Using changes in framing to account for differences in a teacher's classroom behavior

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Abstract: In this paper we account for how a 5th grade teacher changes in how she attends and responds to student thinking in terms of differences in her framing of the instructional situation. Coordinating verbal (i.e. speech, voice inflection, and word emphasis) and non-verbal (i.e. body orientation, eye gaze, and gesturing) behavioral data, we characterize three patterns that reappeared with stability throughout a fourteen-day, inquiry-based instructional module on the water cycle. We argue that each of these behavior patterns suggests a distinctive way the teacher frames her instruction. We label these frames as: (A) moving towards content objectives; (B) promoting a student-centered discussion; and (C) making sense of students' ideas. The episodic manner in which these frame shifts occur in the classroom suggests a way of conceptualizing a learning progression in teachers' ability to attend and respond to student thinking.

Introduction

The following transcripts document two brief exchanges between a fifth grade teacher and her students that took place on successive days during a fourteen-day, inquiry-based, science unit on the water cycle. Exchange #1 is part of a classroom discussion where the teacher and students are trying to understand an idea for an experiment suggested by a student (Jasper). Exchange #2 is part of a classroom discussion where the teacher (Mrs. Miller) is trying to get students to come up with specific ideas about precipitation. Words in italics indicate words emphasized by the speaker. Non-verbal behaviors that coincide with talk are indicated in brackets.

Exchange #1: Day 13

Jasper: If you did that with a *different* drink, that would work.
Mrs. Miller: Now *why* would you want to use a different drink? Other than water?
Jasper: 'Cause then you have no clue if it's leaking or not. I mean *that* could be water from a leak or water from the condensation.
Mrs. Miller: Like, what would you want to freeze?
Jasper: You could use, like … like soda or something, and then water appeared in the *bag*, you know it's- And you, like, *drank* it and you found out it wasn't like, soda or something-
Jamil: Oh yeah. I get what you're trying to say-
Mrs. Miller: OK. Alright. Go ahead. Go ahead. Finish what you're saying. (…)
Jamil: I get what Jasper's saying. Like, if you use, like, a different *drink*, like let's say, *orange juice* or something or *soda*, um- If it was *leaking*, … if you thought it was leaking *water*, you would know if it was from the *condensation*, because the orange juice is *yellow*, it's not all like clear like *water*.

Exchange #2: Day 14

Mrs. Miller: What s*teps*- notice that word right there- [points to the word "steps" written on the easel] What steps might be involved in making each type of precipitation? … And does somebody have a thought? Cam? (…)
Cam: First, rain is collected by the ocean, and the cloud carries it until it can't carry it anymore. So, it drops- so it- so when it can't carry it anymore, it drops it. It holds it until it's completely- it- it completely can't hold it anymore, at all. And, then it just falls.
Mrs. Miller: So, (…) does that define precipitation? Does what you say really tell me what *these* four [points to the types of precipitation] are? Or does it tell me what *that* [points to the word "precipitation"] is? What do you guys think? Is Cam telling me what *this* is, or is he telling me what *these* are?
Jack: He's telling you what rain is.
Mrs. Miller: *Really*?

Although the context for both teacher/student exchanges is the same (i.e. the water cycle), the verbal information gleaned from the transcripts suggests that the interactions taking place on these two days are substantively different. If these transcripts are analyzed along with the co-occurring extra-verbal behavior, such as the participants' body orientation, eye gaze, and gestures, the case is strengthened that something dramatically

different is taking place in these exchanges. How can researchers best make sense of this shift in the dynamics of the classroom, particularly with respect to the teacher's practice? We propose that the construct of *framing* is a potentially useful framework to help answer this question.

Framing as a Framework

Educational researchers have adopted the theoretical construct of framing in recent years to help account for the dynamic nature of students' and teachers' reasoning during instruction. A concept that originated in the disciplines of anthropology, sociology, and linguistics, framing refers to an interpretation of how an individual makes sense of "What's going on here?" (Bateson, 1972; Goffman, 1986; Hammer, Elby, Scherr, & Redish, 2005; Tannen, 1993). Framing is considered to be a mechanistic, cognitive process, serving to activate sets of locally coherent epistemological, conceptual, and social resources and enabling individuals to effectively navigate their current situation (Hammer et. al, 2005; Redish, 2004). An individual's frame, and the resources that are thereby activated, informs the set of expectations that he or she has about a situation, which is necessarily grounded in his or her previous experience with similar types of situations.

In the context of education, framing influences both what individuals attend to within instructional situations and how they think to respond in the moment. For example, a teacher's framing of instruction influences how and to what she attends in the classroom, as well as how she thinks to respond (Levin, Hammer, & Coffey, 2009). How students frame instructional activities helps determine the ways they interact with one another, their teacher, and the available learning materials (Hammer et. al, 2005; Scherr & Hammer, 2009). In an empirical study, Scherr and Hammer (2009) characterized distinct sets of co-occurring behavioral clusters that suggested that college students were framing their group activities in different ways at different points in time. Shifts *between* these frames were observed within single physics sessions, indicating that students did not maintain one consistent way of making sense of and approaching their learning activities. By considering frames as a theoretical framework, researchers may be able to better make sense of changes in students' and teachers' behaviors and posit *why* they behave as they do.

It has been previously suggested that when teachers attend and respond to the substance of students' ideas, the students are more likely to genuinely engage with the material under investigation and advance in their learning (Black and Wiliam, 1998; NRC, 2001). With respect to developing students' inquiry practices, a teacher's focused attention and response can, therefore, help students refine and develop their questions, investigations, and explanations surrounding specific natural phenomena (Levin, 2008; NRC, 2000). If attending and responding is a key component of promoting student inquiry, then it is critical for researchers to be able to account for how and why teachers attend and respond to the things that they do. Framing provides a vehicle for us to do just that. Characterizing the ways a teacher frames instruction enables us to make sense of how she attends and responds to students in the moment and explore how her attention and responses change longitudinally.

The objective of this paper is to present behavioral evidence that suggests different ways a single teacher frames her inquiry-based instruction within a unit on the water cycle. This work lays the foundation for research that investigates the frequency by which she shifts between frames, how this frequency changes over time, and how such changes may indicate progress in learning to attend and respond to student thinking. Furthermore, this research enables us to determine whether similar frames and shifting patterns are observed in additional teachers.

Methods

The setting for this study was a fifth grade teacher's classroom during her implementation of a fourteen-day "module" on the water cycle. The module represented one of several developed by our research group designed to provide teachers with a context with which to explore and promote student inquiry practices (1). To accomplish the goal of encouraging practices such as making-sense of and reasoning about scientific phenomena, proposing plausible, mechanistic explanations of those phenomena, and collecting evidence to support or refute these explanations, the water module begins with the teacher posing an open-ended question to her students:

> Suppose that one night it rains. When you arrive at school, you notice that there are puddles of rainwater in the parking lot. When you go home, you notice that the puddles are gone. What happened to the rainwater?

The students are encouraged to suggest possible answers and consider reasons *why* these answers are plausible. While the minimal curricular materials provide teachers with potential student responses and possible ideas for follow-up discussion topics, the teachers are encouraged to base their future instructional moves solely on the nature

of the students' ideas as they emerge during the discussion itself. Hence, the teacher may choose to go in a variety of different directions in this and subsequent class sessions depending on the responses of the students.

A single teacher, Mrs. Miller, was observed in her classroom throughout the duration of the water module in the spring of the 2008-9 academic year. Mrs. Miller is a national-board certified teacher and has taught elementary school for over twenty-five years. She has served as a mentor teacher for novices and has identified herself as a teacher comfortable with teaching science. Prior to the module implementation, Mrs. Miller participated in inquiry-based professional development (PD) activities organized by our research group for just under one year. Our PD sessions provide opportunities for in-service elementary and middle school teachers to practice attending and responding to student thinking, with the explicit intent of helping them develop their ability to promote rich student scientific inquiry in the classroom.

Mrs. Miller's class sessions during the module were video recorded in entirety. This video served as the primary source of data for analysis, supplemented by field notes taken by the first author both during class and during debriefing interviews with the teacher that occurred shortly after each instructional session. Since the focus of the research was on *teacher* framing, portions of the classes that centered on student group work and experimentation, which tended to involve minimal teacher participation and to which we had less access, were excluded from the data analyses. Methods of analysis were modeled after those used by Scherr and Hammer (2009), in that video data was evaluated for patterns that displayed specific sets of Mrs. Miller's verbal (i.e. speech, voice inflection, and word emphasis) and non-verbal (i.e. body orientation, eye gaze, and gesturing) behavior that seemed to consistently co-occur. Once such behavioral pattern sets were tentatively characterized, they were compared with additional segments of class video to determine whether they occurred with relative frequency and stability. From those that were established to be regularly occurring patterns, inferences were drawn regarding how these patterns might reflect Mrs. Miller's framing of the instructional session.

Results

Three distinct and coherent patterns of Mrs. Miller's verbal and nonverbal behaviors seemed to emerge from the data, which we are calling patterns (A) "focusing on content," (B) "focusing on generating student interaction and discussion," and (C) "focusing on making sense of student ideas." These patterns seemed to occur with some regularity throughout the module, with some occurring more frequently and lasting for a longer duration than others. Interestingly, these patterns did not seem to appear in a specific chronology. For instance, pattern (A) was not only observed in the earliest class sessions of the module, nor was pattern (C) detected only in the final sessions. The data also indicated that Mrs. Miller's students were actively engaged in discussion throughout the module, no matter the pattern of behavior exhibited by Mrs. Miller. The types of interactions in which they engaged and the substance of the discussion that took place, however, did appear to shift in coordination with Mrs. Miller's behavior.

In the sections below, each of Mrs. Miller's three behavioral patterns is described in detail. Supporting evidence for these patterns is provided via portions of classroom transcript, digital stills taken from video, and field notes taken from the debrief interviews. These data provide the basis for inferences drawn regarding how Mrs. Miller was framing her instruction. The emerging behavioral patterns were considered to be stable in that they were consistent for *at least* several exchanges between discussion participants. It is worth noting that while there were occasions where a single behavioral pattern seemed to last for the entire class session, there were several occasions where Mrs. Miller shifted between different sets of behavior(s) at different points during a single session.

Pattern (A): Focusing on content

Behavior associated with pattern (A) was observed regularly throughout the module and often lasted for large portions of the class session. Throughout these segments, Mrs. Miller regularly employed gestures emphasizing and/or enacting specific words or phrases, seemingly to help her students focus on particular concepts. These gestures often involved pointing out important terms or characters selectively inscribed on an easel (Fig. 1b) and/or drawing attention to specific content terms she employed in her verbal questioning. For example, in Figure 1c, Mrs. Miller held her hand up above her hand at a horizontal angle, emphasizing the idea of cloud height to her students.

With respect to teacher talk, Mrs. Miller tended to initiate these discussions by asking pointed questions in a direct, clear voice (e.g. line 1-2 in Exchange #2 shown in the introduction). These questions were often prefaced with "what is/are" and repeated at various intervals throughout the session to keep the students following a particular line of thinking. Her intonation during her speech, like her gestures, tended to emphasize content specific terms and phrases. Mrs. Miller seemed to pay close attention to students' terminology, as reflected in her repeating or emphasizing a particular term or phrase volunteered by a student and/or asking a student follow up questions regarding a term or phrase he or she used. Furthermore, Mrs. Miller selected certain pieces of her students' talk for display on the easel, seemingly choosing those phrases that advanced the discussion towards content goals.

Teacher/student interactions throughout these discussions tended to follow the traditional initiation, response, evaluation (IRE) format (Mehan, 1979).


a


b

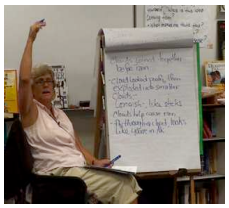
c

Figure 1: Examples of Mrs. Miller's body orientation and gestural movements consistent with behavioral pattern (A): (a) Mrs. Miller creates a summary table that her students are to fill out; (b) Mrs. Miller gestures across her easel, directing their attention to the "steps" she is looking for; (c) Mrs. Miller emphasizes a particular descriptor she is looking for in her students' responses.

The following section of transcript displays an interaction between Mrs. Miller and her students taken from Day 2 of the module. The discussion illustrates behavior typical of pattern (A) and centers on the different types and locations of clouds.

Tommy: When you're at the, like the, um, *ocean*? To the *west*, in *early*- you get dark clouds. Usually, it would be *marine* layer, and it- um, most of it would be moving in, and then when it gets in enough, it will just come *into* a cloud. I don't know- [Mrs. Miller writes: "West early, dark clouds moving in."]
Mrs. Miller: But, ah- wh- are they *high* [moves hand horizontally above head, indicating "high"] or *low*? What's the *altitude*, I guess is what I'm asking. What's the *altitude* of the clouds?
Tommy: Well, when they're by the ocean, they're gonna be low. And then, when- When they're going on land, they're just going to drift a little higher and higher. [Mrs. Miller writes: "low" and "higher."]
Mrs. Miller: 'K, so they're gonna get *higher*. *Is* there someway we can connect how high they are with what they *look* like? (…)
Cam: Um, like, maybe when, like, there's storm rainy clouds, *way* high, maybe that means it just gonna drizzle or something. But, when they're *lower*, they're gonna- it's gonna, like, pour and rain really hard.
Mrs. Miller: Lower. Clouds. *Heavy* rain. *Higher* clouds. Drizzle. [Mrs. Miller writes on a new sheet of paper: "Lower clouds, heavy rain. Higher clouds, drizzle."] What does anyone else think about that? About *clouds* and their *altitude* as to how they look?

Notice in lines 1-4 that Tommy does not refer to the height of the clouds. Nevertheless, Mrs. Miller introduces the concept of altitude (line 6) and then goes on to emphasize specific terms in her own talk and in that of her students (e.g. *high*, *low,* and *altitude* in lines 5-6 and *higher* in line 9). She appears to be trying to get her students to recognize a relationship between clouds' appearance and their altitude. This is reinforced by Mrs. Miller inscribing what she identifies as the most pertinent words and phrases (e.g. "Lower clouds, heavy rain. Higher clouds, drizzle." in line 14) on the easel and repeatedly asking questions about a relationship between clouds and their location (e.g. "*Is* there someway we can connect how high they are with what they *look* like?" in lines 9-10). During her debriefing interview, Mrs. Miller's focus centered on the fact that her students' thoughts "were really scattered" during the discussion and they weren't "getting it." She seemed disappointed that they hadn't reached specific conclusions.

This pattern of behavior, exemplified by Mrs. Miller in both this segment and Exchange #2 in the introduction, suggests that she is framing her instruction in these types of discussions as *moving toward content objectives*, which we shall refer to as "frame (A)." Her direct line of questioning, reiteration of questions, emphasis on terminology and phrasing, and her later description of students "not getting it," all appear to be consistent with maintaining this type of content-driven frame. Rarely during these types of interactions would Mrs. Miller allow herself or her students to veer onto trains of thought that differed from this singular agenda.

Pattern (B): Focusing on promoting student interaction and discussion

Similar to pattern (A), behavior associated with pattern (B) was observed throughout the module and lasted for large portions of the class session. In these discussions, Mrs. Miller neither directed her students' attention to an easel nor to her notes, as was commonly observed in pattern (A). In fact, she did not seem to direct the students' attention to herself at all. Rather, Mrs. Miller seemed to position herself, both verbally and non-verbally, as a discussion

facilitator and "traffic cop," deciding who speaks next and who must wait. Her gestures seemed to be less emphatic or enactive than those observed in pattern (A) and were usually limited to pointing out the sequence of students next in line to contribute to the discussion (see Figure 2).

With respect to teacher talk, Mrs. Miller would generally initiate discussions with an open-ended question about some type of phenomenon (e.g. "Which clouds cause lightening?"). Subsequent to this initial question, however, her verbal contributions were generally limited to brief, non-committal "mmm hmmm's," and/or to call out the names of the students next in line to participate. Occasionally, she would insert a brief comment indicating that one student's contribution added to or responded in some way to a comment made earlier by a different student. She rarely evaluated or probed the students' ideas. Instead, Mrs. Miller seemed to expect that the students would comment on and/or ask questions about *each other's* contributions. These segments did not follow a single conceptual strand or delve particularly deeply into a single explanation or observation. Rather, students seemed to pursue several different trains of thought, dependent upon which ideas they decided to take up in the moment.


a

b

c

Figure 2: Examples of Mrs. Miller's body orientation and movements consistent with behavioral pattern (B): (a & b) Mrs. Miller points to the next student to speak; (c) Mrs. Miller faces a student as he contributes to the discussion.

The following transcript, taken from Day 3 of the module, is typical of interactions consistent with pattern (B). The focus of this session was on the causes and consequences of lightening. It is worth mentioning here that Mrs. Miller's behavior varied little during this entire sixty-minute session, reinforcing the idea that pattern (B) behavior is often stable for long segments of class time.

Jack: If you cut down *every* tree in the world, which isn't possible, but if you *did*, and you had nothing attracting lightening, it wouldn't be able to- um, um, some place twice. (4 sec pause.)
Mrs. Miller: Alright. [Points to Tommy.]
Tommy: Well, I was thinking that, if- if- *lightening* comes, is it just how much h- heat or electricity it gets? To touch the ground? Like, how many *volts* it collects? [Mrs. Miller writes in her notebook and looks back up at Tommy.] Or, (…) if a cloud has power, how much power does it get, compared to a *smaller* cloud, you know? If a *big* thundercloud, it might have a lot of it, and always strike the ground…
Mrs. Miller: Mmmm. Sam?
Sam: If you're in a *submarine* (…) Ah, not that that deep down, um, and lightening, um, went *down*, would it be able to, um, shock the submarine from underwater? [Mrs. Miller looks down at her notebook and up at Sam.]
Harry: If it hit the water [Mrs. Miller looks at Harry.], it would probably be able to send an electric current through it (…)
Mrs. Miller: Danny and then Len.

In this dialogue, Mrs. Miller's words are limited to non-committal responses or calling out students' names (e.g. line 9 "Mmmm. Sam?"), and her gestures are constrained to pointing to students. The student ideas are on display and tend to dominate the conversation. This segment also shows that, as commonly observed in pattern (B), multiple student ideas are available at any one time, many of which are never taken up by other participants in the class (e.g. Jack's ideas in lines 1-2 and Tommy's ideas in lines 4-8). In the debriefing interview that followed the class session, Mrs. Miller commented on the large number of students participating in the discussion and the frequency of that participation. While she was able to point out a few emergent student ideas when prompted, her focus was more on the participatory nature of the discussion, rather than on the richness of the expressed ideas.

Mrs Miller's pattern of behavior during these segments of instruction appeared to sharply contrast to that of pattern (A), which tended to be much more teacher-directed. The verbal and non-verbal behaviors of Mrs. Miller depicted in pattern (B) interactions suggest that she is framing the instructional sessions (or portions thereof) as "making room for students to share ideas and reach their own conclusions about phenomena with minimal

interference from the teacher," or *promoting a student-centered discussion* for short. We will refer to this as, "frame (B)." Mrs. Miller's limited talk and her propensity for calling out the names of students seems consistent with eliciting student ideas and encouraging student participation. Mrs. Miller seemed to be intent on making room for her students to express their thoughts and allowing the students' ideas to take the floor. Rarely did she try to control and/or direct the trajectory of the students' ideas. Her focus on participation during her debrief interview, rather than the substance of her students' ideas, seems to reinforce this interpretation.

Pattern (C): Focusing on making-sense of student ideas

The set of behaviors associated with pattern (C) was observed less frequently and for shorter duration (usually less than 15 minutes) than those associated with patterns (A) and (B). Similar to that which was observed in pattern (B), Mrs. Miller's behavior made room for student ideas and allowed them to be objects of discussion. A substantive difference between (B) and (C), however, was Mrs. Miller's active role *during* that discussion. In these sessions, Mrs. Miller seemed to concentrate intently on the substance of the students' ideas, leaning towards the student as he or she spoke. She also actively employed gestures during these interactions, seemingly to enact the situation that the student was describing (see Figure 3a). On one occasion, she even spontaneously constructed a simple demonstration to further enact the student's idea being described (see Figure 3b). These non-verbal gestures are in contrast to those associated with pattern (A), where she tended to use hand and body movements to emphasize specific content terms or phrases in her own talk rather than those of her students.

a

b

Figure 3: Examples of Mrs. Miller's body orientation and gestural movements consistent with behavioral pattern (C): (a) Mrs. Miller uses arm gestures to enact a particular idea posited by a student (see line 14 in transcript below for co-occurring talk); (b) Mrs. Miller constructs a demonstration enacting a student's experimental design.

Similar to what was observed in behavioral pattern (A), Mrs. Miller tended to be more engaged verbally during these discussions. A major difference, however, is her engagement with the students' ideas, rather than her own. During these sessions, she actively asked questions of her students, emphasizing their words and probing more fully into their thoughts about the phenomena under discussion (e.g. "Now why would you want to use a different drink? Other than water?" line 2 in Exchange #1 listed in the introduction). In these discussions, Mrs. Miller seemed to act as a participant, similar to the other members of the class, working with the ideas the students proposed. At times, she attempted to repeat the students' ideas back to them, following such comments with inquiries as to whether she had "got it" or if she "was putting words in [their] mouth." Such questions indicate that she was checking in with her students to determine if she fully understood their ideas.

The following is a transcript that reflects an interaction typical of behavioral pattern (C). It was taken from a discussion that occurred on Day 12 of the module, which centered on a question posed by a student (Tommy) concerning a phenomenon that he had witnessed.

Danny: I just *know* I've seen it before. On the car windows-
Mrs. Miller: So more on a *car* window, though. [Looks at Tommy.] Is it the same idea as a car window? Or is it *different*? Are you thinking something different?
Tommy: It's almost the same concept except- except *that* is sideways, and I'm talking about, ah- up- you- ah- up, like, so as a straight area, so it doesn't have any *tilt*. You know? You have a window that's *this* way [Tommy tilts his right hand downward], you know the drop of water's gonna come *down* [Tommy indicates drops sliding down with his left hand]. And if it's *this* way [Tommy holds his right hand horizontally], it'll come toge- I don't know why, it just comes together, like, you know.
Mrs. Miller: So, you're *asking* if it's on the ceil- First, how's it get on the ceiling?
Tommy: Well, ah- a- I don't know, it was just thinking maybe if you splash water or something.
Mrs. Miller: Oh. If you splash water or something?
Tommy: Ah- ah- yeah.

13 **Mrs. Miller**: So, it [looks up at her hands, which are raised to the ceiling] comes together- [moves her
14 hands together]
15 **Tommy**: And then it makes one drop of water and falls.
16 **Mrs. Miller**: Instead of coming just straight down. [brings both hands downward]
17 **Tommy**: Yeah- like, why does the water *move*? It doesn't have [Mrs. Miller looks up at right hand.] any
18 reason to. [Mrs. Miller drops hand downward.]

Mrs. Miller's interactions with Tommy in this transcript clearly indicate that she is trying to understand the phenomenon that Tommy is trying to describe. She asks several pointed questions (e.g. "Is it the same idea as a car window? Or is it different?" in lines 2-3 and "How's it get on the ceiling?" in line 9) and employs gestures throughout the exchange. This use of gestures seems to serve two objectives: (1) to help herself visualize the phenomenon better, and (2) to ask Tommy if she has grasped his idea correctly. In total, the verbal and non-verbal behaviors of Mrs. Miller displayed during pattern C suggest that she is framing this portion of the instructional session as *making sense of student ideas*, which we refer to as, "frame (C)." Her active participation, probing questions, and use of gestures seems consistent with trying to understand her students' thoughts and further the development of these thoughts. Overall, these appeared to be richer discussions than those that occurred when Mrs. Miller employed frames (A) and (B) in that these conversations tended to extend and develop a single student's idea to its conclusion rather than following a series of different ideas superficially.

Discussion

Mrs. Miller is a teacher who has historically taught science by focusing on reaching content objectives. Data collected from Mrs. Miller's classroom early in the 2008-9 academic year (not reported here) showed a clear tendency for Mrs. Miller to focus her attention on institutionalized content standards. After participating in PD sessions focused on attending to student thinking for one year, however, Mrs. Miller's verbal and non-verbal behavior in the classroom indicated that she no longer framed her instruction solely in terms of reaching content objectives. Instead, our findings show that while Mrs. Miller did demonstrate behavior that indicated that she was framing instruction as *reaching content objectives* in some situations, she also demonstrated that she framed her instruction as *promoting a student-centered discussion* and *making sense of students' ideas*. The employment of different frames, rather than a single frame, suggests that she is shifting in her approach to teaching science and facilitating scientific inquiry.

It might be expected that an experienced teacher, such as Mrs. Miller, would move between frames in a stable, predictable manner. This was certainly not the case. She did not appear to shift from one instructional frame to another sequentially, such as framing the initial module sessions as *reaching content objectives* (A), framing subsequent sessions as *promoting a student-centered discussion* (B), and framing the final module sessions as *making sense of students' ideas* (C). Nor did she seem to shift between frames in a cyclic fashion, moving from frame (A) to (B) to (C) rapidly, only to instantiate a similar cycle in later instructional sessions. Instead, Mrs. Miller tended to shift between frames sporadically, framing instruction differently on successive days and occasionally appearing to shift between frames within single instructional sessions. For example, Exchange #1 took place on Day 13 and provided behavioral evidence that Mrs. Miller was framing instruction as *making sense of students' ideas.* Exchange #2 took place the very next day (Day 14) and provided behavioral evidence that Mrs. Miller was framing instruction as *reaching content objectives*. Furthermore, Mrs. Miller displayed behavioral evidence (although not included here) that she was framing instruction as *promoting a student-centered discussion* just twenty minutes prior to the Exchange #2 segment.

Mrs. Miller once again participated in our research project during the 2009-10 academic year. Her second implementation of the water module provided us with the opportunity to explore how her framing of instruction may have changed from her first implementation. Preliminary behavioral analysis indicates that Mrs. Miller employs frame (A) considerably less frequently, whereas evidence of frames (B) and (C) seems to be more prevalent than was observed during her first implementation. Furthermore, while instances of frame (C) continue to be fewer in number and of shorter duration than those of frame (B), Mrs. Miller does appear to be shifting between these two frames more frequently *within* session than was observed during her first implementation of the module. Although these data are admittedly tentative, fewer instances of (A) (e.g. focusing on content only) and shifting from (B) to (C) more regularly (e.g. engaging with student ideas *in-the-moment* during student discussions) suggests that Mrs. Miller is progressing with respect to attending and responding to the substance of her students' thinking. Her debrief interviews from this fall seem to corroborate this interpretation, for her comments seem to be focused primarily on her students' ideas and how these ideas can promote additional explanation and discussion about

phenomena. This focus contrasts with last year, when she tended to comment on whether her students did or did not achieve content goals and/or to what degree her students were participating in discussion.

Part of the broader scope of our research project is to begin to conceptualize a teacher learning progression in the promotion of scientific inquiry. We expect that such a learning progression necessarily involves a dimension in how teachers attend and respond to the substance of their students' ideas. Linear descriptions of learning progressions tend to characterize learning as happening in stable, plateau-like stages representing the increasing degrees of sophistication (e.g. Thompson, Braaten, & Windschitl, 2009). The dynamic, episodic nature of Mrs. Miller's observed behavioral patterns, however, suggests that it might be less meaningful to describe longitudinal progress in terms of successive stages or levels. While it is arguable that frame (C) is more sophisticated than frame (A) regarding a teacher's consideration of the substance of her students' thinking, it is questionable as to whether it is desirable (or feasible) for a teacher to only frame instruction this manner. Allowing students to first share their ideas and reasoning in a student-centered discussion might be a necessary foundation for engaging, probing, and working with their ideas. Characterizing *how* a teacher shifts in her framing of instruction, as well as the *frequency* in which she shifts between frames, might serve to be a more productive way to think about a learning progression in attending to and responding to student thinking. Hence, a learning progression in this dimension might consider the degree to which a teacher is able to move flexibility between frames *in-the-moment* as different students' ideas emerge through discussion.

From a research perspective, framing appears to be a useful construct to help make sense of the ways Mrs. Miller attends and responds to her students thinking. Such a construct allows us to move from just describing observable classroom activity to positing reasons for *why* she might be attending and responding in specific ways at different times during instruction. Furthermore, thinking of framing in terms of activation of specific resources provides a means to consider the possible explanatory mechanisms underlying that activity.

Endnotes

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