observation conference, Valerie explained why she scored the lesson a 3 for the discussion category in the following way: “I count the number of students that respond to that particular question, because it shows that it's not teacher to one student type of conversation, it's teacher to student to student to student to student, and then back to teacher.” In this statement, Valerie was attending solely to who was talking when, not the substance of what they were saying, so she is framing the activity in this moment as *parsing participation patterns.*

(2b) Focusing on the substance of the teacher's questions

Within the broader mode of *getting through the rubric*, Valerie also sometimes attended to the substance of the teacher's questions in the context of the *Quality of Questions* category which considers the "quality" of the teacher's questions (but not the students'). So, while Valerie did not attend much to the substance of the students' ideas, she did attend some to the substance of Deborah's questions. For example, on the rubric itself, Valerie recorded Deborah's question, "since we've been learning about protecting our resources, I wonder if there is a way we can start at our school and possibly have a trash-free lunch." In discussing this question with Deborah in the post-observation conference, Valerie noted that it was "so open," and in the later interview, Valerie restated the question as, "okay we have all this trash, what can we do to help our whole school be better for our environment." In these statements, Valerie is attending to the substance of her question by identifying it, interpreting it, and judging it to be high level. Furthermore, recall that Valerie attended to the stems of the students' questions but not their substance, consistent with Valerie's focus being on the *teacher's* questions.

Conclusions and Implications

I started this chapter by asking what is at risk when we try to align leaders' observations of classrooms. While alignment in classroom evaluations is a valuable goal, it is only as valuable as *what* observers are being asked to align around. In this chapter, we have seen the substantial impact that one observation tool has on a science leader's observations of classroom episodes. While Valerie is *able* to attend closely to the substance of students' thinking and engagement in scientific practices, the observation rubric effectively prevents her from doing so. Do we want educators to align around a tool that discourages a focus on student thinking? This question calls into the question the *goals* of leaders' observations of classrooms. The Danielson Group (2011) emphasizes the high interrater reliability of their observation tool; if the goal is reliable scoring, then the FFT is successful. But, if we want to assess the *disciplinary ideas and practices* present in a classroom, the FFT does not meet that goal. In other words, the FFT may be a *reliable* tool, but if it is not a *valid* measure of students' engagement in disciplinary practices, then it has limited value for improving teaching and learning.

The problems associated with reliable teacher evaluation echo the challenges around student standardized testing: is it possible to have a reliable, inexpensive, widely used assessment that is also assessing meaningful learning in each discipline? I do not know the answer to this question nor do I know how to create a better teacher observation instrument. It is a difficult problem to solve, because of the wide variety of leaders who must assess teacher practice. While Valerie is an experienced science teacher and coach, there are also principals with no science experience who must use the FFT to evaluate science teachers. If an observation tool *did* have components specific to disciplinary ideas and practices, many principals would not know how to use it. One possible solution to this problem is an increase in "distributed leadership" (Spillane, Halverson, & Diamond, 2001), where leadership tasks are distributed over multiple leaders in a school district and disciplinary experts observe lessons using an observation tool that reflects the sophisticated practices of the discipline. Researchers continue to explore the implications of distributed leadership, but as long as leaders use generic observation tools such as the FFT, attention to disciplinary substance is unlikely to happen. In order to use the FFT *and* conduct a meaningful classroom observation, Valerie would have to be aware of the tool's limitations and strategize around how to overcome those limitations, much like Ms. Diggins did in the beginning of the chapter.

Chapter 5: Conclusion

In this Chapter, I will first summarize the results from Chapters 3 and 4, relating conclusions to the issues raised in Chapter 1 about the importance of educators developing shared goals for science education. I will then explore the notion that observation is an inherently subjective task, connecting my findings to work philosophers have done on representation. Next I will consider directions for future studies, and finally I will discuss the implications this work has on educational practice.

Summary of results

In Chapter 3, I showed the many ways that educators could attend to and interpret the same short science classroom episode. Importantly, I determined that much of the variability in interpretation could be attributed to differences in how participants were framing the activity of watching the episode. When participants framed the activity as *trying to figure out what the students meant,* they attended primarily to the substance of students' ideas. When participants framed the observation task as one about evaluating the teacher's use of certain terms, they attended to what the teacher was saying at the expense of attending to the substance of student thinking. When participants framed the task as one about the correctness of students' ideas, they attended more closely to those ideas that were closer to the canon.

In some ways, these conclusions are quite circular - what an observer attends to is used as evidence of an observer's framing. This circularity highlights how closely attention and framing are intertwined. Framing adds an important layer, though, because without it, we could describe what a person is attending to without thinking about *why* they are attending in particular ways. In Chapter 3, framing helps us to understand that people are actually engaging in different activities when they watch the clip; it's not just that they happen to attend to a different set of features in the classroom. Instead, the patterns in what participants attended to serve as evidence that people often had entirely different observational lenses when watching and interpreting the clip.

The findings in Chapter 3 speak directly to the issue of developing shared goals for science education that I raised in Chapter 1. Researchers have primarily focused on how we should work to align educators' *goals* for what should happen in the classroom without addressing the possibility that educators could disagree about what they see when they observe an actual classroom. In Chapter 3, we saw that educators saw very different things when they watched one single five-minute classroom episode. Some educators thought it was an exemplar of effective science teaching and learning while others thought there was not much student reasoning or learning happening in the clip. Recall that many of these educators work closely together, either in the same professional development project or in the same school. These are educators who talk frequently about effective teaching and learning in the abstract and likely think that they share a vision for the science classroom. Indeed, one principal, Shelia, could not fathom that someone would not share her high praise of the focal clip. When educators do not realize that they disagree about what is or should happen in the science classroom, they will not be able to work together to effectively improve science teaching and learning.

In Chapter 4, I explored the variability in attention exhibited by one science coach in different contexts. I found that Valerie doesn't just have one way of looking at classrooms but that her attention is highly dependent on context. Specifically, I explored the influence that a county-mandated observation rubric had on Valerie's attention. I showed that Valerie is quite skilled at attending to student thinking and engagement in scientific practices in some contexts, but her attention is pulled away from those things when she uses the FFT rubric to observe classrooms.

To explain this shift in Valerie's attention, I determined that the FFT rubric influences how Valerie frames that task of observation. Without the rubric, Valerie often framed the classroom observation task as *trying to figure out what a student means*. When using the rubric, Valerie exhibited an overarching framing of *getting through the rubric*, which included several finer-grained framings such as *parsing participant patterns* or *evaluating the teacher's questions*. In sum, the FFT rubric pulled Valerie's attention away from students' ideas and engagement in scientific practices, even though she was skilled at it and thought it was a valuable thing to do.

The inherent subjectivity of observation

The act of observation results not in a description of reality but in an interpretation of it. The substance of that interpretation depends on what is attended to in that reality, which as we have seen in this dissertation can be highly variable. Any classroom has an almost infinite number of things to notice, which means the reality of a classroom can never be fully captured in any description or observation instrument. This challenge of representation is not one that is unique to education. Any representation of reality, no matter how detailed, is not the same as the thing that is being described as philosopher Alfred Korzybski (1933) articulated in his famous statement “the map is not the territory” (p. 750).

The benefit of a map is that it includes only the most important features of the territory. As economist Joan Robinson argued, "A model which took account of all the variegation of reality would be of no more use than a map at the scale of one to one" (as cited Harris, 2004, p. 3). As the cartographer must make decisions about what to include in his map, so does a classroom observer when attending to classroom episodes. These decisions may be relatively conscious; for example, a principal may want to see if a teacher is calling on boys and girls equitably, and her representation of the teacher’s class is a set of tally marks.

Even if an observer does not have an explicit focus in mind, an observer’s attention must be selective in *some* way, whether she is aware of it or not. Sometimes the observer’s attention is driven by something explicit, such as the FFT rubric, while other times it is less obvious why someone’s attention is focused in a particular way. Either way, observers can literally *see different things* in a classroom depending on what they are attending to.

Gregory Bateson helps us understand this phenomenon by extending the metaphor of the territory and the map. Bateson (1972) argued that while it is obvious that the *map* is a representation of the territory, there isn’t actually any way to understand the *territory* on its own terms. Instead, even viewing the territory is an act of representation. As Bateson explained:

> Operationally, somebody went out with a retina or a measuring stick and made representations which were then put on paper. What is on the paper map is a representation of what was in the retinal representation of the man who

> made the map; and as you push the question back, what you find is an infinite regress, an infinite series of maps. (p. 461)

What is included in any representation of classroom practice, whether it's a completed FFT rubric or a free-form narrative ultimately comes from the "retinal representation" of the observer. In this way, an observer isn't describing and evaluating a *classroom* but instead describing her perception of a classroom. When attention is variable, this perception can change.

The finding that differences in attention drive differences in observation and interpretation is what connects Chapter 3 and 4 of this dissertation. The FFT rubric is a highly conspicuous contextual factor that influences attention, and does so very strongly and stably for Valerie. But, it is just one thing out of many that can influence attention, and other attentional influences are likely less conspicuous.

Indeed, in Chapter 3, participants' attention was pulled in many different ways, and it was not immediately obvious what was driving those shifts in attention. At times, participants cited specific tools, such as Donna's mention of the Depth of Knowledge chart, which seemed to be strongly influencing her attention, and in turn, her interpretation of the clip in those moments. Other times, participants' attention seemed to shift within one reflection with no external cue as to why it did so. For example, Lynn shifted from attending to student thinking to correctness within the same utterance.

Improving my studies to better answer my research questions

Before discussing how I would expand on this study to answer new questions that came up in the course of research, I will briefly reflect on how I would change my study if I were to do it over again. In hindsight, there are ways that I could have improved my study differently to more effectively answer my research questions.

If I were to redo the interviews that were the basis for Chapter 3, I would be more consistent in what I asked participants and how I asked it. I used a semi-structured interview protocol, but in some interviews I deviated more from it than in others. If I want to make claims about how different people attend to one classroom episode, I want the interview context to be as similar for participants as possible. Another way I would want to improve the study in Chapter 2 is to find a video clip that is publicly available. I want readers to be able to see the episode for themselves, not just read about it, so that they can compare what they think about the episode to what the participants said.

In Chapter 4, I cannot make broad claims about patterns in Valerie's attention because the data I have is from so few contexts. I would want to see Valerie engage in an observation cycle with several teachers. One possible reason Valerie did not attend to student thinking in Deborah's classroom is that the quality and quantity of student thinking in Deborah's classroom was significantly different than that in the videotaped episode. I want to see Valerie observe classrooms with similar types of mechanistic reasoning that came up in the condensation episode to see if she attends differently in such a classroom.

Directions for Future Study

This study only begins to characterize the nature and causes of the variability in educators' attention. It also introduces new questions that would be worthwhile to pursue. Much more work must be done to look at all of the different ways that educators attend to classrooms. I interviewed educators who were in the same professional development project or close to a teacher who was; it is possible that educators in other institutional contexts would have different lenses through which to look at classrooms. Educators in various independent schools could be interviewed to investigate the different influences that teachers in public versus private school face. Policy makers and higher district leaders could also be interviewed. Once we have a larger corpus of data we might begin to see patterns that were not apparent in my small data sample.

In addition to characterizing the different ways that educators look at classrooms, I am also interested in exploring the interactions and influences between educators. It is possible that we could trace certain patterns through a network of educators who interact on a regular basis. With this data, we could try to find out where a certain curricular "push" is coming from – an initiative might be coming down from the state science office that district leaders must follow in their teacher evaluation practices. In my study, some participants spontaneously shared information like this, noting where their own views diverged from the policies they were required to follow. For example, Rachel knew that her administrators were looking for questions to come from the Depth of Knowledge chart, but she knew that did not necessarily correspond to high quality questions. By mapping out the ways that supervisors and policies influence teachers' attention, we could more effectively use these pathways to improve teaching and learning.

Rachel's awareness in the previous example suggests another worthwhile direction for future research: When are educators *aware* that their ideas about effective teaching and learning are different from the ideas of others? Why are some educators more aware of these misalignments than others? These are important questions because educators cannot begin to develop a *truly* shared vision for science teaching and learning until they realize that they don't have one. Recall that Shelia couldn't believe that anyone would think the focal clip was anything other than excellent. If she learned the some educators have a strongly negative reaction to the clip, she would be highly motivated to understand why they had that reaction, and this could spark a deep discussion about their different notions of good teaching and learning.

For Valerie, we would need *much* more data to begin to make claims about the rubric's influence on her attention. As mentioned in the previous section, the differences in Valerie's attention may partially be due to the different quality in the students' ideas and engagement in scientific practices in the two contexts. To further characterize variability in Valerie's attention, I would look at Valerie's behavior in many more contexts. If she saw Deborah do a lesson on condensation similar to the one we saw in the video, would we see Valerie thinking more about the students' mechanistic explanations? Valerie might also interact with different teachers in different ways. If Valerie knows a teacher is more experienced with "inquiry," then maybe she would focus more on students' engagement in specific scientific practices.

Coming back to the issue of *awareness*, I am also interested in what Valerie thinks about the use of the rubric. Is she aware of the pull it has on her attention? Valerie may have thoughts on the county-mandated rubric she is not comfortable sharing if she felt it might jeopardize her good standing in the county. She also may be taking a decidedly pragmatic approach: principals are using this rubric to evaluate teachers, and she wants to help the teachers do well in their evaluations whether or not she believes it is the best measure of good teaching. Of course this is all speculation, but it suggests the potential generativity of more in-depth interviews with Valerie about what she thinks about the value of the rubric.

Implications for practice

A person's attention is always going to be highly variable, sometimes to a life-saving effect: a hunter-gather focused on gathering berries *must* shift his attention when he notices a nearby predator. So how then can a classroom observer make progress in the nature and substance of her attention, progress that supports improvement in teaching and learning? Answering this question in its entirety is beyond the scope of this dissertation, but I will make some suggestions.

First and foremost, the more a teacher or observer is *aware* of the pulls on her attention, the more she will be able to control it. As I shared in the introduction of this dissertation, while my own attention as a teacher is often pulled away from the substance of student thinking, I am usually aware of it. I *want* to focus on students' ideas, but some other contextual factor, such as student behavior, prevents me from doing so. As I gain experience as a teacher, I expect I will be able to manage those contextual factors better so that I can have more of a consistent, deliberate focus on the substance of students' ideas.

A classroom observer has somewhat more ability to direct her attention in the classroom: she does not have to manage behavior, or keep track of time, or answer students' questions. She is there to observe. While there are many tools that act to focus observers' attention, the observer has time and mental space that teachers do not. If an observer is aware that a certain tool pulls her attention away from meaningful classroom interactions, she can smartly navigate those tensions. She could do what Ms. Diggins did, and attend closely to student thinking *while* completing this district-mandated form. Alternatively, she could come back a different day and focus exclusively on student thinking. Of course these are time-consuming suggestions for busy observers: Valerie and the other coaches are each responsible for observing dozens of science teachers. The observation cycle as it currently stands requires many hours of preparation for the coaches; adding anything to that is likely unrealistic. Even so, the more that an observer is aware of the pulls on her attention, she can be more thoughtful in her work with teachers and not be at the mercy of an observational tool.

At a broader level, the findings in Chapter 4 suggest that schools and districts should be more cautious in their adoption of observation tools such as the FFT. As discussed earlier, Danielson acknowledges that this is a subject-neutral rubric and explains this by saying that "good teaching is good teaching." While the FFT might be a starting point for recognizing practices that correspond to good teaching, as we saw in Chapter 4, it also pulls observers attention away from the rich, disciplinary-specific practices that are the foundation of the most recent science education reforms (e.g., NRC, 2013).

On one hand, the discipline-neutrality of the FFT is a benefit because it allows any administrator, regardless of subject experience and knowledge, to observe any classroom. It is unrealistic to ask principals to use multiple, discipline-specific observational tools, especially when most principals only have expertise in one or two subject areas. A possible solution to this challenge is to distribute more of the classroom observation work to discipline experts and allow each discipline to use a different tool that captures the important practices of that discipline. Indeed, with a better tool, Valerie could likely engage in very rich, productive conversations with teachers about the scientific practices in their classrooms. Without some alternative institutional structure, Valerie is constrained by the requirements of the FFT.

With the findings in this dissertation, we can think again about how to make real progress toward a sophisticated, shared vision of science teaching and learning. In Chapter 3, we saw the promise in watching and discussing classroom video. If we continue to debate science education reforms in the abstract, we will not make much progress. Continuing to make more detailed versions of the reform "map" isn't helpful if observers are not looking at the territory of the classroom in the same way. By marshaling classroom video, educators can begin to align both around their *goals* for science education as well as their *interpretations* of what's happening in actual classrooms[20]. Indeed, science education researchers have begun to systematically analyze classroom video in the context of science education reforms (e.g., Gardner, Stuhlsatz, & Roth, 2013). Once we establish what science reforms look like *in practice*, we can work toward improving science classrooms to meet those goals.

[20] Of course, these are not unrelated notions: your interpretation of a classroom is informed by your goals for education, and vice versa.

Appendix A: Complete transcript of the focal clip

1. Teacher: So, guys, I have a question for you. I want you to look at this with me. I want you to look at this. Where is this water coming from on the outside?
2. Daniel: From the air?
3. Casey: (shaking head no) I think it's from in there (pointing inside glass) - because the-
4. Teacher: Okay, Casey thinks it's from in here. Let's talk- let's talk a minute about why you think it's from in there, Casey.
5. Casey: Because where-- I don't think there is as much- enough moisture to make it come from here. And like the glass over here or the glasses over there don't have any water on them, unless they've been like washed. They don't get it like this one did. And if it came from the air. It would have to- all glasses would be wet when-
6. Teacher: If it came from the air, all glasses would have to be wet.
7. Casey: All the time.
8. Teacher: All the time. Huh!
9. Daniel: Um, I think it's actually steam.
10. Teacher: Well, where's the steam?
11. Daniel: I don't know.
12. Teacher: How- where is the steam?
13. Daniel: In the air.
14. Teacher: You think there might be steam in the air?
15. Daniel: Mmm hmm.
16. Teacher: So, Casey, my question for you is, if you think it's coming from inside the glass, how does it get from there to the outside?
17. Casey: I think it's both. I think that him and me are kind of right.
18. Teacher: You think you're both kind of right?
19. Casey: The air takes it up and then it kind of makes it come back down onto this.
20. Teacher: Okay, so let's think about that a minute. You think the air takes it up. What do we call that when- when it changes from liquid?
21. Casey: Water vapor.
22. Teacher: It changes it to-
23. Casey: Water vapor.
24. Teacher: water vapor. So do you think there's water vapor in the air around here?
25. Daniel: Yeah.
26. Casey: Yeah.
27. Teacher: Yeah? What makes you think there might be water vapor in the air?
28. Casey: Well, because there's mostly water vapor everywhere.
29. Teacher: So you think there's a lot- there's water vapor everywhere.
30. Daniel: So is it water vapor?

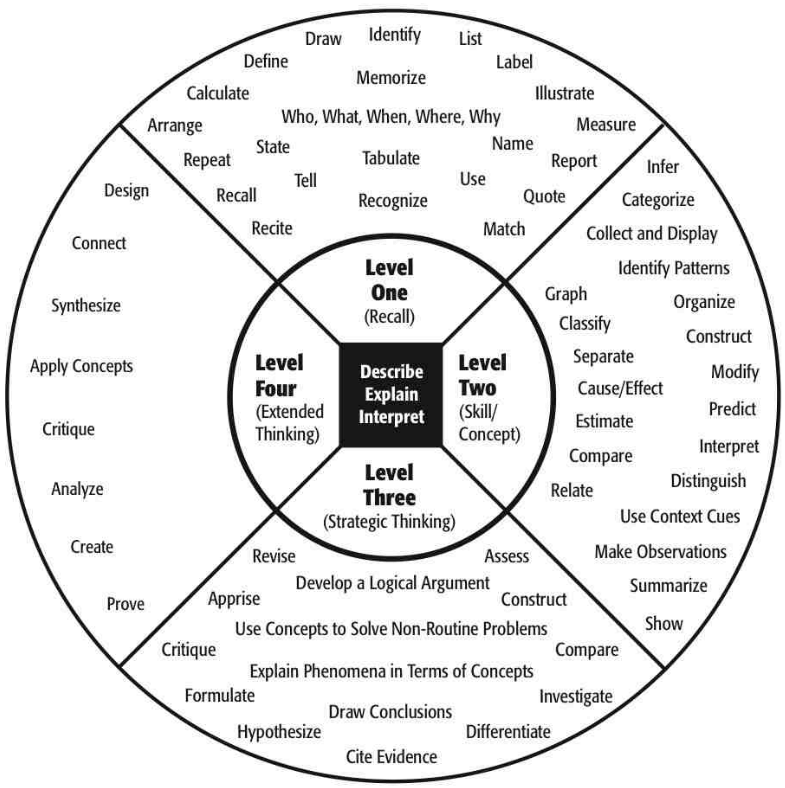
31. Teacher: Well, Daniel, that's what we're trying to figure out. Does it- do you think it comes directly from inside out to here?
32. Daniel No.
33. Teacher: That- that doesn't- does that make sense?
34. Casey: It has to go up and then-
35. Teacher: It has to go up and then come-
36. Daniel: (back down the outside?)
37. Teacher: -down to here. Do you think it makes sense that it's water vapor?
38. Daniel: Yeah.
39. Casey: Cause there’s also water in here. (pointing to the inside of the glass, above the water level, where it’s also wet)
40. Teacher: Do you think water vapor- okay, so we know that water can change from liquid to-
41. Daniel: Solid.
42. Teacher: to- to-
43. Daniel: No wait, solid and water vapor.
44. Teacher: and to water vapor. So we know that the liquid can change into a gas. My question for you is, can the gas change back into a liquid?
45. Daniel: Yes, because I think this is water vapor.
46. Teacher: So do you think that the water vapor is changing back into a liquid, maybe?
47. Daniel: Yeah.
48. Casey: Because we can see it then.
49. Daniel: Yeah.
50. Casey: We- we can't see it right away. But then it kind of-
51. Teacher: Can you- can you see some evidence that the-
52. Casey: Yeah.
53. Teacher: that it's- that something has changed back into a liquid here?
54. Daniel: Yeah.
55. Teacher: Yeah.
56. Daniel: Should we write that down?
57. Teacher: Well, that's okay. Just put down what you have now. That's okay.
58. Daniel: Shall we- shall we write that down?
59. Teacher: Well, I- if that- if that's what you think is going on-
60. Daniel: Yeah.
61. Teacher: Yeah, yeah, go ahead and write that, guys. I think you're really doing some great thinking here.
(5 minutes later)
62. Teacher: Okay, Daniel, are you done drawing what's going on here? Okay, I need you guys to see if you can give me an explanation of what's going on here and what it's called, okay? "We think that..." what?
63. Daniel: It's just water vapor that turns back to liquid water.
64. Teacher: Yeah, do you- there's a word for that. Do you have any idea what it might be called?
65. Daniel: No.
66. Teacher: Any idea what it might be called?

67. Daniel: Evaporation.
68. Teacher: Well, is this evaporation?
69. Daniel: Condensation.
70. Teacher: Hm, where did you get that word?
71. Daniel: I just heard it before.
72. Teacher: You heard it before, you guessed. Well, is it- it- is this evaporation?
73. Daniel: No.
74. Teacher: if water vapor turns back into liquid?
75. Daniel: No.
76. Teacher: Okay, so do you think it might be called condensation?
77. Daniel: Yeah.
78. Teacher: Well, both evaporation and condensation are going on a lot of times when it- with rain, with clouds. So, what do you think this one might be called?
79. Daniel: Condensation.
80. Teacher: Well, let's- let's come back and talk about it as a group and see if other people think that- that that makes sense, too.
81. Teacher: We'll see if that does make sense. Okay, "I think it's just water vapor that turns back to-"
82. Daniel: Liquid water.
83. Teacher: into liquid- "to liquid." What do you think might influence the water vapor changing? A change in what?
(another student?) How wet it is (inaudible).
84. Teacher: What is the- these things are what?
85. Daniel: Change in surface.
86. Teacher: Well, a surface might have something to do with it. That's a great idea, Daniel. Just a second, Malik.
87. Teacher: What else about these things, Casey? These things are what? What's different? Remember you were talking about those glasses over there.
88. Daniel: This is metal and this is plastic (pointing to closed soda can and clear cup)
89. Teacher: Don't- yeah, yeah, that's true. That's true, but you were saying that the glasses over there don't get this on it.
90. Casey: Mm-hm.
91. Teacher: What's different about this glass? It's- has- it's- it has what?
92. Casey: Ice and-
93. Teacher: It has ice. The ice changes the what?
94. Casey: Temperature.
95. Daniel: And I think we also (inaudible).
96. Teacher: It changes-
97. Casey: If we used a regular glass of water, it would still do the same thing.
98. Teacher: Do you think it would do it as fast-
99. Casey: No.
100. Teacher: without the ice?
101. Casey: No.

102. Teacher: Do you want to try that? Do you want to go get a glass? Go get 103. another glass and let's try that out.
103. Daniel: (I have proof) that it's not the, um- it's not that- the water.
104. Teacher: What is our proof that it's not the water?
105. Daniel: Because this has a lid on it. (pointing to unopened can of soda)
106. Teacher: Oh!
107. Daniel: And so that can't (inaudible).
108. Teacher: Great! That is really neat, Daniel, that you're noticing that. That's great!

Appendix B: Webb's (2005) Depth of Knowledge Levels

Depth of Knowledge (DOK) Levels



Level One Activities	Level Two Activities	Level Three Activities	Level Four Activities
Recall elements and details of story structure, such as sequence of events, character, plot and setting. Conduct basic mathematical calculations. Label locations on a map. Represent in words or diagrams a scientific concept or relationship. Perform routine procedures like measuring length or using punctuation marks correctly. Describe the features of a place or people.	Identify and summarize the major events in a narrative. Use context cues to identify the meaning of unfamiliar words. Solve routine multiple-step problems. Describe the cause/effect of a particular event. Identify patterns in events or behavior. Formulate a routine problem given data and conditions. Organize, represent and interpret data.	Support ideas with details and examples. Use voice appropriate to the purpose and audience. Identify research questions and design investigations for a scientific problem. Develop a scientific model for a complex situation. Determine the author's purpose and describe how it affects the interpretation of a reading selection. Apply a concept in other contexts.	Conduct a project that requires specifying a problem, designing and conducting an experiment, analyzing its data, and reporting results/ solutions. Apply mathematical model to illuminate a problem or situation. Analyze and synthesize information from multiple sources. Describe and illustrate how common themes are found across texts from different cultures. Design a mathematical model to inform and solve a practical or abstract situation.

Webb, Norman L. and others. "Web Alignment Tool" 24 July 2005. Wisconsin Center of Educational Research. University of Wisconsin-Madison. 2 Feb. 2006. <http://www.wcer.wisc.edu/WAT/index.aspx>.

Appendix C: Danielson's (2013) Framework For Teaching: Domain 3: Instruction

Component 3a: Communicating with Students

Element	Level 1 Evidence	Level 2 Evidence	Level 3 Evidence	Level 4 Evidence
Expectations for Learning	Teacher's purpose in a lesson or unit is unclear to students.	Teacher attempts to explain the instructional purpose, with limited success.	Teacher's purpose for the lesson or unit is clear, including where it is situated within broader learning.	Teacher makes the purpose of the lesson or unit clear, including where it is situated within broader learning, linking that purpose to student interests.
Directions and Procedures	Teacher's directions and procedures are confusing to students.	Teacher's directions and procedures are clarified after initial student confusion.	Teacher's directions and procedures are clear to students.	Teacher's directions and procedures are clear to students and anticipate possible student misunderstanding.

Component 3b: Using Questioning and Discussion Techniques

Element	Level 1 Evidence	Level 2 Evidence	Level 3 Evidence	Level 4 Evidence
Quality of Questions	Teacher's questions are virtually all of poor quality, with low cognitive challenge and single correct responses, and they are asked in rapid succession.	Teacher's questions are a combination of low and high quality, posed in rapid succession. Only some invite a thoughtful response.	Most of the teacher's questions are of high quality. Adequate time is provided for students to respond.	Teacher's questions are of uniformly high quality, with adequate time for students to respond. Students formulate many questions.
Discussion	Interaction between teacher and students is predominantly recitation style, with the teacher mediating all questions and answers.	Teacher makes some attempt to engage students in genuine discussion rather than recitation, with uneven results .	Teacher creates a genuine discussion among students, stepping aside when appropriate.	Students assume considerable responsibility for the success of the discussion, initiating topics and making unsolicited contributions.
Student Participation	A few students dominate the discussion.	Teacher attempts to engage all students in the discussion , but with only limited access.	Teacher successfully engages all students in the discussion.	Students themselves ensure that all voices are heard in the discussion.

Component 3c: Engaging Students in Learning

Element	Level 1 Evidence	Level 2 Evidence	Level 3 Evidence	Level 4 Evidence
Activities and Assignments	Activities and assignments are inappropriate for students' age or background. Students are not mentally engaged in them.	Activities and assignments are appropriate to some students and engage them mentally, but others are not engaged.	Most activities and assignments are appropriate to students, and almost all students are cognitively engaged in exploring content.	All students are cognitively engaged in the activities and assignments in their exploration of content. Students initiate or adapt activities and projects to enhance their understanding.
Instructional Materials and Resources	Instructional materials and resources are unsuitable to the instructional purposes or do not engage students mentally.	Instructional materials and resources are only partially suitable to the instructional purposes, or students are only partially mentally engaged with them.	Instructional materials and resources are suitable to the instructional purposes and engage students mentally.	Instructional materials and resources are suitable to the instructional purposes and engage students mentally. Students initiate the choice, adaptation, or creation of materials to enhance their learning.

Component 3d: Using Assessment in Instruction

Element	Level 1 Evidence	Level 2 Evidence	Level 3 Evidence	Level 4 Evidence
Assessment Criteria	Students are not aware of the criteria and performance standards by which their work will be evaluated.	Students know some of the criteria and performance standards by which their work will be evaluated.	Students are fully aware of the criteria and performance standards by which their work will be evaluated.	Students are fully aware of the criteria and performance standards by which their work will be evaluated and have contributed to the development of the criteria.
Monitoring of Student Learning	Teacher does not monitor student learning in the curriculum.	Teacher monitors the progress of the class as a whole but elicits no diagnostic information.	Teacher monitors the progress of groups of students in the curriculum, making limited use of diagnostic prompts to elicit information.	Teacher actively and systematically elicits diagnostic information from individual students regarding their understanding and monitors the progress of individual students.

Component 3e: Demonstrating Flexibility and Responsiveness

Element	Level 1 Evidence	Level 2 Evidence	Level 3 Evidence	Level 4 Evidence
Lesson Adjustment	Teacher adheres rigidly to an instructional plan, even when a change is clearly needed.	Teacher attempts to adjust a lesson when needed, with only partially successful results.	Teacher makes a minor adjustment to a lesson, and the adjustment occurs smoothly.	Teacher successfully makes a major adjustment to a lesson when needed.
Response to Students	Teacher ignores or brushes aside students' questions or interests.	Teacher attempts to accommodate students' questions or interests, although the pacing of the lesson is disrupted.	Teacher successfully accommodates students' questions or interests.	Teacher seizes a major opportunity to enhance learning, building on student interests or a spontaneous event.

Appendix D: Sample pre-observation form

Pre-Observation Map

What are your goal(s) for this lesson? (Content, Inquiry)

Content: Students will recognize waves in various situations in order to describe how waves transfer energy from one place to another.

Inquiry: Students will:
identify waves in real world experiences through discussion.
define a wave in their own words.

Where do we need to start? What are our priorities?

(Assuming the use of the CFPG)
Modify the lessson.
Look for opportunities for discussion and Accountable Talk.
Look for opportunities to get students to think critically.
Identify where I can ask "how".

What do you know about how your students learn science?

Hands-on activities
Discussion
Small groups
Manipulatives

How are you currently collecting evidence/data to assess students?

Edusoft/Performance Matters
Student Work
Teacher Generated Assessments
Oral response
Listening to student questions

Observation focus area:

☐ **Chemistry** ☐ **Earth/Space Science** ☐ **Environmental Science**

☐ **Life Science** ☐ **Inquiry** ☐ **Physics** ☐ **Other:**

Standard/Content covered: 4.D.1.a- Cite examples to show that waves transfer energy from one place to another.

Number of students in class: 25

Accommodation(s) needed: extended time for assignments, verbatim reading

Assessment Method(s): How are you evaluating the success of inquiry and understanding of the content taught in the class?

The quality and consistency of student discussion, Student engagement and participation, Student responses, BCR, Closing assessment/exit ticket

Instructional strategy/strategies planned:

Grouping, Accountable Talk, Questioning, Modeling, Fish Bowl, Equity Sticks, Clickers

Resource(s) needed:

Clickers, visualizers, computers, overhead projectors, video clips, textbook, online resources

Observation date and time: ______________________

Adapted from J. Killion & C. Harrison. (2006). *Taking the Lead: New roles for teachers and school-based coaches.* Ohio: National Staff Development Council.

Appendix E: Valerie's notes from her observation of Deborah's class, 10/6/2011

[redacted] observation [redacted] notes from 10/6/11

Warm Up:

T: If you'll on the table, you will see a plastic baggie...

T: Please share the responsibilities.

• students are using white boards to organize pictures of renewable or non-renewable resources

S: We are done.
S2: Really we are done.

C: Tell me about what you are doing

• discussion surrounding whether or not trees are ren. or non-ren.

S: I think gas is not-renewable because it generates heat.
• job cards are given out

• Cows moved to non-renewable

T: OK everyone. What I you to do now... [When I was walking around I saw one picture that seemed to be a thorn in everyone's side.

T: [This group put a picture on the line.

S: We put forest in the middle is because it has trees in it + it takes a long time to grow back, T: So what you said is... the difference is [if you cut down a forest it will take longer to grow back than one tree

T: Everybody put the forest on the line

· holding up two trays (Chipotle + cafe tray, Styrofoam)

My big question to you is... [on board] Big question: Since we've been learning about protecting our resources, I wonder if there is a way we can start at our school + possible have a trash free lunch.

T: The one important thing we can do is

· students ask to see tray up close

S1: [we can reuse this [Chipotle tray]
S2: + like the plate, we can just wash it off

T: If we were trying to have a trash free lunch here at
[redacted] what could we do?

S: Use paper cups instead of styrofoam cups [because

S2: We can recycle the stuff we use, like recycle day [on Tuesday]
S3: We can reuse these water bottles.

· T gives students paper to record ideas

S: if you wanted grapes, you could put them in a container

C: What thoughts do you have about using the 2 trays that she showed

S: [good] both have ideas to use different materials than

S: [good] the trays though

S3: I think its a good idea, no bad, no... good idea because [those trays are trash. You can bring materials from home that can be washed.

T: It's 1:03. I'm ready to hear some of your ideas. because when you were at lunch, I approached Ms. A. about [a trash free lunch]

T: OK now, do we have some volunteers?

T: Table 3

S: always use something that you can recycle.

Don't throw away stuff you

Don't waste any kind of paper.

Table #7 has to say

S: Instead of using trash bins we can use recycle bins.

S: The second thing we can do is for people who walk right in.. [do not get food that you know you are not gonna eat.

S: We can reuse bottles, plates [less electricity + less gas]

T: So you're saying that...

S: But how do electricity + gas go w/ the problem of a trash free lunch. (asks of the group above)
S: That's actually a good question

T: Table 2 is ready to share out so hold you thoughts for a second.

T: OK so we can bring our own plastic bottles, ok...

T: Do you want add on or do you [have another idea?
S: We want to add on...

- raising hands (a group) S: We have a question
- student who questions electricity + water bottles still challenging these 2 groups

Artifacts: I wonder wall; def.-renewable/non-renewable etc., on board
Objective: Students will learn about natural resources in order to learn ~~take~~ about Maryland's resources.
S: If we ~~take~~ all these ideas + put them together [we can save the Earth.]
S:

S: We can reuse bottles, plates [less electricity + less gas]

T: So you're saying that...

S: But how do electricity + gas go w/ the problem of a trash free lunch. (asks of the group above)

S: That's actually a good question

T: Table 2 is ready to share out so hold you thoughts for a second.

T: OK so we can bring our own plastic bottles, ok...

T: Do you want add on or do you have another idea?

S: We want to add on...

- raising hands (a group) S: We have a question
- student who questions electricity + water bottles still challenging these 2 groups

Artifacts: I wonder wall; def.-renewable/nonrenewable etc., on board

Objective: Students will learn about natural resources in order to learn ~~take~~ about Maryland's resources.

S: If we ~~take~~ all these ideas + put them together [we can save the Earth.]

S:

Appendix E: Rubric completed by Valerie with evidence from Deborah's class

Element	Support and Evidence
Expectations for Learning	Objective (posted): Students will learn about natural resources in order to learn about [State's] resources. Artifacts << I wonder >> wall; definitions of renewable and nonrenewable resources (and other current terms); students are discussing an issue that affects their school, a trash-free lunch. The trash-free lunch idea also relates to the trip to [local camp]
Directions and Procedures	In small groups, S1: We are done. S2: Really we are done. Coach (C): Tell me about what you are doing. (Students are able to explain the activity to the coach.); Teacher (T): Please share the responsibilities.; job cards are used to assign roles to students within the groups.
Quality of Questions	Students are asked to sort items into two categories.; <<Big question>> (on screen): Since we've been learning about protecting our resources, I wonder if there is a way we can start at our school and possibly have a trash-free lunch; T: If we are trying to have a trash-free lunch here at [school], what could we do?; Student (S): We have a question. (A student asks another group to explain how electricity and water bottles solve the problem of a trash-free lunch.); S: What can we use solar energy for?
Discussion	A small group of students are discussing whether or not trees are renewable or nonrenewable.; T: [When I was walking around, I saw one picture that seemed to be a thorn in everybody's side.] This group placed a picture on the line. S: We put forest in the middle because [it has trees in it and it takes a long time to grow back.] T: So what you said is… [if you cut down a forest it will take longer to grow back than one tree].; T: Let's leave that right there for a second. Everyone put the forest on the line.; T is holding up two trays (Chipotle bowl and cafeteria tray). <<Big question>> (on board): Since we're been learning about protecting our resources, I wonder if there is a way we can start at our school and possibly have a trash-free lunch. The teacher asks the students to talk within their groups about this idea. S: The important thing we can do is… (student asks to see the tray up close) S1: We can reuse this tray (Chipotle). S2: and I like the plate, we can just wash it off.; With a small group, T: If we were trying to have a trash-free lunch here at [school name], what could we do? S1: Use paper cups instead of Styrofoam cups because… S2: We can recycle the stuff we use… like recycle day on Tuesday and Thursday. S3: We can reuse these water bottles.; (Whole group) S1: Always use something that you can recycle. S2: Don't throw away stuff you can reuse. S3: Don't waste any kind of paper.; (Next table) S1: Instead of using trash bins, we can use recycle bins. S2: The second thing we can do is for people who walk right in… [do not get food you know you are not gonna eat.]; S: We can reuse bottles, plates [less electricity and less gas] T: So you're saying that… S: But how do electricity and gas go with the problem of a trash free lunch (question is directed to the group speaking). S: That's actually a good question.; T: Do you want to add on or do you [have another idea?] S: We want to add on… S: If we take all these ideas and put them together, [we can save the Earth].

Activities and Assignments	Warm up – Students are using white boards to organize pictures of renewable and nonrenewable resources into two columns. In small groups, Student 1(S) We are done. S2: Really we are done. (nodding in agreement with S1). Coach (C): Tell me about what you are doing. (Students are able to explain the activity to the coach): Students are in groups discussing a plan for a trash-free lunch at [school]. The teacher gives the students paper to record ideas and plan. It is announced that students will continue making a plan in the next class meeting and present them to [principal]
Instructional Materials and Resources	Students use dry erase boards and markers to sort resources into two categories. After small group discussions, students chart their ideas about a trash-free lunch of their school. Each group is allowed to share their ideas during the whole group session.
Assessment Criteria	Students are able to answer questions (asked by the coach) about creating a plan for the trash-free lunch. When asked, students are unable to describe how they will be scored on the assignment. Some student charts have recorded evidence for their plan/ideas. A scoring sheet is included with the lesson plan.
Monitoring of Student Learning	(during warm up) T: It's 12:31. You have another 3 minutes. The teacher walks around to groups during the small group sessions. The teacher asks questions as she moves from group to group. (T: If we are trying to have a trash-free lunch here at [school], what could we do? During the whole group discussion, the teacher calls on each table to share ideas. {T: okay now, do we have some volunteers? table 3?)
Lesson Adjustment	Students will complete plans for the trash-free lunch during the next class
Response to Students	The teacher is answering student questions as they are asked. Students are guided to research/seek their own answers to some questions. (S: what can we use solar energy for? T: you come back and tell me tomorrow.)

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