

**Supporting preservice teachers' reform-based practices: The importance of intellectual and emotional support in a community**

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Paper presented at the  
Annual Meeting of the American Educational Research Association  
New Orleans, LA  
April 8-12, 2011

We open with an excerpt from a seventh-grade science talk led by Maria<sup>1</sup>, a secondary science intern. In this classroom discussion, Maria and her students were talking about Louis Pasteur's experimental set-up, pictured below:



Pasteur designed the pictured flask to settle the issue of whether life could spontaneously generate. Given that any microbes that entered the flask would get stuck at the bottle-neck, spontaneous generation would be refuted if the broth inside the flask remained clear. Pasteur ultimately found that the broth did remain clear until he tilted the flask, depositing the collected microbes into the broth.

The previous day, Maria's students were confused about how the physical set-up of Pasteur's experiment could provide support for or refute spontaneous generation, so Maria decided to spend time in class discussing why Pasteur designed his experiment the way he did. In the exchange that follows, Maria and a student, Lindsay, discussed why boiling works as a form of sterilization:

**Maria:** "Okay, so he's sterilizing the flask, and why does boiling clean it? Why wouldn't you just take a paper towel or something and clean it? Lindsay?"

**Lindsay:** "Well, one, because water is a liquid..."

**Maria:** "But why, why is – water is a liquid – why is that going to clean?"

**Lindsay:** "Um, like, when um, like, when, if you boil the water because, um, since it's hot it kills the, um, microbes and the bacteria."

**Maria:** "Okay, so the heat, maybe they can't live, maybe the microbes and bacteria can't live in such high heat." (November 18, 2008)

Lindsay initially responded to Maria's question with the idea that water is a liquid. Maria probed Lindsay to fill in the mechanism – what does the fact that water is a liquid have to do with sterilizing the flask? When Lindsay responded that boiling the water makes it hot, which kills the microbes, Maria acknowledged and repeated Lindsay's idea that the microbes cannot live in such high heat.

In this example, we see Maria listening to and making moves to clarify her understanding of Lindsay's idea. Maria identifies the start of Lindsay's idea – water is a liquid – and strives to make sense of why Lindsay is bringing this idea up in this moment. This striving to make sense of a student's idea from the student's

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<sup>1</sup> All teachers' and students' names are pseudonyms.

perspective illustrates what we mean by attending to the substance of students' thinking<sup>2</sup>, which is the reform-based practice at the heart of our three-semester science pedagogy course sequence.

We highlight Maria's interaction with Lindsay as an example of what our candidates do in their internship placements. We find that while candidates are enrolled in our one-year masters certification program (of which the science pedagogy course sequence is part), they do attend to students' ideas and reasoning while teaching, despite accounts in the literature that question whether novice teachers are able to do so (Ainley & Luntley, 2007; Jacobs, Lamb, & Philipp, 2010; Kagan & Tippins, 1991). Once candidates leave the program, though, their practices of attending tend to dissipate. There are times when they attend closely to what their students are saying, but those times are fewer than when they are in the program. This vacillation mirrors findings from other teacher education programs in which candidates were reported to enact reform-based practices more consistently while they were in the program than they did after they graduated (Cady, Meier, & Lubinski, 2006; Grossman et al., 2000; Steele, 2001).

Thus, the primary question at hand in this paper is how can we best understand why our candidates' practices of attending to the substance of students' thinking diminish after they leave the program? In what follows, we first review other teacher educators' responses to similar questions about their own methods courses, highlighting their tendency to focus on the attributes of individual candidates (candidates' beliefs and characteristics) in their responses. However, these accounts also offer examples of the individual candidates in interaction with others, during which the candidates exhibit substantial variability in their practices reflective of their participation in broader communities.

We argue that our science pedagogy course sequence functions as a local community of practice (Lave & Wenger, 1991) in which there is a constant interplay between candidates attending to the substance of students' thinking in their internship placements – enacting the central reform-based practice – and candidates discussing their experiences in class. This interplay stabilizes a framing of teaching as being primarily about student thinking and provides candidates with community support in making sense of students' ideas and reasoning. In addition to intellectual support, the community can also provide candidates with emotional support, which we draw attention to as an underemphasized but essential community role. We consider the implications of our focus on the community and

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<sup>2</sup> Within science and mathematics education reform, a clear consensus is emerging that a cornerstone of effective instruction involves listening and responding to the substance of students' thinking (NCTM, 2000; NRC, 2007). Attending to the substance of student thinking has recently been conceptualized as a central aspect of formative assessment in the classroom (Levin, Hammer, & Coffey, 2009), which has been linked to enhanced student learning (Black & Wiliam, 1998). Focusing instruction on students' ideas and reasoning is also critical for building on and respecting the intellectual resources that students bring to bear in their learning (Ball, 1993; Warren, Ballenger, Ogonowski, Rosebery, & Hudicourt-Barnes, 2001), and for engaging students in authentic disciplinary practices, such as argumentation and explanation-building in science (Driver, Newton, & Osborne, 2000; Duschl & Gitomer, 1997).

various kinds of community support for teacher education practice and research in our conclusion.

**Literature review: Why do candidates' reform-based practices diminish after they graduate from teacher education programs?**

A commonsense explanation for why candidates do not often enact the practices they learn in their methods courses has been that methods courses are typically housed in universities and divorced from the real work of teaching in schools. Darling-Hammond (2006) highlighted this explanation as one of the problems inherent in many teacher education programs: "Because they learned theory in isolation from practice and had a quick encounter with classroom practice divorced from theory, it is little wonder the problem of enactment has been severe for many beginning teachers" (p. 153).

However, a trend towards closer integration between theory and practice was highlighted in Clift and Brady's (2005) review of 105 empirical studies on methods courses and field experiences across numerous content areas from 1995-2001. In their introduction, Clift and Brady stated, "Much of the research documents how the methods courses and outside assignments are conjoined in an effort to integrate recommended teaching practice with actual teaching practice" (p. 313). Although the "actual teaching practice" may vary from shorter field experiences to longer internship placements, candidates are receiving opportunities to try out in classrooms what they are learning in university settings. These opportunities for interactive practice may be fewer than those afforded in other sorts of professional education (Grossman et al., 2009), but they are present in the studies we review below. However, the opportunities for interactive practice while candidates are in teacher education programs do not necessarily translate into continued practices once candidates graduate.

Thus, given that candidates have opportunities to practice in classroom contexts what they learn in methods courses, why do candidates' practices diminish after they graduate? The studies we review offer two primary conclusions – candidates have not sufficiently altered their beliefs and conceptions relative to the desired reform-based practices, or candidates possess or lack characteristics that make it difficult for them to sustain reform-based practices on their own. We briefly summarize studies that draw each of these conclusions and then challenge these conclusions with evidence from the same studies that call into question the focus on individual attributes.

***One explanation in the literature is that candidates have not sufficiently altered their beliefs and conceptions relative to the desired reform-based practices***

In their review of studies on methods courses and field experiences, Clift and Brady (2005) acknowledged that many studies emphasized whether candidates learned new concepts or changed their beliefs in ways that aligned with reform-based practices: "Researchers often note or assume a connection between belief and

action. They have abandoned the earlier, narrower focus of methods courses and research on instructional practices for a new emphasis on changes of beliefs and conceptions" (p. 331). Instead of focusing on the teaching and learning of isolated teacher moves, researchers now seem to be focusing their efforts on facilitating deeper changes in candidates' beliefs and conceptions related to teaching and learning, presuming that these changes will influence candidates' teaching practices.

This focus on candidates' beliefs and conceptions is evident in Adams and Krockover's (1997) study of four beginning secondary science teachers who all graduated from the same university program. Adams and Krockover's explicit focus was on the "knowledge structures for teaching used in the classroom" (p. 634), and they used teachers' recall of their experiences in the program to draw connections between the program and the development of particular constructs. Throughout their paper, Adams and Krockover illustrated that "there are aspects of the science education program that do translate into praxis and become part of the teachers' knowledge structures" (p. 649), with individual differences in which aspects of the science education program were most influential and how these aspects were subsumed into teachers' resident knowledge structures. The resultant knowledge structures, though, were not always evident in teachers' practices in the classroom. For instance, one of the teachers, Bill, expressed constructivist beliefs despite being identified as didactic in his teaching.

Steele's (2001) longitudinal study of four elementary school teachers who had taken the same reform-based mathematics methods course focused on teachers' conceptions as well. In her study, Steele aimed to understand "whether perceived changes in conceptions of preservice teachers have been sustained over time, that is, through the first years of teaching" (p. 141), and which factors influenced the maintenance of these conceptions. She found that although all of the teachers espoused conceptions about mathematics teaching and learning in line with cognitively guided instruction at the end of the methods course and at the end of their internship placements, only two of the four teachers sustained these conceptions into their full-time teaching positions. We return to the explanatory factors that Steele cited in our next section on teachers' characteristics.

***Another explanation in the literature is that candidates possess or lack characteristics that make it difficult for them to sustain reform-based practices on their own***

Another conclusion that researchers draw about why candidates' reform-based practices diminish after they graduate from their teacher education programs is that candidates possess or lack characteristics that make it difficult for them to sustain such practices on their own. For instance, the explanatory factors that Steele (2001) cited in her analysis centered on perceived characteristics of the teachers in her study. For example, take Steele's analysis of Mary. Mary was one of the teachers who sustained conceptions and practices aligned with cognitively guided instruction, which Steele explained in terms of Mary's "personal commitment" and "professional strength": "Mary had definitely sustained her

conceptions about mathematics and mathematics teaching and learning, and demonstrated a personal commitment to her conceptions when she taught... Mary also had a professional strength that helped her maintain her conceptions and align her practice with them" (p. 161). In response to strife, "Mary was able to negotiate her conceptions about teaching amidst the pressures from school administration and parents" (Steele, p. 167), which other teachers were unable to do. Thus, Mary's maintenance of reform-based conceptions of mathematics teaching and learning seemed to be entirely due to her own personal mettle.

Cady, Meier, and Lubinski (2006) also drew on teachers' characteristics to explain differences in teachers' beliefs and practices relative to cognitively guided instruction in mathematics. In their study, Cady, Meier, and Lubinski framed their second research question in the following manner: "Did the participants' level of intellectual development influence their cognitively based beliefs and implementation of practices?" (p. 296). They then used survey data to explore correlations between participants' "locus of authority" and their alignment with cognitively guided instruction. Participants with an external locus of authority were more likely to revert to traditional beliefs about teaching mathematics once project support was removed than participants with an internal locus of authority, leading to the conclusion that professional development needed to continue for participants with an external locus of authority until they developed an internal locus of authority.

***The variability seen within individuals, though, calls into question the focus on fixed individual attributes***

However, there is reason to question this focus on individual attributes, whether these attributes are conceived of as stable beliefs and conceptions that individuals possess or characteristics of the individuals. We draw on Bill, one of the teachers in Adams and Krockover's (1997) study, as an illustrative example of our contention.

As we stated previously, Bill expressed constructivist understandings despite being identified as didactic in his teaching. Adams and Krockover (1997) returned to Bill's case at the end of their paper:

However, in his third year of teaching he began a shift toward conceptual learning. When asked about this apparent change, he credited the opportunity to reflect on his teaching as part of his involvement in the Salish I Research Project at Glass University. We probed into this and discovered that the experiences which he was recalling to implement a conceptual/constructivist classroom were from his methods course. Thus, it would appear that the context of his situation did not press him to change; being asked to reflect on his beliefs about teaching motivated a shift in his teaching style. The implication is that beginning teachers need a forum through which they can reflect about their teaching (pp. 649-650).

Thus, Bill exhibited a change in his practices over the course of the study. According to Adams and Krockover, the research project provided Bill with an opportunity to reflect on his beliefs about teaching, which ultimately motivated him to align his teaching style with constructivist practices from his methods course.

However, Adams and Krockover (1997) also stated that “the context of [Bill’s] situation did not press him to change” (p. 649). We are not sure what Adams and Krockover are taking as the relevant “context” to consider in their statement, but we argue that it is *precisely* the context of Bill’s situation that facilitated his change. The change in Bill’s teaching came as a result of his involvement with a research project. For Bill, reflecting on his teaching was a feature of being part of the research project, part of a broader community that provided him with opportunities he did not have (or take) otherwise. In other words, we do not take the variability in Bill’s practices to be a feature solely of Bill; rather, we take the variability in Bill’s practices to be reflective of his participation in the broader community provided by the research project.

Grossman et al. (2000) align more closely with the kind of analysis we undertake here. In their longitudinal study following ten teachers from the last year of their teacher education program through their first three years of full-time teaching, Grossman et al. used a sociocultural approach to understand “the development of each individual’s understanding and practice in teaching writing” (pp. 635-636). In particular, their analysis situated the teachers they were studying in particular activity settings and sought to understand how features of the various settings influenced teachers’ appropriation of pedagogical tools. Variability in teachers’ practices was expected.

The changes seen in Bill and several teachers in Grossman et al.’s (2000) study call into question the explanatory value of individual attributes. After all, if individuals vary in interaction with different contexts and communities, it does not make much sense to focus on the attributes of individuals as stable entities. In what follows, we present an alternate explanatory framework that permits individuals to demonstrate variability more generally but also accounts for stabilities seen while individuals are members of a broader community.

### **Theoretical framework: We use the notion of framing to emphasize the context-dependency of candidates’ practices**

Our perspective for understanding candidates’ teaching practices draws from research on learning in physics, which demonstrates that students often marshal different patterns of reasoning in different situations (Redish, 2004; Rosenberg, Hammer, & Phelan, 2006). This perspective aligns with views of cognition as both manifold and situated – individuals are not thought to possess stable, unitary beliefs or conceptions, but rather a host of “fine-grained resources that may be activated or not in any particular context” (Hammer, Elby, Scherr, & Redish, 2005, p. 92). Thus, the analytical focus is not on fixed individual attributes, but on which varied sets of resources are activated in which contexts.

This kind of analytical focus aligns with the notion of *framing*, which describes such “context-dependent coherences of individuals’ interpretations of

social or natural phenomena” (Hammer, Elby, Scherr, & Redish, 2005, p. 94). The concept of framing has a diverse history in anthropology, computer science, linguistics, and sociology (MacLachlan & Reid, 1994; Tannen, 1993) and can roughly be thought of as forming a sense of “What is going on here?” Forming this sense involves critical interactions between the contextual cues present in any given situation and the resources that various participants already exhibit.

Research on teachers’ practices is just beginning to draw on framing as an explanatory framework. Framing has been used to explore the variable roles of institutional influences on teachers’ practices in the classroom (Levin et al., 2009), as well as to explain shifts in teachers’ practices within particular classroom episodes (Lau, 2010). In the current study, we add another account of framing to the literature surrounding teachers’ practices. Additionally, we provide an example of how framing can be used to drive coherent course design, which we turn to next.

**Course design: Our science pedagogy course sequence promotes a framing of teaching as being principally about attending and responding to the substance of students’ thinking and comes to function as a local community of practice over time**

The focus of the three-semester science pedagogy course sequence in our one-year masters certification program is based on the premise that a large part of achieving expertise as a science teacher hinges on refining abilities and strategies for attending to students’ ideas and reasoning, using what students’ say and do as the basis for further instructional decision-making. We see our role as being one of helping candidates activate and stabilize the use of skills that they already have – skills for listening to and understanding others’ ideas – in a new context. In other words, we promote a framing of teaching as being principally about attending and responding to student thinking, which draws productively upon candidates’ resources for listening to others and emphasizes the applicability of these resources in the context of teaching.

Our science pedagogy course sequence begins in the summer and runs throughout the duration of the school year, during which candidates are concurrently teaching in their internship placements. The sequence is explicitly structured to draw candidates’ attention to the substance of students’ thinking, first by having them collectively examine records of classroom practice (videos and samples of student work), and then by having them collect and analyze such records from their own classrooms. During the first pedagogy course in the summer, teacher candidates identify frameworks for understanding students’ science learning in the literature, interview students about science topics, engage in their own scientific inquiry, examine curricula for opportunities to draw out students’ ideas and reasoning, and discuss samples of student thinking in classroom video and student work. The second pedagogy course (fall semester) continues these practices of examining and discussing samples of student thinking but goes beyond the first course in asking candidates to write lesson plans in which they anticipate what students might say or do and how they (as teachers) might respond instructionally. They then teach these lessons, collect student work or recordings of



the class, and analyze the student thinking in evidence. The third pedagogy course (spring semester) involves candidates in collecting data from their own teaching and presenting and writing case studies of the student thinking in evidence<sup>3</sup>.

By engaging candidates in iterative cycles of attending to the substance of students' thinking in their internship placements and discussing their experiences in class, we aim to promote a framing of teaching as being principally about attending and responding to student thinking. Moreover, we argue that the science pedagogy course sequence comes to function as a local community of practice (Lave & Wenger, 1991) in which candidates take on various roles in supporting each other in making sense of students' ideas and reasoning. Lave and Wenger argue that newcomers to a particular community of practice learn the relevant norms of that community through participation, starting as "legitimate peripheral participants" who then gain status as they gain responsibility within the community. In our case, candidates enter as legitimate peripheral participants who have resources for listening to and understanding others, but who have not yet activated these resources in the context of teaching. Their engagement and participation in practices of the community, as initially set by the instructor but taken up over time by the participants themselves, helps to establish and reinforce the intended framing. In other words, community interactions around the central practice of attending feed back into the intended framing, stabilizing candidates' senses of "What is going on here?" According to this view, stabilities may not be seen as attributes of the individuals within the community, but rather as features of the community itself.

In what follows, we provide evidence of 1) how our candidates experienced the framing and broader community affordances of our science pedagogy course sequence and 2) what candidates' practices looked like after they graduated from the program in order to speak more substantively to the role of the community in influencing teachers' practices.

### **Participants and methods: We drew on the experiences and perspectives of two candidates to better understand how our candidates interacted with the science pedagogy course sequence**

To better understand the role of the community in influencing teachers' practices, we focused on the experiences and perspectives of two candidates, Alex and Maria, who completed the program during the 2008-2009 school year. Alex is a career changer in his late twenties, now certified as a physics teacher at the secondary school level after attending law school and spending a few years working

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<sup>3</sup> To many, this approach may seem backward. There is a conventional wisdom, based in part on outmoded developmental models of teacher development (Kagan, 1992) that novice teachers cannot attend to student thinking until they have mastered basic skills of classroom management and instruction. Thus, many methods courses focus on issues of classroom management and instructional models. Our approach is to begin all conversations about teaching with attention to the substance of students' thinking, thereby helping our candidates to frame teaching as being principally about attending and responding to students' ideas and reasoning.

as a patent lawyer. (His undergraduate major was physics.) During the year that he was in the certification program, Alex shared teaching duties with a mentor teacher for part of the year before moving to his own classroom and taking responsibility for three classes. He is now working as a high school physics teacher. We focused on Alex as a candidate who was a particularly active participant in the science pedagogy course discussions about student thinking from the very beginning.

Maria is also a career changer in her mid twenties, now certified as a biology teacher at the secondary school level after working in a laboratory at the National Institutes of Health. During the year that she was in the certification program, Maria served as teacher-of-record for three classes of seventh-grade science. She has remained in her position as a seventh-grade science teacher at the same school since graduation. We focused on Maria as a candidate who was representative of some of the quieter participants in the science pedagogy course discussions about student thinking, but who gradually began to participate more over time.

Both candidates agreed to participate in a research project that permitted us to visit the classrooms in which they were teaching and see whether the focus on attending to the substance of students' thinking in the science pedagogy course sequence carried over into their own teaching. Over the course of several visits, we saw that both candidates made efforts to elicit and attended closely to the substance of their students' ideas and reasoning (as in the discussion of Pasteur's experimental set-up in Maria's class).

Thus, we decided to examine Alex and Maria's written assignments, as well as interviews that we conducted with them, for specific mention of the science pedagogy course sequence and/or interactions with their colleagues in the course sequence in order to better understand how they experienced the framing and broader community affordances of the course sequence. We did not design these assignments and interviews to speak to participants' perspectives on the science pedagogy course sequence itself, so in this paper, we can only make claims from what participants spontaneously offered in the way of connections. Although the data is sparser than it would have been had we specifically set out to query participants about their experiences in the science pedagogy course sequence, the data provides a more authentic read of how participants experienced various facets of the course sequence and what they found important to mention.

We also followed Alex throughout the 2009-2010 and 2010-2011 school years to see how his practices of attending to the substance of students' thinking changed and developed after he graduated from the program. In total, we directly observed and videotaped twelve of Alex's classes over the course of the three school years, and we are in the midst of transcribing and analyzing five of them in detail. (We intended to follow Maria as well, but she went on maternity leave shortly into her first year of teaching and has not been able to rejoin the project.)

**Findings: Alex and Maria adopted practices of attending to the substance of students' thinking while they were in the program, but less stably after graduation**

***Alex and Maria took up the intended framing of the science pedagogy course sequence***

In looking at both Alex and Maria's assignments and interviews throughout the 2008-2009 school year, we see evidence that both candidates took up the intended framing of the science pedagogy course sequence. For instance, Maria differentiated the science pedagogy course sequence from other classes that she took in the program:

**Maria:** "[It] was different than like all the other ones, I thought, but it was with a major focus on student thinking. Like, you really had to think about what they were, I mean, what they got from certain activities." (June 2, 2009)

Maria acknowledged the emphasis on student thinking in the science pedagogy course sequence and used it to distinguish the course sequence from her other classes. She was aware of the need to think about what her students were getting out of the activities in which she was engaging them, which she later characterized as a "lot of effort" but also "valuable to do."

Alex also recognized the focus on student thinking in the spring semester case studies:

**Alex:** "I think it's going to start really getting into gear once we start doing the case studies. I think that's the real focus of this semester, is just everyone presenting their own case studies, and then us talking about them."

**Interviewer:** "And what are you focusing on when you are presenting the case studies and then discussing them? What's the focus of the assignment?"

**Alex:** "Well, the idea is just to focus on, you know, the student thinking and the evidence of student thinking that you can get from either a transcript or student work or something, and then sort of evaluating the lesson based on that. So, you know, your lesson was good or thought-provoking, and I can know that by looking at this student work." (February 10, 2009)

In this exchange, Alex noted that discussion of the case studies would focus on student thinking. What Alex said, though, indicates more than a simple understanding of the assignment. He seemed to acknowledge that a lesson should not be evaluated on its own merits, or on what the teacher did, but rather on what evidence of student thinking there was and what the student thinking indicated about how students comprehended the lesson. In a manner similar to Maria, Alex highlighted the importance of evaluating activities or lessons via understanding the

student thinking they elicit, which aligns with the intended framing of the science pedagogy course sequence.

***Two different types of community support developed around attending to the substance of students' thinking***

Alex and Maria's assignments and interviews throughout the 2008-2009 school year also provide evidence of how candidates came to support each other in various ways in their pursuit of attending to and providing opportunities for student thinking to emerge while teaching. We provide two examples to illustrate two different types of community support that developed. In the first example, we show Alex drawing intellectual support from another candidate, Steve, in making sense of a particular student's statement. In the second example, we show Maria appealing to the community for both intellectual and emotional support as she grapples with a particular tension that she is experiencing in attending to the substance of students' thinking in the classroom.

*1) Candidates provided each other with intellectual support in analyzing student thinking*

Given that much of the conversation during class focused on unpacking particular students' meanings, it is unsurprising that candidates came to support each other in making sense of students' ideas and reasoning. We find evidence of this kind of intellectual support in Alex's first lesson planning assignment, in which he cited conversation with another candidate, Steve, as helping him make sense of what a student's response could have meant.

Alex provided his physics students with a problem about what angle a gun must be fired at to hit a monkey in a tree, presuming that the monkey drops from the tree as soon as the gun is fired. Since the bullet and the monkey become subject to only the force of gravity in the vertical direction at the same time, the correct answer is to aim the gun directly at the monkey.

In his reflection, Alex was trying to make sense of the following interaction with a student:

**Student:** "Is it the same time for the monkey and the pellet?"

**Alex:** "You tell me. Is the pellet moving the same amount of time that the monkey's moving?"

**Student:** "No. But we were writing an equation for the pellet and an equation for the monkey, and then we equalize the times!" (October 31, 2008)

Alex was confused about why the student responded that the pellet was not moving the same amount of time as the monkey, yet she equalized the times for the pellet and the monkey anyway. He reflected on his puzzlement in his write-up:

**Alex:** “[The student] was making some good progress. She figured out one of the important aspects of the problem was that both the monkey and the bullet were moving for the same amount of time. Her response... is somewhat puzzling. She asks me whether the time is going to be the same, and I ask her back, ‘You tell me.’ She initially says, ‘No,’ but then explains her answer as if she had said, ‘Yes.’ Steve and I were talking about this line, and he suggested her response might be a typical student reflex that if the teacher says anything other than, ‘You’re right!’ it indicates the student is wrong.” (November 10, 2008)

Again, Alex’s confusion centered on why the student said no when her next words were affirmative. Alex acknowledged that Steve, another candidate, provided him with a possible interpretation of this apparent discrepancy in the student’s response – that she might have been reacting to the perhaps unusual situation of a teacher continuing to probe her reasoning. While it is unclear whether this is a correct interpretation of what the student was doing, it is an interpretation that serves to resolve the discrepancy in the student’s answer. We provide this example to highlight one of the broader community affordances that candidates capitalized on – intellectual support from each other in analyzing and trying to make sense of student thinking from their own classrooms.

## *2) Candidates provided each other with emotional support in pursuing student thinking*

In addition to intellectual support, we found that candidates also relied on the broader community for emotional support. For example, early in the year, Maria became concerned about how she handled the discussion that ensued after she asked her students, “How does a rainbow occur?” in the midst of a unit on light:

**Maria:** “So the first day, they were saying reflection a lot, and I was kind of cringing inside, like, I didn’t want them to think that, but I didn’t want to be like no, that’s completely wrong... So I went home that night, and I was feeling, I felt upset about it because I was like oops, I think I, you know, reinforced the wrong thing. And I talked to Dan about it...”

**Interviewer:** “Right. Was that something you talked about at class with him? Because I know he sometimes does those ‘how are things going’ discussions in class.”

**Maria:** “Yeah, and I did talk to him in class. He was like how are things going, and I was like I have something that I need to share because I felt so guilty

about this rainbow issue... And even talking to people in between classes, or like in between breaks and stuff, like other of my peers, it's great... And not just complaining because, I mean, we do a great deal of complaining, you know, like oh, I'm having this issue, but constructively talking about things." (October 2, 2008)

Here, in the first interview with Maria, she spontaneously brought up an instance in which she felt that she mishandled a discussion and sought support from Dan (the instructor of the science pedagogy course sequence) and her classmates. Her particular concern was that students were grappling with how to explain rainbows, and their primary thoughts centered on an incorrect application of the concept of reflection. Maria was torn between wanting to correct her students and wanting to support their thinking, which is a common tension that arises in our program.

Maria's concern, however, was not solely intellectual, as in Alex's example above. Alex was puzzled by a discrepancy he saw in his student's comment, and his approach was to try to make sense of the comment in collaboration with another candidate. Maria, on the other hand, "felt upset" about the situation in which she found herself. She felt that she had reinforced the students' incorrect application, and she brought her concern to public attention because she "felt so guilty." Maria was careful to note that she *was* seeking intellectual support – she desired constructive input on how to handle the situation. But she also seemed to be seeking emotional support from her colleagues in dealing with the tension and the guilt that she was feeling.

Maria's example points to an underemphasized but essential community role – not just learning from each other, but reassuring and supporting each other emotionally when things do not go as expected. Numerous examples of classroom interactions highlight the complexities of teaching and the dilemmas that arise in the moment for teachers (Ball, 1993; Hammer, 1997; Lampert, 1985). With reform-based practices in particular, which may run counter to the more traditional settings in which teachers find themselves, the inherent tensions in teaching become all the more prominent. Thus, we should take seriously the importance of emotional support for teachers involved in implementing reform-based practices, particularly novice teachers just entering the field for the first time.

***Alex's practices of attending to the substance of students' thinking became less stable after he graduated***

We now turn to a brief description of Alex's practices of attending to the substance of students' thinking after he graduated from the program. In general, he appears less stable in his attention to student thinking. There are certainly instances when he alters his lesson plan in response to what his students are saying:

**Alex:** "I like that as a teacher to go where they're thinking and to, to go along with their thinking, and I sort of threw out my worksheet because we didn't need it today... the worksheet was a step-by-step going through the same

type of thing in case they hadn't thought about it, but they had thought about it." (October 20, 2009)

The worksheet in question was designed to draw students' attention to a possible paradox in Newton's third law (that two objects exert equal and opposite forces on each other, so how can either object move?). However, Alex attended to the substance of what his students were saying in class and realized that they were authentically grappling with this very paradox, so he decided to follow their lead instead of going with the structured worksheet.

Yet, Alex also seems more concerned with getting through the curriculum than he did when he was in the certification program. In his current position, he has a good deal of flexibility when it comes to designing his own lesson plans, yet he does not seem to feel that he has much freedom. For instance, Alex described how he only facilitates a particularly rich conceptual physics discussion once he has covered what he feels he needs to cover:

**Alex:** "I've gotten through all the content I'm supposed to get through, and I have, like, one or two more days before final exams, and this is something to just sort of kick around. And I don't worry that we haven't gotten to Chapter two-dash-three in the book today because we spent all our time on one question, and we didn't get the answer. And so, I mean, I can't, I don't find myself having the ability to do that a lot... but I would like to do more of this where we just sort of meander around and think and talk and argue with each other." (January 6, 2011)

Thus, although Alex states that he would like to have more class discussions, he feels constrained by what he needs to get through in the curriculum. Without continuing support from the local community of practice centered on attending to the substance of students' thinking (other than visits for research purposes), other priorities – likely emphasized by other communities of which Alex is part – appear to take precedence.

### **Summary and implications: The cultivation and maintenance of community should be a focus of teacher education efforts**

In summary, we set out to understand why our candidates' practices of attending to the substance of students' thinking diminish after they leave the program. Other teacher educators' responses to similar questions about their own methods courses foregrounded individual attributes, arguing that candidates did not sufficiently alter their beliefs or conceptions relative to the desired reform-based practices or that candidates possessed or lacked characteristics that made it difficult for them to sustain reform-based practices on their own. We do not dispute the fact that individual differences matter. What we dispute is the focus on individual attributes as fixed, given the variability that we see as individuals transition from context to context and community to community.

We presented framing as an alternate explanatory framework that permits individuals to demonstrate variability more generally but also accounts for stabilities seen while individuals are members of a particular community. Our science pedagogy course sequence was explicitly designed to promote a framing of teaching as being principally about attending and responding to student thinking, which we saw Alex and Maria take up. Moreover, through engaging candidates in iterative cycles of attending to the substance of students' thinking in their internship placements and discussing their experiences in class, a local community of practice formed in which candidates provided each other with intellectual and emotional support.

According to this account, it is not surprising that Alex became less stable in his attention to student thinking after he left the community instantiated in the science pedagogy course sequence. His vacillating practice does not reflect a lack of relevant beliefs, conceptions, or characteristics on his part; on the contrary, when he facilitates class discussions, he is phenomenal at attending to and following the substance of students' thinking over long periods of time. (We are in the process of analyzing episodes of Alex's teaching for a forthcoming manuscript.) In addition, the fact that Alex continues to attend to student thinking at all after graduating indicates that it was not just something that he was doing to get through his teacher education program. Without continuing support, though, it is difficult for Alex to maintain his focus on this reform-based practice – particularly in light of the demands of other communities of which Alex is part.

This finding calls our attention as teacher educators and researchers to the importance of community support in promoting the enactment of reform-based practices. We echo calls for a more cohesive trajectory of teacher education extending from preservice preparation to professional development (Feiman-Nemser, 2001). As we think about how to extend the community formed within the science pedagogy course sequence beyond the bounds of the sequence itself, we welcome ideas about the variety of forms this extension could take.

## Funding

This work was partially funded by NSF ESI-0455711 and NSF DRL-0733613.

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