Eliciting, Identifying, Interpreting, and Responding to Students' Ideas: Teacher Candidates' Growth in Formative Assessment Practices

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Abstract With the goal of helping teacher candidates become well-started beginners, it is important that methods courses in teacher education programs focus on high-leverage practices. Using responsive teaching practices, specifically eliciting, identifying, interpreting, and responding to students' science ideas (i.e., formative assessment), can be used to support all students in learning science successfully. This study follows seven secondary science teacher candidates in a yearlong practice-based methods course. Course assignments (i.e., plans for and reflections on teaching) as well as teaching videos were analyzed using a recursive qualitative approach. In this paper, we present themes and patterns in teacher candidates' abilities to elicit, identify, interpret, and respond to students' ideas. Specifically, we found that those teacher candidates who grew in the ways in which they elicited students' ideas from fall to spring were also those who were able to adopt a more balanced reflection approach (considering both teacher and student moves). However, we found that even the teacher candidates who grew in these practices did not move toward seeing students' ideas as nuanced; rather, they saw students' ideas in a dichotomous fashion: right or wrong. We discuss implications for teacher preparation, specifically for how to promote productive reflection and tools for better understanding students' ideas.

Keywords Teacher preparation · Formative assessment · Secondary science

One of the goals of teacher education programs is to produce "well-started beginners" (Hallon et al. 1991), novice teachers who are prepared to address core problems of practice and continually reflect on and learn from their teaching. Because methods courses in teacher education provide limited amounts of time to work with teacher candidates, it is necessary to prioritize certain aspects of teaching over others. Thus, to prepare teacher candidates to be well-started beginners, it is important to focus on "high-leverage practices" or "teaching

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practices in which the proficient enactment by a teacher is likely to lead to comparatively large advances in student learning" (Ball et al. 2009, p. 460).

One high-leverage practice is eliciting, identifying, interpreting, and responding to students' ideas, also known as using "formative assessment." Formative assessment is an essential aspect of teaching in which teachers gather evidence of what their students know and use this information to modify their teaching practices and provide focused feedback to students to improve their learning (Black et al. 2004). Formative assessment—implemented in ways that provide motivating feedback to students, involve students actively in the process, and guide teachers' actions—can have extraordinarily strong impacts on student learning (Black and Wiliam 1998). Teachers who are able to use information gathered from students to adjust the content that they teach and the methods by which they teach it are more likely to help all kinds of students succeed at high-quality work (Fennema et al. 1993; Hill et al. 2005; Windschitl et al. 2011). This study examines the extent to which teacher candidates changed their planning for, implementation of, and reflection on formative assessment practices in ways that promoted responsive teaching over the course of a yearlong methods course.

Literature Review

Formative Assessment and Responsive Teaching Practices

Formative assessment refers "to all those activities undertaken by teachers—and by their students in assessing themselves—that provide information to be used as feedback to modify teaching and learning activities" (Black and Wiliam 1998, p. 140). When done well, formative assessment practices can be thought of as "responsive teaching," or teaching that is characterized by a teacher's attempts to understand what students are thinking through questions and probes and to use this understanding to guide their future instructional moves (Pierson 2008). When teachers enact formative assessment practices well, they (a) provide opportunities for students to demonstrate their understandings, (b) identify students' ideas, (c) interpret students' responses, and (d) respond to students' ideas with feedback and/or instructional decisions that will help move from or build on current understandings (Ruiz-Primo and Furtak 2007; Sadler 1989).

Formative assessment that is done during the course of instruction, i.e., "informal formative assessment" can be responsive to students' ideas (Cowie and Bell 2001; Ruiz-Primo and Furtak 2007; Shavelson et al. 2008). In this type of responsive teaching, teachers may engage students in dialogic conversation about big ideas (Duschl and Gitomer 1997; van Zee et al. 2001). These conversations allow multiple opportunities for improving learning: identifying prior knowledge that can be built on (Otero 2006), identifying problematic ideas and misconceptions that can hinder learning (di Sessa and Minstrell 1998), providing feedback to motivate improvement (Hattie and Timperley 2007), and adjusting teaching and learning strategies in an ongoing manner (Kohler et al. 2008). While these conversations may be seen as informal, there are often planned aspects. For example, teachers may plan the types of questions to elicit student understanding and research common student ideas in order to guide their next steps.

Crucial to these conversations are the quality of teachers' listening or "noticing" (van Es and Sherin 2002, 2008). When teachers engage in "hermeneutic listening" (Davis 1997), in which they regularly provide and seek feedback from students to guide their interpretations about what students mean by particular responses, students are more likely to learn. This is contrasted with evaluative listening, in which teachers listen for the "correct" answer. This type of interpretive listening, or noticing of ideas, more often leads to productive assessment

conversations in classrooms (Duschl 2003) and higher responsiveness to students' ideas (Pierson 2008).

Teachers, especially beginning teachers, struggle with responsive teaching (Athanases and Achinstein 2003; Davis et al. 2006). Specifically, some of the problems beginning teachers face in the classroom may include limited abilities with framing questions that elicit more than declarative knowledge from students (Mergendoller et al. 1988), and focusing primarily on whether students "get it" or not rather than on eliciting student reasoning and understanding (Furtak et al. 2012; Otero 2006). In addition, many teacher candidates do not "notice" students' ideas even when they are elicited (e.g., van Es and Sherin 2002, 2008) and do not involve students in reflecting on and revising their own thinking (Penuel et al. 2006). Finally, many teachers and teacher candidates do not know how to adjust instruction based on what student responses reveal about student thinking (Feldman and Capobianco 2008; Ruiz-Primo and Furtak 2007).

However, despite these struggles, research has shown that, with careful scaffolding, novice teachers are able to be more responsive to students in eliciting rich information and responding to students' ideas (Levin et al. 2009). When supported, teachers can develop responsive teaching practices where they engage meaningfully with students' ideas (Atkin et al. 2005). Thus, we (and others) believe that scaffolding prospective teachers' formative assessment practices is an important, yet often underdeveloped, area of their initial teacher preparation (Buck et al. 2010; Popham 2009; Stiggins 2009).

Promoting Responsive Teaching and Formative Assessment Practices in Teacher Education

In order to prepare well-started beginners in becoming responsive teachers, teacher preparation programs should attend to main components of informal formative assessment (Black and Wiliam 2009). Specifically, some have argued that teacher preparation programs should include explicit teaching of formative assessment and provide teacher candidates with case-based examples of good formative assessment practices (Buck et al. 2010). Complementing these components, teacher preparation programs also need to scaffold teacher candidates in recognizing the nuances of students' ideas so that they can productively use students' prior knowledge in instruction to attain specified learning goals (Morrison and Lederman 2003; Otero and Nathan 2008).

In addition, bridging the theory of responsive teaching and formative assessment with the practices of formative assessment is especially important because teacher candidates often struggle making connections between the ideas that they learn in their methods courses and the "real life" experiences that they encounter in their field placements (Luehmann 2007). Despite these struggles, field placements coupled with reflection opportunities have been shown to have the greatest impact on teacher candidates' practices and beliefs about science teaching (Bryan and Abell 1999; Zembal-Saul et al. 2000). Specifically, teacher candidates who attend teacher preparation programs that have extended field experiences tend to hold more student-centered beliefs and enact inquiry in their classrooms more than those teacher candidates who are in more traditional preservice programs (Roehrig and Luft 2006).

One method for scaffolding teacher candidates in bridging the theory that they learn in methods courses and their practice in the field is having them observe and reflect on teaching videos and their students' ideas (e.g., van Es and Sherin 2006). Research has shown that guiding teacher candidates in observing videos of their own and others' teaching promotes productive reflection and noticing of salient features of the classroom (Santagata et al. 2007; Star and Strickland 2008). However, the guidance provided to teacher candidates in their reflection is crucial. Without guidance on where to focus their attention, teacher candidates

may only describe what they see and not attend to issues that may move them toward more student-centered practice (Abell et al. 1998; Davis et al. 2006). Through guided analysis of video, however, teacher candidates can learn to focus their attention on student thinking (Franke et al. 2001; van Es and Sherin 2006) and on student learning (Davis et al. 2006). Thus, we believe that guided reflection on practice, specifically through the use of video, is an important aspect of preservice teacher education.

Based on all of this prior work, the research question guiding this study is: "To what extent do teacher candidates change their planning for, implementation of, and reflection on formative assessment practices in ways that promote responsive teaching over the course of a yearlong methods course?"

Methods

In this section, we describe our methods for investigating our research question. Specifically, we describe our purposeful selection of participants, describe our data sources and how they map to our research question, and explain our analytic techniques, specifically the use of comparative case studies.

Participants and Context

This study examined the nature of seven secondary science teacher candidates' responsive teaching practices over the course of one year (see information about the teacher candidates in Table 1). The teacher candidates represent a sample of the Biology and Chemistry majors from the senior year methods course (described below). These seven teacher candidates were selected from the larger class (about 35 students) as those who had sufficiently high quality audio-video recordings from their classroom teaching throughout the year and gave permission to use their materials. The first author was the instructor of the secondary science methods courses. The second author was not involved in teaching the courses and did not know any

Table 1 Information about the teacher candidates

Name	Gender	Major/minor	Senior placement and topic taught
Lara	Female	Biology/chemistry	Fall: Urban HS ELL Biology (osmosis) Spring: Urban HS Biology (evolution; finches)
Kristin	Female	Biology/math and chemistry	Fall: Urban HS ELL Biology (osmosis) Spring: Suburban HS Biology (nervous system)
Chris	Male	Biology/integrated science	Fall: Urban MS Earth Science (soil) Spring: Urban MS Biology (genetics)
Elisha	Female	Biology/chemistry and integrated science	Fall: Urban MS Earth Science (soil) Spring: Suburban HS Biology (plant pathology)
Mike	Male	Chemistry/math	Fall: Suburban HS Chemistry (electron configuration) Spring: Urban HS Chemistry
Lissa	Female	Chemistry/math	Fall and spring: Suburban HS Chemistry (electron configuration; molar conversions)
Lila	Female	Chemistry/math	Fall and spring: Suburban HS Chemistry (electron configuration; molar conversions)

All names are pseudonyms

HS high school, *MS* middle school, *ELL* English language learner

members of the course before the study. He recruited participants and gathered all participant teaching videos and assignments.

The teacher candidates were in their fourth year of a 5-year reform-oriented teacher preparation program at a large Midwestern university in the USA. During their senior year, teacher candidates took a yearlong science method course (fall and spring semesters; five credit hours in the fall, six credit hours in the spring) that involves both university-based classes and placement in local teachers' classrooms. The university classes focused on preparing teacher candidates to work within a teaching cycle: *planning* based on standards, learning theories, and research on students' ideas; *teaching and assessing* based on plans and students' interactions with the activities; and *reflection on/revision of teaching* in which enactment of teaching is analyzed and ideas for improvement are considered. The course is close to practice in that many of the assignments are centered on teacher candidates' placements in classrooms.

The teacher candidates began the year in one of four field placements based on their major: a high school chemistry class, a high school physics class, a high school biology class, or a middle school integrated science class. In consultation with the mentor teacher, the teacher candidates worked in groups to develop clinical interview questions about a topic that they would later get to teach. They conducted clinical interviews with groups of students in pairs and used the information that they gathered, in addition to state standards and research on students' ideas (e.g., Driver et al. 1993), to co-plan a lesson that they would co-teach with a partner to a small group of students. They videotaped these lessons and collected written student work. Using prompts, teacher candidates reflected in critical friend groups[1] on their videos and student work. Then they individually wrote up their reflections on their teaching. They completed this cycle twice in the fall semester.

After these experiences, teacher candidates were placed in pairs in classrooms (based on their major) in which they spent 3–5 hours per week for the remainder of the fall semester and all of spring semester. In these placements, they observed their mentor teacher, helped with labs and group work, and eventually taught whole class sessions. Teacher candidates worked with the mentor teacher and university instructors to plan single lessons and a 3-day lesson sequence all based on unit plans. Similar to the fall, they planned using standards, research on students' ideas, and input from their mentor teachers; videotaped their teaching and collected student work; and after viewing segments of their video in critical friend groups, individually reflected on their teaching. They completed this cycle three times (for the two individual lessons and for the 3-day lesson sequence). These assignments were sequenced in order to engage teacher candidates in the teaching cycle. In the spring, they planned and taught individually. In addition, in the fall, they only taught a small group of students (a microteaching experience), while in the spring, they taught a whole class. The hope was that through engaging teacher candidates in teaching cycles that are closely related to their own development as learners, they would be more likely to make strides in inquiry practices and student-centered pedagogy (Zembal-Saul et al. 2000). These experiences helped prepare teacher candidates for their full year teaching internship during the fifth year of the program.

Data Sources

We used multiple data sources to identify patterns in teacher candidates' formative assessment practices, triangulate findings, and develop explanatory models. All of the data sources were course assignments (or related to course assignments) that were centered on the teaching cycle.

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[1] Critical friends group refers to a small group of students that shared work, offered critique, and supported each others' practice throughout the course.

In order to better understand how the teacher candidates were planning for formative assessment, we examined two of their course assignments: a lesson plan from the fall semester and a unit plan from their spring semester. In order to examine teacher candidates' enactment of their plans, we examined four self-made teaching videos for each teacher candidate—one from the fall semester (in which they enact their lesson plan) and three from the spring semester (in which they enact three sequential lessons from their unit plan). Finally, in order to examine teacher candidates' reflections on their teaching, we examined course assignments (one for the fall enactment and one for the spring enactment) that included analysis of written student work, video analysis, and ideas for how to improve their teaching.

Analytic Techniques

We used a comparative case study with multiple data sources at two time points (Yin 2009). To examine each of our data sources, we used qualitative data analysis (e.g., Corbin and Strauss 2007) to investigate teacher candidates' formative assessment practices. More specifically, we used a recursive coding process, employing both top-down and bottom-up procedures. We began with themes identified by the literature—specifically, we looked for evidence of teacher candidates (a) *providing opportunities* for students to demonstrate their understanding (or eliciting students' responses), (b) *identifying* students' ideas, (c) *interpreting* students' responses, and (d) *responding* to students ideas. These predetermined categories were supplemented and elaborated by emergent categories that were suggested by a close study of the teaching videos and assignments during the coding process. Each of the authors examined the data sources for each teacher candidate to ensure investigator triangulation and reliability (Patton 2002); however, each author took primary responsibility for coding data for specific teacher candidates.

After the initial round of coding, the authors developed a case study template and wrote case studies for each teacher candidate. The case study template examined teacher candidates' teaching thematically through their artifacts (plans, videos, reflection) in both the fall and spring semesters. The template consisted of a description of the teaching context followed by a look into the following themes identified during the first stage of analysis including (1) teacher positioning/interaction patterns with students; (2) eliciting, interpreting, and responding; and (3) timing. Discussion of these themes was divided into sections on the fall and spring semester and drew from relevant data collected in lesson plans, teaching videos, and reflections written after teaching the lesson. After developing cases for each teacher candidate, we looked for patterns within and across teacher candidates and over time by creating a linkage chart (Miles and Huberman 1994), which assisted us in moving from themes to claims.

Findings

In this section, we present three patterns that emerged from analyzing growth (or nongrowth) within and between teacher candidates in their plans, teaching videos, and written reflections. We focused on the practices of eliciting students' ideas, identifying and interpreting students' ideas, and responding to students' ideas. These patterns allowed us to characterize the nature of teacher candidates' responsive practices over the course of the year of methods courses. The first pattern that emerged through analysis of teacher candidates' artifacts was a shift (for five of the seven teacher candidates) in the *focus of classroom practices* from themselves as teachers to a more balanced focus on both teacher and student moves. Specifically, in the fall, all but one teacher candidate focused solely on their own moves as a teacher, while in the

spring, many (though not all) teacher candidates shifted their focus to include students' ideas and responses in some form, indicating a shift to more responsive teaching.

The second pattern that emerged was a growth in the ways in which teacher candidates *elicited students' ideas* in terms of both the opportunities for students to share ideas, as well as the physical positioning of the teacher candidate. In the fall, almost all teaching interactions were in an IRE format (i.e., teacher initiates (I) dialog by asking a question, a student offers a response (R) to the question, and then the teacher evaluates (E) the student's response; Cazden 2001; Mehan 1985). In addition, in the fall teaching videos, all teacher candidates positioned themselves in an authoritative position at the front of the classroom influencing the types and frequency of interactions between teacher candidate and students. In the spring, all but two teacher candidates moved to asking follow-up or probing questions with a reflective toss nature (i.e., where the teacher puts at least some of the responsibility of meaning-making back on the student, for example, through asking follow-up questions; van Zee and Minstrell 1997). The spring videos also revealed a change in teacher candidates' physical positioning (from the front of the room to moving around the room) resulting in a shift in interaction patterns and providing opportunities to elicit student ideas from small groups and individuals. These findings also indicate a shift toward more responsive teaching practices.

The final pattern that emerged was the way in which teacher candidates *conceptualized students' ideas*. Specifically, in both the fall and spring, most teacher candidates conceptualized students' ideas in a dichotomous fashion: either correct or a misconception. There were very few instances of identifying student ideas that, while not what the teacher candidate was anticipating in connection to their question, could be considered productive or built upon. In the following sections, we expand on each of these patterns; describe how these patterns played out in teacher candidates' plans, then in their teaching, and finally in their reflections; and provide illustrations from teacher candidates—both for cases in which teacher candidates seemed to make strides in their practices and cases where growth in formative assessment practices was not observed.

Plans

Teacher candidates' plans allowed us to gather information about how they envisioned their teaching practice would be carried out. Thus, the plans gave us insights into how teacher candidates viewed students' ideas and how they envisioned interacting with students around these ideas. As we only had unit plans from the spring semester, which contain less detail about the specific questions for each lesson, our abilities to make claims about growth from these plans in terms of how they elicited student ideas and the focus of their classroom practices were limited. Despite this, we saw consistency from fall to spring in teacher candidates' notion about the nature of students' ideas as non-nuanced through inclusion of students' prior knowledge and possible misconceptions in their planning documents. In the following section, we elaborate on this idea of seeing students' ideas as non-nuanced in the pattern of *conceptualization of student ideas*.

Conceptualization of Student Ideas

In both fall and the spring, teacher candidates researched students' prior knowledge and possible misconceptions as part of the planning process for their methods courses. Specifically, they were instructed to include both "Accurate examples or ideas you can build on" and "Common misconceptions." Thus, students' ideas were a central component of the plans for all teacher candidates in both fall and spring. However, the way in which these ideas were framed and used in their planning varied between the teacher candidates. In the fall, many

teacher candidates, when asked to provide productive ideas that students might have, listed what students might have learned in class or have not yet learned in class. For example, in her writing of prior knowledge or ideas that can be built upon, in both the fall and spring, Lila focused on student ideas originating from previous classroom experiences or lack of classroom experiences (Table 2). In the fall, she envisioned students as "blank slates" who lacked both prior knowledge and misconceptions regarding the topic due to never having been exposed to it. In a spring unit on moles and empirical and molecular formulas, Lila drew on experiences students had in the prior unit, building math competencies, which would be applied to the current unit. All of the prior knowledge Lila envisioned as holding possibilities to be built on stems from only one context: previous classroom experiences.

Similarly, Kristin focused on student ideas originating from previous classroom experiences in both the fall and spring plans (Table 2). In the fall, Kristin conceptualized student prior knowledge in terms of experiences in the classroom that had recently been tested. However, in the spring, Kristin was beginning to think about prior experiences outside of the classroom that might influence the ways in which students engage with the content although she still believes the accurate examples most likely came from experiences in school or "are likely from previous units or earlier grades." While Kristin acknowledged students may have prior experiences, she noted in the introduction of the unit "Students will come in with preconceived notions about nerves and senses, but most likely have never seen the majority of this material prior to class." These preconceived notions or the "accurate ideas to build on" (e.g., muscle twitches) are not referenced as something to be built on throughout the rest of her unit in either her assessment tasks or activities.

Except for Kristin, none of the teacher candidates explicitly wrote about any out-of-school knowledge that students might bring to the class that they could build on, despite this having been discussed as part of the methods class and there being a section about accurate ideas or examples to build on in the planning template. The pattern among teacher candidates in how

Table 2 Lila, Kristin, and Elisha's "accurate ideas to build on" section of the lesson plan (fall) and unit plan (spring)

Fall	Spring
Lila: Because the students have never learned about electron configurations, Bohr diagrams, or electron dot diagrams before this year, it is really unlikely that they will have any misconceptions about this topic because it is all new	Lila: The previous unit covered by the class was about math application to science and they became familiar with unit conversions and with the process of dimensional analysis, which will be important skills to have in this unit
Kristin: Students have worked previously on cells. The different components, functions, and the major differences between a plant and animal cell. They were just tested on this material within the last week of class. Students should also be familiar with molecules, atoms and elements (i.e. oxygen, nitrogen, and hydrogen)	Kristin: • Students will be aware, or may have had sometime in their life, muscle twitches, reflexes, paralysis, etc. • Autonomic nervous system ties in with blushing, hair standing up on the back of your neck and arms
Elisha: Other misconceptions we have found that are similar to our student's responses are that soil is always brown, soil is not useful, and that soil is a solid Source: http://www.smartplanet.com/people/blog/pure-genius/ten-misconceptions-about-soil/1577/	Elisha: There are many common misconceptions with students (and adults) when discussing diseases in plants, for example believing that all bacteria are bad and will cause disease. Another misconception is that disease causing agents are found in dirty places, such as dirty water or soil. Lastly, all disease will lead to death. [http://www.actionbioscience.org/biodiversity/wassenaar.html]

they wrote about students' prior knowledge in both the fall and spring was to either include ideas that students had learned previously in their class that could be built on or to discuss ideas that had not been covered in class and thus students would have no prior experience with. For the most part, teacher candidates envisioned students' prior knowledge originating from classroom experiences with similar curriculum and did not consider out-of-classroom ideas.

In addition to "accurate ideas," teacher candidates were asked to think about the misconceptions students brought with them in relation to the intended curriculum. In addition to experiences with their students and discussions with mentor teachers, teacher candidates turned to the Internet to explore possible misconceptions students may bring to investigations of specific content (see Elisha, Table 2).

Despite the fact that teacher candidates provided common misconceptions that students may have, there was little evidence in either fall or spring that the teacher candidates thought of students' understandings as nuanced or complex. For example, Elisha wrote about the common misconception that students have about diseases and bacteria—but did not mention that their knowledge of bacteria might be a good starting place for students in their foray into this unit. Similarly, in the spring, Kristin wrote that student misconceptions include "students believe that only humans have a well-developed nervous system and humans have only five senses." Kristin mentioned these misconceptions alongside prior knowledge, such as the feeling of having their hair stick up on the back of their neck, but did not write about how these ideas may provide a connection to components of the nervous system the class will investigate during the unit. Instead, prior knowledge and misconceptions were viewed as being either right or wrong. The perception of students' ideas as either correct or a misconception persisted throughout the year. As we will discuss later, this may have been due to the nature of the assignment.

Overall, we saw very little growth in how teacher candidates conceptualized students' ideas from the fall to the spring. None of the teacher candidates viewed students' ideas as nuanced and holding possibilities to be built on beyond determining whether they were right or wrong. Additionally, with only two exceptions, teacher candidates saw these ideas originating from only one context: student experiences in school.

Teaching

In examining the teaching videos, we found rich information about the ways in which teacher candidates enacted their written plans and interacted with students. These analyses provided rich information about how teacher candidates *elicited students' ideas* both through shifts in their questioning practices and their positioning within the classroom. Specifically, we saw a growth in the interactions that teacher candidates had with students—moving from mainly IRE patterns in the fall to more of a reflective toss pattern in the spring. We also saw a shift from lower cognitive demand questions to higher cognitive demand questions (Leach and Scott 2002). Specifically, teacher candidates moved away from "can you guess what I (the teacher) am thinking" questions in the fall to questions that asked students to explain or expand upon their reasoning. In addition, we saw growth in both the physical positioning of teacher candidates (from standing in front of the room to circulating more and interacting with students) and in the ways in which they seemed to view their role as a teacher—from providing information to students in the fall to attempting to have students interact with concepts in the spring.

Eliciting Students' Ideas

When teacher candidates taught their planned lessons, they sometimes stuck close to their plans, while at other times, they veered away. One theme that emerged is that teacher

candidates who planned for lower cognitive demand questions tended to stick close to their plans, while those who had more ambitious plans to gather evidence of students' explanations sometimes struggled to enact them, especially in the fall. However, there were a few, sporadic instances of ambitious questioning in the fall (e.g., asking for clarification of students' ideas, posing questions that allowed students to answer at a deeper level) and more systematic instances in the spring semester.

In order to illuminate these points above, we share two specific examples of teacher candidate movement in eliciting student ideas. First, Kristin provides us with an example of minimal growth in her formative assessment practices over the course of the year (Table 3). In the fall, Kristin's questioning consisted mainly of her asking whether students had heard of something or knew a specific fact and then moving forward with the lesson when students either responded in the affirmative or did not respond at all. This was a very typical type of questioning pattern for teacher candidates in the fall. The types of questions that she asked in the spring also tended to be about declarative knowledge or facts. The difference was that, in the fall, Kristin consistently accepted the students' response of "yeah" as evidence of understanding. However, in the spring, Kristin had several instances when she followed up students' responses of "yeah" with a push to have someone explain the idea. Thus, she moved from gathering students' self-reports of their understanding to actual evidence consisting of explanations of what they did understand so that Kristin could possibly be in the position of determining how to move forward to help students better understand the core ideas.

Students' responses to the questions that she asked, however, lend themselves to be interpreted as right or wrong. It is clear Kristin had a response or explanation that she was looking for when she asked the question. Additionally, her response to students tended to be "yes" or "no" followed by Kristin giving the correct response. In the spring interaction below, she accepted the students' explanation of the difference between motor and sensory neurons as "feeling and movement." However, while this might be a good way of remembering some differences, she did not push the students further to explain what they mean by these terms.

In contrast, most teacher candidates exhibited more growth in their questioning strategies. For example, in the fall, Lara often gave students the answer she was looking for and explained the answer to students (Table 4). However, in the spring, similar to Kristin, she elicited student responses and asked in places for them to expand on their ideas. Unlike Kristin, however, Lara provided opportunities for students to share ideas and allowed time for these conversations to play out.

More evidence of Lara's growth in eliciting and responding to students' ideas was observed when the class began generating questions they still had after their discussion of beak sizes.

Lara: What kind of questions do you have?
Student 1: Umm, like what food they eat?

Table 3 Kristin's interactions with students in the fall and spring

Fall	Spring
Kristin: Have you heard of concentration or solution? Students: Yeah… Kristin: Okay, good, so…	Kristin: We remember what the difference between a motor and a sensor is, right? Students: Yeah Kristin: Can someone explain it to me real quick? Student: Feeling and movement Kristin: Feeling and movement, good. Did everyone hear that? Feeling and movement, that is a very good way to remember it.

Table 4 Lara's interactions with students in fall and spring

Fall	Spring
Lara: Looking at the picture, is water a molecule or atom? Shawn? Shawn: [No response] Lara: Take a guess. Shawn: [mumbling] Lara: A molecule? Yeah, great… water is a molecule because these H's are hydrogen and the O is oxygen, so there are three atoms in one molecule of water. Make sense?	Lara: What kind of environmental factors do you guys think might have caused the beak sizes to get bigger? Student 1: Food sources Student 2: Drought Lara: Ok, I heard food sources and drought. Wait, what do you mean by drought? Student 2: The ground got hard so they couldn't get worms Lara: Ok, what else…

Lara: Ok, what food do birds eat?
Student 1: Like, on the different islands there might be different kinds of food.
Student 2: Are they nocturnal? (Students continue to ask questions)
Student 3: How old they are?
Lara: Ok, maybe older birds are better hunters or younger ones.
Student 4: What happened to the island?
Lara: What do you mean by that?
Student 4: Maybe it went through a drought.
Lara: Ok, we can say—What is different about the island?

In these interactions, Lara revoices students' ideas and asks clarifying questions. There was much more dialog in these interactions, providing space for students to share ideas as opposed to the interactions in the fall. Student ideas were elicited based on the activity and types of question Lara set up. She continued asking questions and inviting students to participate, which encouraged the sharing of many ideas from multiple students. Thus, she was able to hear from several of her students in order to assess their understanding of the concept as well as what questions were left unanswered. Her response to student ideas was often to ask for clarification or further information—putting some of the onus on students to explain their responses and elaborate their ideas.

Not only did we observe a shift in the types of questions being asked to elicit student ideas and the questioning patterns, we also saw a shift in teacher candidates' physical positioning allowing for opportunities to elicit ideas from students in small group and/or individual contexts. In the fall, all of the teacher candidates taught their lesson from a static position in front of the students. They delivered instruction, asked and answered questions, and assessed student understanding from this fixed position. The positioning of the teacher led to an instructional style that aligned with IRE. There was very little dialog between teacher candidates and students, and none of the teacher candidates moved around to elicit individual students' understandings or questions.

In the spring, all except one teacher candidate planned lessons in which parts of it were spent circulating and consulting with smaller groups of students. For example, Lara was observed moving around the room working with groups, asking clarifying questions and making herself available for students to ask questions of their own. This allowed Lara to elicit understandings from a greater number of students and have conversations regarding key concepts in a smaller environment more conducive for multiple students to both share their ideas and ask clarifying questions. This enabled Lara, as well as the other teacher candidates, to elicit ideas and formatively assess small groups and individual students.

The change in physical positioning not only influenced teacher candidates' ability to elicit ideas from individual students; it also provided opportunities to find patterns in student ideas across the classroom. In the spring, several teacher candidates had instances where they began to also focus on the collective instead of just responding to one student by synthesizing ideas across students. This often happened when students were working individually, in groups, or in a lab setting, and the teacher candidate moved around the class, creating opportunities to work with smaller groups or individuals. For example, after circulating through students completing a worksheet, Lissa stated, "I noticed that a lot of you were struggling with number 4, let's think about it together." This is an instance where a teacher candidate recognized an issue students were having and responded in the moment.

Reflections

Teacher candidates' reflections provided an in-depth way of examining their lens on teaching by revealing specifically what each teacher candidate focused on after the lesson. In both the fall and spring, teacher candidates used two main sources of evidence to reflect on the lessons that they taught. First, they chose two video clips on which to receive feedback from their group of critical friends; one clip showcased a piece of their teaching that they thought went well and one showcased a piece of their teaching that they wanted to work on. The second source of evidence was their analysis of students' written work. Then teacher candidates were prompted to provide a "story of what happened" in the lesson(s) and then, using the pieces of evidence listed above, provide "lessons learned" for what went well and what they would change in terms of their plans, their interactions with students, and their written assessment.

The reflections provided information about all three of the patterns that we identified: *eliciting students' ideas*, *conceptualization of students' ideas*, and *focus of classroom practices*. Specifically, while many teacher candidates noticed their questioning patterns and reflected on the need to ask questions that elicited more than declarative facts in both the fall and the spring, they still tended to view students' ideas in a dichotomous framework—right or wrong— without noticing the nuances in how students understood ideas. Those teacher candidates who made shifts in their practice, moved either from mainly a teacher-centric interpretation of their teaching in the fall to having a more balanced reflection that included both their own moves as well as the students in the spring, or they held a more balanced stance the whole year.

Eliciting Students' Ideas

In both the fall and spring, teacher candidates were very cognizant of the questions that they asked and the implications of their questions. Many reflected on the fact that they mainly asked "what" questions and did not ask higher order questions (i.e., "how" and "why" questions). For example, Lissa reflected on her video from her fall lesson, "I asked how many electrons would go around in the ring each time I filled it in, but I did not ask too many WHY questions." Lissa recognised that her questioning did not allow students to explain the phenomenon; instead, she only elicited discrete pieces of information from her students. Similarly, Kristin noted in her fall reflection on her video that,

> Most of my questions in this lesson were "what" responses, and this is not what I intended when I planned my lesson. I got started with a review, and right off the bat students were not responding, and not giving correct statements, and so I noticed that I stepped down the level of expectation when I asked questions. … A specific improve- ment to my lesson plan would be to lay out specific questions for each level of "what",

"how", and "why". This would allow me to stick to specific questions, and see what students would respond to the more in depth thinking questions. Maybe stopping at the "what" didn't allow me to truly understand the students thinking, and maybe if I push them with higher level thinking questions, they would push themselves for higher level responses.

This focus on the ways that they elicited students' ideas (specifically, the types of questions they asked) appeared in many teacher candidates' reflections in the spring as well. For example, Mike reported on the feedback that his peers gave him about his teaching video:

My peers said that I did a good job of pushing the students past the *what* and *how* by asking *why* when they answered questions. They said that this helped even if they could not get the answers because it was getting them to think about it even if the answers were wrong. One problem I was told was it seemed I wasn't giving enough time to answer some of the questions, and most of the questions were being answered by the same students.

So, while teacher candidates struggled to ask high-level questions in the fall, through examining their videos, they were able to recognize this about their own teaching and, as reported above, most teacher candidates' questioning patterns had shifted by the spring. Some teacher candidates were able to move past their own moves to see how they could gather evidence of student understanding. For example, Chris reflected in the spring that sometimes his questions were not the most important opportunities, but rather it was the students' questions:

Allowing the students to ask questions during the lecture is a fantastic way of gauging where the students are with their knowledge (formative assessment). They asked a number of pertinent questions that really got at the heart of what we were discussing in class; Why do babies sometimes not get born? Do both parents have to have a bad gene for it to get passed on? Why are [sic] some mixed people have skin like their mom and dad put together? Will white flowers always have white flower babies?

Even at the beginning of the year, teacher candidates reflected on their interactions with students and the importance of not asking questions that only required one-word responses. In addition, they noticed the importance of "pushing the students past the 'what' and 'how'" type questions to get them to illustrate their thinking. Thus, teacher candidates were keenly aware of the need to ask higher cognitive demand questions in order to create opportunities for students to provide evidence of their thinking throughout the year.

Conceptualization of Students' Ideas

Despite teacher candidates' abilities to reflect on the importance of asking higher cognitive demand questions, when they reflected on students' ideas in both the fall and spring, they often treated students' ideas in a dichotomous form, in other words, students either understood a concept or they didn't. For example, in the fall, Kristin reported that,

The review did not go as well as I had planned, and the students kept giving me incorrect statements about molecules, cells, and the cell membrane. No one was talking except one student (Lori), and so I tended to focus my questions toward her most of the time.

Here she did not provide information about how the students' responses were wrong, but just that they were wrong. Similarly, in the spring, Kristin reflected on students' responses to

the written question, "Explain how a nerve impulse leaves a presynaptic neuron to go on to a postsynaptic neuron. Make sure to describe the role of neurotransmitters, and give an example of a neurotransmitter. Also, remember to include how the neurotransmitters are packaged, what causes their release, as well as how are they released." She wrotes,

> My students understood the process of how the cell membrane depolarizes and repolarizes to cause an action potential, but … student[s] had trouble naming an example of a neurotransmitter. I could tell that students had trouble with this part of the question, because many students did not name a neurotransmitter in their responses.

Here Kristin presented what students "understood" and what students "had trouble" with—dichotomizing students' ideas. She did this for four different examples. Her analysis was simplistic in that she did not provide evidence of what students wrote to let her know that they understood this process of cell membrane polarization. Her evidence of students not understanding neurotransmitters was also quite simple; they did not include it. This interpretation held true for the four examples she provided. There was very little interpretation or writing about nuances in student understanding in her reflections or those of others.

In addition, in the spring, Lara reflected about the use of student ideas and questions that did not align with her intended outcomes. This was evident in a remark she wrote about her students answering questions about finches using the data provided:

> I had a lot of students answer this question with ideas they brought to the classroom instead of using the information I gave them in class to work with. This showed me that they either weren't paying attention or didn't understand the information when I gave it to them.

Lara interpreted her students actions here as either defiant or unable to understand directions. She had not considered that the information they bring with them might be valid evidence or may help her think about how they were considering the questions and what they were drawing on to make sense of the phenomenon. Instead, she wanted them to use specific data to answer the questions posed. The fact that many did not do this resulted in an interpretation of answering the questions incorrectly.

Focus of Classroom Practices

In the fall, teacher candidates tended to focus on their own moves as a teacher without considering the ways in which their moves influenced students. However, we saw growth in most of the teacher candidates in shifting from a mainly teacher-centric version of their story of what happened and their ways of judging whether the lesson went well in the fall, to a more balanced lens on both teacher moves and student understanding in the spring. Those teacher candidates who did not make this shift are also teacher candidates who did not show growth in eliciting students' ideas (i.e., Kristin, Mike, and Lila).

For example, we can see growth in how Elisha reflected on her practice in Table 5. In the fall, Elisha's story of what happened focused mainly on her actions and did not include students' ideas. Similarly, her main focus for reflection on her video was how her habits frustrated her. In contrast, in the spring, Elisha wrote both about her moves as a teacher and some of her students' ideas in her story of what happened. In reflecting on one of the activities that she did, one type of evidence that Elisha used to determine its effectiveness was that she was able to see how students' ideas changed throughout the lesson.

In contrast, Lila did not show as much growth in her reflection (Table 6). In both the fall and the spring, Lila's story of what happened focused almost exclusively on her moves as a

Table 5 Elisha's movement from teacher-centered to more student-centered

Fall	Spring
Story of what happened I explained to the students that we would be observing two different soils and had to describe them using our new vocabulary terms, as well as filling out the provided worksheet. They were excited to perform this lab and listened to this section very well. I demonstrated each kind of observation before they were allowed to try it and as the students needed a tool I gave it to them. *Criteria for success* Any interaction where I was physically holding things that they could see or touch was the most helpful….I did notice that I have a few habits that drive me a little nuts to watch; I always fidget with the dry erase markers in my hands, and I look a little uncomfortable when I am stuck lecturing at the front…	*Story of what happened* I walked around the room for a few minutes watching to make sure they were answering the questions and trying to gather a few ideas of what they were writing. After 5 minutes I asked them for some of their responses. I had a few volunteers; they had written about what makes them sick like colds, viruses, diseases, bad food, and they had written about how they knew when they're sick; upset tummy, headache, runny nose, etc. … Then I asked them if anyone knew what made plants sick or what plant pathology meant. I got responses like, plant paths, paths, pathogens, illnesses, to which I told them they had the right idea and the unit we would be working on was all about plant diseases. *Criteria for success* [Students] each wrote down separate ideas, and I got to see how their initial ideas changed after they heard more information from me, and again after they heard their classmate's ideas. It was more informative than just a discussion out loud because each student had their own work and they were all very involved in the discussion because it was a very engaging activity.

teacher without including any reference to students' ideas. She did note in the spring that she made her problems "more student-led each time." However, she did not bring in any sense of students' ideas or abilities to solve these problems. Similarly, in her evaluation of her lessons in both the fall and spring, she only focused on her own moves as a teacher to determine whether the lesson was successful. For example, in the fall, Lila reflected a belief that student learning was predicated mainly on her ability to communicate in a "confident and clear way" and she felt she could have been more successful if she had written out questions ahead of time. In the spring, she stated that she was successful because she had her notes written ahead of time. In both of her reflections, her focus was on being prepared ahead of time, which is important, but it may indicate a lack of flexibility or ability to pick up on students' ideas that appear in the moments of teaching.

While the general pattern was a move from teacher-centered reflection in the fall to a more balanced (i.e., teacher and student) reflection in the spring, even in the fall, two teacher candidates reflected more on the students. For example, Chris reflected on what he thought was the least successful part of his lesson—and his criteria for judging was on how the students reacted:

> The least successful segment of the lesson plan was undoubtedly the portion in which I attempted to illuminate the differentiation in size of the particles and how that affected the texture. … I say this portion was unsuccessful because the video shows some difficulty the students were having when drawing the particles on the Venn diagram…. Not all of the students had this problem, but there were enough that I consider it to be a prime candidate for revision and improvement on my part.

Table 6 Lila's teacher-centric reflection in fall and spring

Fall	Spring
Story of what happened	*Story of what happened*
I had the students call out the electron configuration for Neon, and then for Sodium, and I wrote the configuration of sodium below the configuration of neon on the white board. I asked the students what was the same between the two and what was different, and then highlighted the fact that part of sodium's configuration was neon's configuration, and explained that sodium can be written as [Ne]3 s^1 and that this is called the abbreviated electron configuration or the kernel structure	I made sure to emphasize that the particles are molecules for covalent compounds and formula units for ionic compounds because [Mentor teacher] emphasized this distinction. I went through an example of each kind of problem, making them each more student-led each time. I then assigned some homework for practice with this skill and they had the remainder of the class to work on it. I collected the molar mass problems they had done during the hour as the students left and graded them (for completion) that night.
Criteria for success	*Criteria for success*
When I was confident and clear, the students understood my explanation and were able to answer all the questions I asked, even the whys. When I wasn't clear and confident, they seemed more confused and weren't able to answer the questions without further prompts. If I had been slightly more prepared for the lesson by having my specific questions written out word-for-word for the whole lesson, and not just the first part, I would have been more successful overall because I would have been more confident and clearer.	Overall, I think my lesson was well planned and that it showed in my teaching and my peers agreed. I had the notes I was going to give outlined and the problems I was going to do with the students worked out ahead of time, so everything went pretty smoothly. … I knew exactly what I was going to do ahead of time.

His balanced approach to seeing how his teaching influenced students continued into the spring and aligned with many other teacher candidates' abilities to reflect on how their teaching practices influenced student learning.

Discussion

In this discussion, we present possible explanations for the patterns of growth or nongrowth in teacher candidates' responsive teaching practices and the implications for teacher preparation. While we had a small sample of teacher candidates who were a part of a specific teacher preparation program, we believe that the triangulation of the data sources and the strength of the patterns that we have allow us to draw conclusions that have implications for a range of teacher candidates. Our sample of teacher candidates was representative of the teacher candidates in our program; however, our purpose is not, necessarily, to generalize our results to other teacher preparation programs. Rather we feel that through presenting rich data from multiple sources, our results may resonate (Connelly and Clandinin 1990) with other teacher educators and allow them to reflect on both their teaching practices and their research into best ways to prepare teacher candidates to become well-started beginners.

Enacting effective formative assessment in science requires teachers to know their students, know the content, and know how to use evidence that students share with them to modify their instruction taking into account students' diverse ideas (Matese 2005; Otero and Nathan 2008). Because teacher candidates are at the beginning of their trajectory into the profession of teaching, we would not expect that they would be experts in this complex practice. In addition, changes in teachers' formative assessment practices are slow (Bennett 2011; Black et al. 2004;

Black and Wiliam 2005; Webb and Jones 2009; Wylie et al. 2009), so even when examining changes over the course of two semesters we might not expect to see substantial growth.

Despite this, examining all three of our data sources (i.e., plans, teaching videos, and written reflections), we were able to find clear patterns for ways in which teacher candidates grew and did not grow. Each data source provided specific types of information about teacher candidates' formative assessment practices and understandings. In the plans, we learned mostly about teacher candidates' *conceptualization of students' ideas*. Though the assignment asked for both "Accurate examples or ideas you can build on" and "Common misconceptions," teacher candidates focused mainly on the misconceptions and ideas that students had learned in school. The course assignments may have inadvertently encouraged this by providing time for teacher candidates to research misconceptions using resources such as "Making Sense of Secondary Science" (Driver et al. 1993), while only discussing how to build on students' out-of-school ideas in class sessions. We found this non-nuanced conceptualization of students' ideas permeated their plans, their ways of interacting with students in the classroom (through the types of questions they elicited), and in their reflections.

In teacher candidates' teaching videos, we saw a large shift in the methods that teacher candidates used to *elicit students' ideas*. Specifically, we saw a movement from more of an IRE questioning strategy in the fall (almost universally for the teacher candidates) to a more reflective toss type pattern in the spring. Providing opportunities for students to demonstrate their understanding (i.e., eliciting students' ideas) is, perhaps, the most crucial (and baseline) step in the formative assessment process, since without knowing what students know, teachers cannot provide feedback or make informed instructional decisions and students do not know how to alter their learning experience. In addition, we saw a shift toward asking questions that allowed a range of responses and were at a higher cognitive demand level. While this shift did not happen for all teacher candidates, the majority of teacher candidates asked questions that had a higher cognitive demand and also allowed for multiple students to respond. Through the use of these more probing questions, some teacher candidates were able to encourage students to reveal more of their thinking and understanding. However, given that teacher candidates did not tend to view students' ideas as complex or nuanced, rather they viewed them as right or wrong, this limited the ways in which teacher candidates could respond to students' ideas.

Finally, the teacher candidates' written reflections on their teaching illustrated our three main patterns all together. These reflections allowed teacher candidates to point out what they noticed in their teaching videos and the student work, which allowed us a lens into their interpretative framework for their teaching. Similar to the plans, we saw a shift from a solely teacher-focused lens on their practice to one that allowed them to view how their practices impacted student learning. Teacher candidates noticed, in both the fall and the spring, the important role played by the questions that they asked. They were very cognizant of not asking high-quality questions in the fall. While the teaching videos illustrated a shift in their elicitation techniques in the spring, teacher candidates were still very aware of the types of questions that they asked. However, what the reflection allowed us to see was that the plans and teaching videos only gave us a glimpse into the nature of the teacher candidates' focus in their classroom practices. Through our analysis, we observed that teacher candidates who seemed to make growth in formative assessment practices also held a view of their teaching as (more) student centered. Based on our findings, we propose implications for teacher preparation.

Implications for Teacher Preparation

Our findings have implications for how we engage teacher candidates in formative assessment practices in their teacher preparation program. Because teacher candidates are new to the

profession of teaching and have limited experiences in the classroom (in the role of a teacher), they may not be able to fully engage in all of the components of formative assessment as laid out by Black and Wiliam (2009). However, there are likely ways of structuring teacher preparation to allow teacher candidates to have experiences that will move them from being novices to becoming well-started beginners in this important high-leverage practice. In this section, we discuss two implications for teacher preparation: (1) providing tools for teacher candidates to conceptualize students' ideas and (2) the importance reflection.

Tools for Conceptualizing Students' Ideas

One area in which we did not see much growth was teacher candidates' conceptions of students' ideas. This may be a result of the course assignments (as we discussed above), but this stance had widespread implications for the teacher candidates' plans, teaching, and reflections as they used the construct of misconceptions to frame their thinking about students. The idea of misconceptions was one that seemed to limit the teacher candidates' abilities to consider students' ideas in a nuanced way. Rather than viewing the ideas that students had as potentially productive building blocks, teacher candidates categorized students' ideas as right or wrong/misconceptions. Teacher candidates' consideration of students' ideas as correct or as misconceptions (rather than considering also what they do understand and the nature of the thinking) influenced (1) the ways in which they asked questions, (2) their purpose for asking questions, (3) their in-the-moment responses to students, and (4) the ways in which they interpreted students' ideas. Rather than asking questions to elicit a broad range of students' ideas with which to guide instruction, teacher candidates seemed to ask questions to make sure that students had the "right idea." In addition, even when teacher candidates were able to elicit a range of student responses, they still tended to evaluate students' responses as "right" or "a misconception" both in the moment of teaching and in their written responses. While getting students to the scientifically correct explanation for phenomena is the goal of teaching, we know that we must use students' ideas in order to build to more sophisticated understandings (National Research Council 2005). Thus, rather than only seeing if students had the correct idea, we would rather have teacher candidates asking questions that elicit a range of ideas and probing for more evidence of the nature of student thinking.

Below, we present two seemingly disparate tools for helping teacher candidates consider students' ideas in a more nuanced manner: learning progressions and funds of knowledge. While these tools are based on different theoretical assumptions regarding the nature of student ideas and may not always align, we outline how they may prove powerful tools for teacher educators to use with teacher candidates in order to push their thinking about students' ideas away from solely "right" or "wrong" toward a more holistic view of students' ideas as productive building blocks.

Learning Progressions In discussing the role of learning progressions as a tool for formative assessment, Alonzo (2011) states that,

> …I have become increasingly convinced that misconceptions are only part of the picture. As Black et al. describe, an essential feature of "formative learning," or classroom practices informed by formative assessment, is "start[ing] from a learner's existing understanding" (p. 76). To take this notion seriously, we must consider not only what students do not understand (their misconceptions) but also what they do understand and, more importantly, the nature of that thinking. (p. 127)

One potential tool for helping teacher candidates consider students' ideas in a more nuanced way may be the integration of learning progressions as tools in teacher preparation: "Since one of the uses of learning progressions is to represent the ways student ideas develop in a conceptual domain, they may be ideally suited to support teachers in conducting formative assessment" (Furtak 2012, p. 1183). Specifically, by providing a model that portrays students' ideas as ranging from less to more sophisticated (National Research Council 2007) rather than as right/wrong, learning progressions can illustrate the range of student ideas and potential ways of moving students forward. However, research in the learning progression field is young (Gotwals and Alonzo 2012), and early attempts at using learning progressions for formative assessment purposes have been met with challenges (Furtak et al. 2012). Specifically, Furtak (2012) found that even when teachers were provided with professional development around a learning progression that teased out the nuances in students' thinking, teachers still tended to classify student responses in a dichotomous format. In addition, Furtak (2012) found that "several of the teachers seemed to use the learning progressions simply as catalogs of misconceptions to be 'squashed' rather than drawing upon the developmental affordances offered by a learning progression" (p. 1181). However, despite these early challenges, if we are able to design learning progressions at an appropriate grain size and embed these learning progressions in support systems, such as teacher preparation courses, learning progressions may be tools that support teacher candidates in noticing the nuances in students' ideas. Thus, similar to Alonzo (2011) and Furtak (2012), we believe that learning progressions have the potential to influence formative assessment practices and that, with more research, could be a powerful tool for pushing teacher candidates to better understand ways of using students' ideas in a productive way.

Funds of Knowledge Our findings indicate teacher candidates' capacity to see student' ideas as productive and valuable requires more than an understanding of the development of an individual's cognitive domain. An additional focus on *students' funds of knowledge*, or the diverse cultural ways of knowing and being students' leverage when making sense of a phenomenon, also needs to be elicited and considered (Calabrese Barton and Tan 2009; Moje et al. 2004). Calabrese Barton and Tan (2009) found that students' funds of knowledge were valuable resources when encountering school science concepts and they point to the important role the teacher played in eliciting and opening space for students to leverage their funds. These authors argue, "(S)tudents … were ready to use their funds openly in school science because the teacher was actively inviting such funds into the discussions, reading and writing activities as well as the science tasks" (p. 68).

In our study, when students leveraged experiences or ways of knowing from outside the classroom, these ideas were viewed as a deficit that distracted them from engagement with the intended curriculum. This was evidenced through Lara's statement regarding students answering questions on an assignment "with ideas brought to the classroom," indicating to her a failure on these students' part to follow directions or understand science concepts. It reveals a narrow vision of what counts as science and whose ideas are seen as productive, thus restricting what is elicited and drawn on through formative assessment practices.

If we desire for teacher candidates to conceptualize students' ideas as productive and valuable, eliciting and responding to students' ideas should extend beyond classroom experiences to the funds of knowledge their students leverage when making sense of science investigations. Thus, providing opportunities for teacher candidates to elicit and reflect on sources of student funds of knowledge through assignments in methods courses may provide insights for teacher candidates regarding the knowledge their students draw on in order to

make sense of observed phenomena. Small group conversations, participation in community events, and focused classroom observations could assist teacher candidates to identify students' sources of funds of knowledge such as family, community, peers, personal talents and interests, and popular culture (Moje 2005). Reflective discussion of these experiences may support teacher candidates' ability to see students' ideas not originating in the classroom as productive and valuable as well as imagine spaces for student funds of knowledge to be leveraged in science classrooms.

The Importance of Reflection

Through our analysis, we observed that teacher candidates who seemed to make growth in formative assessment practices (specifically, those who moved to higher cognitive demand questions and away from a solely IRE questioning pattern) also held a view of their teaching as (more) student centered, or moved to a more student-centered view over the course of the year. This finding relates to other studies that have shown that the implementation of classroom assessment is strongly linked to teachers' beliefs, attitudes, and conceptions about teaching, learning, curriculum (Black and Wiliam 2005; Sato 2003; Shepard 2000; Webb and Jones 2009), and assessment (Brookhart 2007; Matese 2005). In addition, one of the most prominent patterns in what teacher candidates reflected on in both the fall and spring was that they noticed their questioning patterns were not allowing for students to provide deep levels of understanding. Related to this, the largest shift in teacher candidates' practice was in their questioning patterns—perhaps indicating that their reflection on their videos and the students' work influenced their teaching practice. Overall, teacher candidates' reflections allowed us insights into how they interpreted their teaching experiences, which allowed us to make claims for how and why teacher candidates changed or did not change in their formative assessment practices. Thus, as others have argued (e.g., Davis et al. 2006), we view the process of reflecting—both on teaching videos and on students' written work—as crucial for teacher candidates' development and as a potentially formative indicator for teacher educators as they work with teacher candidates in their professional development.

Beginning teachers may not be able to reflect on their teaching moves in the moment because they are new to so many of the tasks of teaching (Anderson et al. 2000). However, research has shown that guiding teacher candidates in observing videos of their own and others' teaching promotes productive reflection and noticing of salient features of the classroom (Santagata et al. 2007; Star and Strickland 2008; Wang and Hartley 2003), and through guided analysis of video, teacher candidates can learn to focus their attention on student thinking (Franke et al. 2001; van Es and Sherin 2006).

As we noted above, one of the most pronounced difference between teacher candidates was between those who were able to reflect only about their own moves as a teacher versus those who were able to have a more nuanced perspective that included seeing things from the students' side. The finding that teacher candidates tend to primarily place importance on themselves and their own teacher moves as opposed to their students as learners is not new (e.g., see Fuller 1969; Fuller and Bown 1975). However, this finding has particular implications for teacher candidates' formative assessment practices, which necessitate seeing learning from students' perspectives. Through guided reflection, teacher educators can tease out the ways in which teacher candidates are thinking about students' ideas and their lens on the moves happening in the classroom. If teacher educators can use these reflections as a means to understand what lens teacher candidates are using in viewing their classroom, they can provide formative feedback and new prompts with which to view the video in order to scaffold teacher candidates toward more productive reflection (that moves away from solely descriptive and

teacher-centered accounts to more evaluative and evidence-based claims about their teaching; see Davis et al. 2006).

There has been some discussion about whether reflecting on others' videos or teacher candidates' own teaching videos makes a difference (e.g., Seidel et al. 2011). Similar to Seidel et al. (2011), we found that having teacher candidates reflect on their own teaching videos was a highly engaging and motivating activity. Teacher candidates were placed in "critical friends" groups that lasted over the course of two semesters, and while teacher candidates were initially hesitant to share their practice with their peers, they quickly grew accustomed to and excited about providing feedback to each other on their practice. These sessions were highly scaffolded, with support for choosing the clips to share and protocols for the sharing sessions—indicating how to talk about what they noticed and provide feedback for moving their practice forward. Thus, these scaffolded sessions and embedding the process of reflecting in a larger community of practice allowed teacher candidates to engage with their practice and their peers' practice in order to think about ways for improving their practice.

In conclusion, structuring the teacher preparation course assignments around the teaching cycle, planning, teaching/assessing, and reflecting/revising allowed us great insights into the areas in which teacher candidates made progress in their formative assessment practices and areas where they still struggled. Similar to others (e.g., Buck et al. 2010; Graham 2005), we feel strongly that basing these assignments close to practice and embedded in their field placements enabled teacher candidates to improve their views about classroom assessment and implement formative assessment. In addition, we feel that our findings can influence the ways that teacher educators work with teacher candidates in order to push their thinking about the nuances in students' ideas and to encourage them to develop a more balanced lens for reflecting on their practice. Overall, planning for, teaching, and reflecting on formative assessment practices is a critical component of helping teacher candidates become well-started beginners. We plan to continue to work on providing tools and scaffolds for preparing teacher candidates to work with their students' ideas in productive ways.

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