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Complementary assessments of prospective teachers' skill with eliciting student thinking

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Abstract As teacher education shifts to focus on teaching beginners to do the work of teaching, assessments need to shift to focus on assessing practice. We focus on one teaching practice, eliciting student thinking, in the context of elementary mathematics. We describe assessments in two contexts (field and simulation). For each assessment, we describe the eliciting of three prospective teachers what could be seen about the skills of group of prospective teachers ($N = 44$). We report on how three prospective teachers had differing opportunities to demonstrate their skills in the context of the field assessment, but similar opportunities in the context of the simulation assessment. Although both contexts make important contributions, in each case, contributions are counterbalanced are by significant challenges. Although the authors do not argue for one assessment context over the other, they offer insights into the affordances and challenges of each so that teacher educators can make responsible decisions.

Keywords Practice-based teacher education · Eliciting student thinking · Elementary mathematics · Assessment of novices' skills

Introduction

In recent years, there has been shift in the content of many teacher education programs to focus on the teaching of specific "high-leverage practices" (e.g., Ball and Forzani 2009; Ball et al. 2009; Davis and Boerst 2014; McDonald et al. 2013). At the same time, there has been increased attention to the teaching of teaching, including teacher education pedagogies (Grossman et al. 2009), which include "approximations of practice" such as coached rehearsals (Lampert and Graziani 2009; Kazemi et al. 2015). The field has also

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made progress with respect to articulating the core practices to be taught, as well as in developing new types of practice-based learning experiences and settings. Needed are complementary shifts in assessment practices that provide information to enhance the use of these pedagogies, information about the nature and growth of prospective teachers' skills with core practices, and a foundation for larger programmatic shifts.

In this paper, we examine what novices are able to demonstrate about their teaching skills through assessments enacted in two different contexts: the field and a simulation. We focus on the teaching practice of eliciting student thinking in the context of elementary mathematics. First, we identify the eliciting skills that prospective teachers (PSTs) are able to demonstrate in an assessment happening in field placements. In this assessment, PSTs interact with students in elementary schools and video record their practice. Then, we identify the skills that the same PSTs are able to demonstrate in an assessment happening in a simulation. In this assessment, PSTs interact with an adult guided by a student's way of thinking and acting in a context that provokes professional work.

In this paper, we argue that each of the two assessment contexts has the potential to provide valuable information. Teacher educators who understand the constraints and affordances of both contexts will gain greater insight into the practices of PSTs and also be able to make responsible decisions about the composition of assessments needed. We put forward this argument knowing that assessments happening in the field may appear to be more valid because it stands to reason that an assessment would more dependably impose real teaching demands when it involves actual children and occurs closer to where teaching most often happens. Correspondingly, an assessment happening in a simulation may provoke skepticism for a number of reasons, including distance from classroom practice and the potential artificiality of the situation. Even though a simulation is an approximation of practice, we argue that it can both be designed to place authentic demands on participants and consistently provide information that would otherwise be left to chance in field settings.

Although many teaching practices could be examined to explore these forms of assessment, we believe that eliciting student thinking is a particularly important focus because of the interactive nature of the practice. Attempting to assess this practice can raise some interesting questions about what is possible to assess and what one can see about teaching skill in a simulated and/or actual school environments.

Assessment approaches in teacher education

Teacher educators use a variety of approaches to assess novices' developing skill with teaching practices. Assessments such as portfolios, analyses of videos and cases, and action research projects often focus heavily on PSTs' skills in analyzing and writing *about* teaching. The unit or lesson plans that PSTs are often asked to create function as assessments that offer information about how PSTs think about or prepare for teaching, but not evidence of the skills needed for enactment. Along with others (e.g., Darling-Hammond and Snyder 2000), we argue that the assessments used in teacher education need to also focus on enactment itself. In other words, the assessments used in teacher education should match the new practice-focused learning goals. Not only does such a match make logical sense, research suggests that specific feedback around practice increases novices' ability to use feedback to improve their practice (Grossman 2010).

Teacher preparation has, of course, often included assessment of the enactment of teaching practices. Approaches have focused on appraising PSTs in microteaching, field-based performance tasks, and systematic field observation of lessons (e.g., Hammerness et al. 2005; NCATE 2003). But, when assessments are enacted in classroom settings, the same contextual variables that make them authentic also make them unreliable. For example, the enactment of a mathematics discussion in a classroom is shaped by factors such as the difficulty and "discussability" of the task, the established classroom routines, and students' experience with discussions (Boerst et al. 2011). The influence of such factors on practice is a part of the reality of classroom teaching and, in some ways, could be considered necessary, or at the very least inevitable, when assessing teaching practice. However, when evaluating the quality of PSTs' enactment of practice, accounting for variability related to the classroom context is both vital to do and complex to carry out (Moss 2010).

With these assessment challenges in mind, we consider an alternative approach used in many other professional fields: a simulation assessment. When designed well, simulations represent a context of practice with enough fidelity to evoke authentic professional work. In many medical and dental schools, trainees engage in simulations of physical examinations, patient counseling, and medical/dental history taking by interacting with "standardized patients." Standardized patients are adults who are trained to act as patients who have specified characteristics (e.g., traits, ailments, preferences, interactional styles, knowledge). Evaluation of trainees' interactions with standardized patients enables common appraisal of candidates' knowledge and skills in ways that control many sources of variability that can complicate assessment occurring in actual settings of practice. In medicine, simulations have been used for formative assessment for over 40 years and are currently used in high-stakes medical licensure examinations (Boulet et al. 2009).

Simulations have not been widely used in education. There is currently a small, but growing, interest in using them as activities to support PSTs' learning of skills such as managing a classroom (Dieker et al. 2014*)* and conducting a parent conference (Dotger and Sapon-Shevin 2009; Walker and Dotger 2011). They are also being used to support the development of school leaders (Dotger 2014; Dotger and Alger 2012). Dotger (2014) argues that there are multiple reasons to use of simulations in education, including that simulations (1) function as a means to offer shared and discrete "approximations of practice" (Grossman et al. 2009), (2) allow practice without consequences to children/families/colleagues, and (3) enable increased control of the experience by the teacher educator. Since 2011, we have been developing and studying the use of simulations focused on eliciting student thinking for assessment purposes. This work has included using simulation assessments to learn about the skills and capabilities that novices bring to teacher education with respect to eliciting student thinking (Shaughnessy and Boerst 2018a). We next turn to a specific teaching practice, eliciting student thinking, which will be the focus of the analysis in this paper.

Eliciting student thinking

Because effective teaching involves engaging students' preconceptions and building on their existing knowledge, instructional practices that make these ideas available to the teacher are essential to the success of the enterprise (Kilpatrick et al. 2001; Fuson et al. 2005). In teaching, teachers elicit student thinking, that is, "teachers pose questions or tasks that provoke or allow students to share their thinking about specific academic content" and the responses can be used by teachers to "evaluate student understanding, guide instructional decisions, and surface ideas that will benefit other students" (TeachingWorks 2011). Eliciting underpins work, such as formative assessment, that has been shown to substantially impact student learning (Wiliam 2010; Black and Wiliam 1998). More specifically, mathematics teachers seek to elicit and interpret information relevant to students' mathematical proficiency, the definition of which we connect to the "strands of mathematical proficiency," particularly procedural fluency and conceptual understanding (Kilpatrick et al. 2001). Within these strands of mathematical proficiency, our assessments focus on carrying out a process (procedural fluency) and comprehension of mathematical ideas including why procedure work (conceptual understanding).

There has been a long history of work to understand student thinking about particular mathematics topics and how such understanding changes over time. Such work has often made use of clinical interviews based on the work of Piaget, and there have been efforts to support teachers in learning to engage in clinical interviews with children (e.g., Ginsburg 1997; Ginsburg et al. 1998). This work has contributed to the field's understanding of the critical nature of the practice. But, we argue that teaching the practice to PSTs—and assessing their growing capabilities with the practice—requires decomposition (Grossman et al. 2009) of the practice into specific areas of work which are entailed in carrying out the practice. Such a decomposition, based both on a practical analysis of the work of teaching and on prior research in this arena, can guide the development of assessments.

Our decomposition includes initiating the interaction in a way that invites the student to share initial thinking; eliciting the specific steps of the student's process; probing key aspects of the focal mathematics such as process/strategies and understandings; attending to the student's ideas in follow-up questions, establishing a supportive environment for sharing thinking; and using tone and manner that reflect a focus on eliciting student thinking (i.e., maintaining a focus on eliciting student thinking). Within each of these components, it is possible to further specify the practice by naming more specific moves by which the work is accomplished (Boerst et al. 2011). This work is iterative. It involves teachers' listening to and interpreting what students are saying, generating and posing questions to learn more about the student thinking, listening to and interpreting what students are saying, and so forth. Importantly, children are at the center of this work. It is their thinking which is sought and intended to be understood, and the work is situated in mathematical contexts that focus dialog, shape interpretation, and influence follow-up questions.

Teaching is professional work that requires skillful and strategic engagement in many practices—often simultaneously. Unsurprisingly, eliciting student thinking is not an isolated practice when done in the context of classroom teaching. In many instances, the practices of eliciting student thinking, interpreting student thinking, and responding to student thinking are connected, integrated, and contingent. As teachers elicit ideas from children, they make sense of, or interpret, those ideas both to ask additional questions to learn more about student thinking and to respond in ways to support student learning. This work is complex. For instance, Jacobs et al. (2010) conceptualize the professional noticing of children's mathematical thinking as having three main components: (1) attending to student's strategies, (2) interpreting children's understandings, and (3) deciding how to respond on the basis of children's understandings. As responding unfolds, teachers continue to engage in eliciting to learn about the ways in which children are making sense of and taking up the instruction. However, the contingent nature of these practices creates assessment challenges (Shaughnessy and Boerst 2018b). Thus, there are practical reasons for focusing on eliciting, while keeping in mind the ways in which the practice is combined with other practices in classroom teaching.

The present study

This paper describes assessments happening in two contexts—field and simulation—that were used for assessing skill with eliciting student thinking in elementary mathematics. The study focuses on the question: What can be learned about PSTs' skill in eliciting student thinking through field and simulation assessments? Specifically, it considers PSTs' demonstrated skill in each of the assessment contexts as well as the affordances and challenges of each context in appraising novices' teaching skills.

Methods

The two assessments were administered as part of regular work in an undergraduate university-based teacher education program in the USA. In the teacher education program that was studied, PSTs had repeated opportunities to demonstrate their developing skills with teaching practice; thus, this program offered a rich site to examine the two types of assessments. The assessment happening in the field (hereafter referred to as the "field assessment") was a final course assignment. The assessment within the simulation (hereafter referred to as the "simulation assessment") was administered as a part of the program's assessment activities and occurred at roughly the same time point as the field assessment.[1] Both assessments were video recorded and written artifacts collected.

All of PSTs ($N = 48$) enrolled in the program in one year completed the assessments, but due to camera malfunctions we analyzed data from 44 of those PSTs. All but six were women and 14% identified as people of color. All were between the ages of 19–23. The PSTs were predominately middle class, with a few first-generation college students. During the semester in which the data were collected, the PSTs were enrolled in coursework focused on eliciting student thinking and engaged in field-based experiences in grade 3–5 classrooms.

The performances of the PSTs were analyzed using observational checklists that will be described in the context of each assessment. To appraise the performances, we developed observational checklists which specified core components of the practice. Some of these components are quite obvious, but others we have developed over time by tracking on the range of things that PSTs do when eliciting student thinking. The five core components that we assessed included: (1) launching the interaction with a question that is neutral, open, and focused on student thinking, (2) eliciting the student's process, (3) probing the student's understanding of key mathematical ideas, (4) attending to the student's ideas, and (5) maintaining a focus on eliciting student thinking. For each of these components, we identified specific "moves" that would be possible to track within a performance. By "moves," we refer to specific steps of talk that teachers take as they interact with students (Chapin et al. 2013). Each performance was appraised by two members of the research team, who are experienced mathematics teacher educators. Disagreements were resolved through review of the data and remediating differences of interpretation.

[1] Learning to elicit and interpret student thinking was an identified goal of the course. The course explicitly taught PSTs to engage in the practice with children and PSTs received feedback on their practice from course instructors prior to the two assessments at the end of the course. In all cases, PSTs engaged in the field-based assessment prior to the simulation assessment but did not receive any feedback on the field-based interview until after the simulation assessment was completed.

For this paper, in order to provide an analysis of PSTs' demonstrated skill in each of the assessment contexts and the affordances and challenges of each context in appraising novices' teaching skills, we identified three PSTs. We chose these PSTs based on differences that the PSTs encountered in the field assessment in terms of what PSTs had to do as a result of what children did. This allowed us to make visible the differences in opportunities to appraise PSTs' skills based on what they were able to do.

The field assessment

Field assessments for eliciting student thinking often make use of an interview setting in which PSTs work with individual students to elicit their thinking about specific content. In this study, as an assignment in a mathematics methods course, PSTs interview individual students in their upper elementary school field placement classrooms, which is video recorded. To prepare, PSTs examine a set of fractions problems (e.g., "Circle the larger fraction: 1/4 or 1/6") and develop a set of questions that they might use to ask students about their work on the problem. PSTs are told that they should have students work independently on the set of problems and that, following the students' independent work, they should interview individual students about their responses for 15 min. The stated goal is to learn about the processes the students used to arrive at their answers and the students' understandings of key fractions ideas that underlie the work done on the tasks.[2] PSTs are told that they will be evaluated on their skill with key aspects of the decomposition of eliciting student thinking.

Course instructors examine a portion of each PST's video record, focusing on the degree to which the PST elicited and probed the child's thinking to learn about the student's process and understanding. As stated earlier, the performance is appraised by using an observational checklist with criteria for proficient performance that are connected to aspects of the decomposition. Because we do not know the nature of the child's thinking in each interaction beyond what is recorded on the video recordings, deciding what constitutes eliciting the student's complete process and probing the student's understanding of the process is challenging. We define eliciting the student's complete process to be instances in which the PST asks one question (or a series of questions) and the student provides a set of steps which coders judge to be a full set of steps for the student's original process. We define probing the student's understanding of the process to be that the student explains why a particular fraction is the greater fraction. Table 1 contains the criteria and includes exemplars.

What does a field assessment allow us to see about PSTs' eliciting?

To consider what the field assessment allows us to see about individuals' skills with eliciting student thinking, we consider the work of three PSTs as they elicited student's thinking around the comparison task: "Circle the larger fraction: 1/4 or 1/6." Ms. Bernstein elicited the thinking of a student who used a common numerator approach to solve the problem and she had to ask a series of questions to learn about the student's strategy. Ms.

[2] To learn more about common patterns of student thinking related to comparing fractions, see McNamara and Shaughnessy (2015).

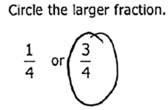
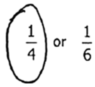
Table 1 Field assessment: observational checklist

Component	Exemplar
Launches the interaction with a question that is neutral, open, and focused on student thinking	*T:* Can you walk me through what you did to solve this problem?
Elicits the specific steps of the student's process	*Student provides a full set of steps for what is judged to be their original process*
Probes the student's understanding of the steps	*Student explains WHY one fraction is larger*
Attends to the student's ideas	
Asks specific questions about what the student did	*T:* I see that you drew a picture. Can you tell me how you used the picture to compare the fractions?
Attends to and takes up specific ideas that the student talks about	*S:* Then I figured out that the bigger number on the bottom means that it's less, it's like less of whatever. *T:* So what do you mean "it's less"? Could you explain that a little bit more?
Maintains a focus on eliciting student thinking	
Refrains from directing the student to a different process[a]	[Without having learned about how the student determined that 1/4 > 1/6] *T:* Can you use common denominators to solve this problem?
Refrains from making evaluative comments	*T:* Can you draw a picture to show 1/4? [student draws a picture] *T:* Your picture is correct. Can you draw a picture of 1/6 and use the two picture to compare the fractions?
Prompts the student fluently	Refrains from long pauses in posing questions OR restarting the posing of a question more than once

[a]We chose to frame this move and the one that follows as "refraining" from a particular move in order to have consistency in how the moves are later interpreted (i.e., the presence of a move is considered positive). The examples that are provided for these two moves are both the negative example (i.e., the PST does not refrain)

Marzilli elicited the thinking of a student who used an invented approach to compare the two fractions, an approach that was not generalizable. She had to ask a series of questions to elicit the process. Ms. Smith elicited the thinking of a student who used a common numerator strategy and shared information about her process and understanding (in terms of why the process used works) in response to an initial question.

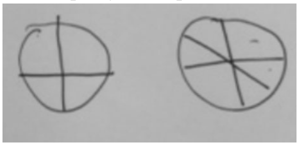
Ms. Bernstein's performance. Ms. Bernstein began by asking how or why the student knew that one-fourth is bigger than one-sixth.

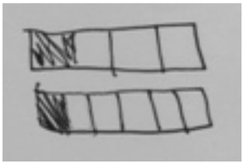
Ms. Bernstein	All right. So, let's move on to the second one. So, one-fourth or one-sixth. How did you  know, or why did you say, that one-fourth was bigger than one-sixth? 
Student	Well, I knew that one- We- In second grade, a lot of- I had [teacher name] and she, a lot of times, would say, "[student name], would you rather have one one-hundredth of a pie or one half of a pie or one-third of the pie?" And I would- At the start, I would usually say one one-hundredth, but then I figured out that the bigger number on the bottom means that it's less, it's like less of whatever

The student offered a response which referred to dividing a pie into different numbers of parts. Ms. Bernstein followed up with a question that appeared to target what the student meant by "the bigger number on the bottom means that it is less."

Ms. Bernstein	So, what do you mean "it's less?" Could you explain that a little bit more?
Student	Like if you have a pie and you split it into fourths and you take one-fourth, it's going to have more than if you split it into one-sixth and take one-sixth

The student used splitting a pie into parts to explain. Then, Ms. Bernstein asked the student whether she could draw a picture.

Ms. Bernstein	Okay. Do you think maybe you could draw that? Uh-huh
Student	(Draws a circle divided into fourths). If it's four, then- (Draws another circle divided into six unequally sized pieces). Wait. They're not equal. Okay. Well- 
Ms. Bernstein	What did you say?
Student	This was not- These ones aren't equal…
Ms. Bernstein	Okay. So, can you still do it if they're not equal?
Student	Nuh-uh
Ms. Bernstein	You could redraw a picture if you-
Student	Yeah, I'll just redraw it. I'll do it like this
Ms. Bernstein	Okay

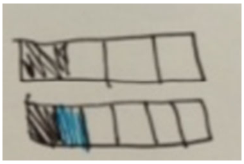
Student	(Draws a rectangle divided into fourths)
	One-fourth, then it's- Make this one 
	(Draws another rectangle divided into sixths). There. If you took one-fourth, it's more than if you took just one of those. (Shades one-fourth in the first rectangle and then shades one-sixth in the second rectangle.) It's smaller

The student represented the fractions using circular models, but did not draw equal parts. On her own, she volunteered that the parts were not equal. After Ms. Bernstein indicated that she could redraw the pictures, the student represented the fractions using rectangular models with approximately equal parts and articulated that one-fourth was more. Ms. Bernstein then asked additional questions about the representations.

Ms. Bernstein	Okay. And can you explain a little bit how you drew that diagram? How come you didn't use this diagram, and then just draw a different diagram for one-sixth?
Student	Well-
Ms. Bernstein	Why did you choose to make them both
Student	The-
Ms. Bernstein	the same shape?
Student	'Cause if I made it like that and that one, and then I made it like that, then the- it would look like this one's smaller because this is smaller than the circle. And so it's- And those ones are easier for me
Ms. Bernstein	Okay. Those ones are easier for you?
Student	Uh-huh

Then, Ms. Bernstein posed a follow-up problem to the student, comparing one-fourth and two-sixths:

Ms. Bernstein	Okay. Great. And what if the fraction was two-sixths? So if it said one-fourth or two-sixths, would your answer change?
Student	Yeah, they'd be equal
Ms. Bernstein	They'd be equal? So, do you think you could explain that a little more?
Student	Yeah
Ms. Bernstein	Or show that?
Student	This. Yeah
Ms. Bernstein	You like the blues and purples

Student	(Shades two-sixths on the second rectangle). Then if it's two-sixths, then these two would be exactly the same, or are exactly the same. Sort of. 
Ms. Bernstein	What do you mean "sort of?"
Student	Well, I know that this isn't like all the same, but it- this one looks bigger than that one. (Points to the two-sixths shaded that appears to be larger than the one-fourth shaded.) This is that
Ms. Bernstein	Huh. Do you want to try maybe investigating that a little bit? Or do you think they'd be the same?
Student	I think they would be the same
Ms. Bernstein	Is there another way you could show that they would be the same?
Student	I don't think so

Using the area models, the student said that one-fourth and two-sixths were "sort of" the same, but when prompted, the student did not have another way to show that the two fractions were the same.

In this interaction, Ms. Bernstein demonstrated skills with multiple components of the teaching practice. She launched the interaction with a question that was neutral, open, and focused on student thinking. She elicited the steps that the student used to compare the fractions and her understanding of the steps (e.g., why the bigger numbers on the bottom means that it is less). She asked specific questions about what the student did (e.g., "And can you explain a little bit how you drew that diagram?") and attended to and took up specific ideas that the student talked about (e.g., "So, what do you mean "it's less?"). There is also evidence that Ms. Bernstein maintained a focus on eliciting the student's thinking by refraining from directing the student to a different process, refraining from making evaluative comments, and prompting the student fluently. These findings are summarized in Table 2.

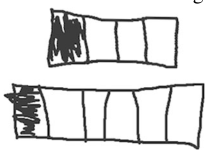
Ms. Marzilli's performance. The student had circled 1/4 as the "larger" fraction, but had not drawn a picture or justified the selection. Ms. Marzilli began by asking about the student's conclusion.

Ms. Marzilli	Can you explain why you thought that one-fourth was bigger than one-sixth?
Student	Because it's closer to four than it is six
Ms. Marzilli	What's closer to four?
Student	The one is closer to four than the one is to the six

The student introduced the idea that "one is closer to four" than the "one is to the six." Ms. Marzilli directed the student to draw a picture of one-fourth, a picture of one-sixth, and then to use the pictures to compare the fractions.

Table 2 Field assessment: summary of three PSTs' demonstrated skills

Scoring criteria	Ms. Bernstein	Ms. Marzilli	Ms. Smith
Launches the interaction with a question that is neutral, open, and focused on student thinking	Yes	Yes	Yes
Elicits the specific steps of the student's process	Yes	Yes	NA
Probes the student's understanding of the steps	Yes	Yes	NA
Attends to the student's ideas			
Asks specific questions about what the student did	Yes	No	NA
Attends to and takes up specific ideas that the student talks about	Yes	Yes	NA
Maintains a focus on eliciting student thinking			
Refrains from directing the student to a different process	Yes	No	Yes
Refrains from making evaluative comments	Yes	Yes	Yes
Prompts the student fluently	Yes	Yes	Yes

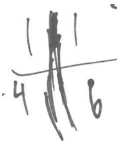
Ms. Marzilli	All right, can you draw me a representation of one-fourth? Like a rectangle or something like that?
Student	(Student draws a rectangle divided into four parts and shades in one part) 
Ms. Marzilli	Okay. And now, can you draw me a representation of one-sixth?
Student	(Student draws a rectangle divided into six parts and shades in one part.) 
Ms. Marzilli	Okay, so which is bigger?
Student	One-sixth is bigger. But, one-fourth is bigger
Ms. Marzilli	Because why?
Student	Because it's closer to four than six
Ms. Marzilli	So, can you explain that a little bit more? What's closer to four?
Student	One-
Ms. Marzilli	Are you seeing the one in the numerator?
Student	Yeah
Ms. Marzilli	Okay. And so- And this numerator is further away from six
Student	Uh-huh
Ms. Marzilli	So what does that mean if it's further away?
Student	That it- That it's probably not going to be four out of fraction, then, one-fourth
Ms. Marzilli	Because why? If it's really far away what does that mean in terms of how much of a whole it is?
Student	That it will be- That I have to- I have to shade more squares to get a whole

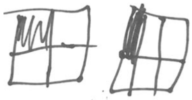
By the end of this interaction, the student had revealed that she was comparing the fractions by examining the number of additional parts that would be needed to make one whole for each fraction (i.e., 1/6 requires five additional 1/6-sized parts to get to one whole). The fraction that needed the least number of equal parts to make one whole is named the greater fraction. This strategy is common among elementary-grades children who are beginning to learn about comparing fractions but it is not a mathematically valid approach because it does not consider the size of the parts being compared.

In this situation, we see evidence of Ms. Marzilli's skills for multiple components of the practice. She launched the interaction with a question that was neutral, open, and focused on student thinking. She elicited the steps that the student used to compare the fractions (e.g., the student compared the number of squares she would need to shade to get to one whole) and her understanding of the steps. Further, Ms. Marzilli attended to and took up specific ideas that the student talked about (e.g., "What's closer to four?"). At the same time, there were instances in which she appeared to be adding words to describe the student's strategy which did not match the language that the student was using (e.g., "Okay. And so- And this numerator is further away from six" when the student was using "closer to" language). We also saw evidence of refraining from making evaluative comments and prompting the student fluently.

But, she did not ask specific questions about what the student had written. For example, she could have asked a question about the representation that the student drew for one-sixth. With respect to the category of maintaining a focus on eliciting the student's thinking, we wondered whether Ms. Marzilli was trying to get the student to change the strategy through the use of a picture representation (i.e., to get the student to see that one also needs to attend to the size of the parts in order to use a distance from the whole strategy for comparing). She asked a series of questions that prompted the student to represent each fraction using a picture and then use the pictures to compare the fractions. While it is possible that she was using these questions to better understand the student's original strategy, it is also possible that she was using these questions to attempt to change the student's thinking. We see Ms. Marzilli's questions as being different from asking the student whether she can draw a picture to show her strategy (and if the student responds yes, asking the student to draw the picture). These findings are summarized in Table 2.

Ms. Smith's performance. A student had circled "1/4" but had not recorded anything beyond the answer. Ms. Smith began by asking the student to share his thinking.

Ms. Smith	What about one-fourths or three-sixths? Or one-sixth, sorry. If you need more paper, you can use one of these pieces
Student	(Writes ¼ and 1/6.) If they have the same numerator, the higher- the lower denominator is larger. Has a larger number because- 

	(Draws two squares roughly the same size: one divided into four pieces and the other divided into six pieces.) 
	Because shaded that would be one of these. (Shades in one piece from both squares.) One-fourth is bigger also, if you- The bigger denominator is smaller because- if the numerator is the same- because if you look at this which- this is the bigger piece. (Points to the one-fourth shaded-in piece)
Ms. Smith	Okay. Okay

The student revealed that he believes that if two fractions have the same numerator, the "lower" denominator represents the "larger" fraction and used area models to show why this is the case. Ms. Smith did not ask any follow-up questions.

This interaction is quite different from the previous two cases in that Ms. Smith did not ask any questions beyond her initial question. In this situation, Ms. Smith demonstrated that she could efficiently launch an interaction. It could be argued that she maintained a focus on eliciting student thinking by not interjecting questions that were unrelated to the way the student was thinking about the problem. However, her performance offered no evidence that she could (1) ask questions to elicit a student's process, (2) probe a student's understanding, or (3) attend to specific ideas the student had shared when asking questions. This is the kind of work that teachers need to do when students do not offer the types of information that are needed to understand their approaches or reasoning. The information shared by the student in response to Ms. Smith's initial question reasonably addressed the main components of what Ms. Smith was seeking to learn and in a way that it was likely that she could follow.

Teachers constantly balance digging into what a student says about a particular example or task and the potential to learn more through the use of other tasks. In this case, Ms. Smith elicited that the student succinctly stated the cases for which this strategy would work, the procedural step needed to compare the fractions and why the procedure worked (i.e., his understanding of the procedure). Specifically, he said that 1/4 is greater, "If they have the same numerator, the higher- the lower denominator is larger" and used diagrams to illustrate and support the generalization. All of this happened without any follow-up prompting from Ms. Smith after the initial question. It was reasonable for her to move on to a subsequent task/example to learn more. The irony is that while this interaction allowed Ms. Smith to learn about her student in some ways, it does not allow the teacher educator to learn much about Ms. Smith's eliciting skills. However, this does not indicate that Ms. Smith cannot engage in additional eliciting practices, but rather that the situation was not sufficient to evoke those practices.

When scoring this simulation, we considered whether there were additional questions that Ms. Smith should have asked to follow up on the student's initial explanation. Ms. Smith could have followed up with questions about the size of the wholes (to determine whether the student understood that the wholes need to be the same size in order to use a picture to compare) and about the size of the parts that constitute each whole. However, since the student's method was numerical and only involved diagrams to illustrate the sense making behind the numerical approach, following up with questions concerning the diagram could plausibly be viewed as straying from the student's method for solving the problem. Further, since the wholes drawn by the student were approximately the same size and the size of the parts within the wholes were reasonably equal given the purpose and time dedicated to creating them, we did not consider following up about the size of the wholes to be crucial in this particular interaction.

These findings are summarized in Table 2. For four of the criteria, Ms. Smith did not demonstrate those particular skills and the context did not require it (which we represent with a score of "NA"). Thus, it remained unclear whether she had the skills and could use them if the context required.

Summary. Across the three cases, there was variation in student thinking and in what the students did in response to questions posed to them. In the first case, the student used a standard approach (common numerator) to compare the fractions and Ms. Bernstein asked a series of questions to elicit and probe the student's thinking. In the second case, the student was using an invented approach to compare the fractions and Ms. Marzilli asked a series of pointed questions to elicit the student's process and understanding of that process. In the third case, the student largely shared his thinking in response to one question posed by the Ms. Smith. Ms. Bernstein and Ms. Marzilli had opportunities to demonstrate their skills with eliciting student thinking; however, Ms. Smith did not have all of these opportunities.

What do children do?

These three cases made us curious about the variation in what children said, did, and understood in the interviews and the implications for PSTs' opportunities to demonstrate skills. We examined records from all of the PSTs ($N = 44$) with a specific focus on the interaction around one task: "Circle the greater fraction—1/4 or 1/6?" We found that most (91%), but not all, students had the correct answer to the task. Further, most students, but not all (e.g., the case of Ms. Marzilli), used a common numerator strategy to solve the problem. Two of the 44 children shared a process for comparing the problem that appeared to be different from the process that they had used when they worked on the problem independently. One of the 44 children changed her answer during the interview. About a third of the children (16 of 44) gave their full process for solving the problem in response to one question posed by a PST and 14 of these 16 children also gave complete reasoning in response to that initial question. Ms. Smith interviewed such a student. Yet another way that children's performances varied is that about 16% of the children (7 out of 44) wrote spontaneously during the interview, that is, they picked up a marker and wrote without being asked to write. Children's performances and ways of interacting in the assessment varied in still other ways, but this analysis points to how PST teachers were being placed in different contexts, with substantially different opportunities to demonstrate their skills.

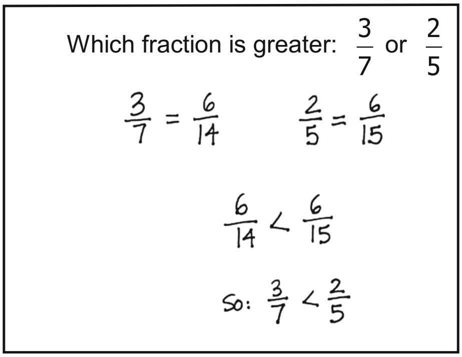
Next, we consider another way of assessing PSTs' eliciting, the use of a simulation assessment. Later, we compare what can be seen about PSTs' eliciting through each assessment.

The simulation assessment

Our simulation assessment makes use of a standardized "student" (i.e., a teacher educator who is trained to act in accordance with a profile that details a particular way a student could complete and think about a mathematics problem)[3] and takes about 25 min to

[3] The standardized "student" is a mathematics teacher educator. Prior to administering the assessment, the teacher educator participates in a series of training sessions to learn about the student's way of reasoning and to practice answering questions in ways that are aligned with the student profile.

Fig. 1 A student work sample on a comparison problem



complete. The assessment involves (1) preparing for an interaction with one standardized "student" about a specific piece of student work; (2) eliciting and probing a standardized "student's" thinking in a simulation to understand the steps she took, why she performed particular steps, and her understanding of the key mathematical ideas involved; and (3) responding to follow-up questions about the performance (see Shaughnessy and Boerst 2018b, for a full description of the assessment).

In the first part, PSTs are given a copy of a student's work on a problem (see Fig. 1) and they have 10 minutes to prepare for an interaction with one standardized student about her work. The task is to determine how the student reasoned about the problem and what she understands and does not understand. The design of this assessment is based on the ideas that students can use an array of methods different from those familiar to adults, and an important task of teaching is to probe and make sense of students' mathematical processes and understanding, both when students have correct answers and when they do not.

Because the assessment is a simulation, the assessment designers can make particular decisions about what the student will say and do during the interaction. We considered and made decisions about a number of different features when designing our simulation assessment. These features include: a particular mathematical content topic, correctness of the answer, type of process being used (standard, invented, alternative), degree to which the student understands the process, the grade level of the student, and the student's "way of being" in the interaction (e.g., being disposed to elaboration). For this particular scenario, we selected comparison of fractions as a mathematical topic using a common numerator strategy with an incorrect answer. We decided that the student would understand some parts of the process (the meaning of equivalent fractions and the process for generating equivalent fractions), but not others—specifically the process for comparing fractions using common numerators. We identified the student as a fifth-grade student and sought to have the student respond in ways during the interaction which would require the PST to ask specific questions to learn about the student's process and understanding.

In the second part, PSTs have 5 minutes to interact with the standardized student. PSTs are told that they should elicit and probe the standardized student's thinking to understand the steps she took, why she performed particular steps, and her understanding of the key mathematical ideas involved. To ensure consistency, the role of the standardized student is guided by carefully articulated rules for reasoning and responding, including scripted responses to questions that are commonly asked. This guidance is provided in a form referred to as the "student profile" (see Fig. 2). This student uses a common numerator strategy to compare the two fractions and rewrites the two fractions so that they have a common

Student work:

$$\frac{3}{7} = \frac{6}{14} \qquad \frac{2}{5} = \frac{6}{15}$$

$$\frac{6}{14} < \frac{6}{15}$$

$$\text{So: } \frac{3}{7} < \frac{2}{5}$$

General orientation to responses:

- do not make basic facts errors
- give the least amount of information that is still responsive to the PST's question
- if a question is confusing, say something like, "What do you mean?"
- do not write unless asked to write

The student:

- uses a common numerator approach to compare fractions
- knows that you need "commonness" in some form to compare fractions
- rewrites 3/7 as 6/14 and 2/5 as 6/15
- knows that the two fractions (e.g., 3/7 and 6/14) are equivalent and can explain why (i.e., understands why the procedure for generating equivalent fractions works)
- understands what an equivalent fraction means
- chooses the fraction with the larger denominator as the larger fraction when the fractions have common numerators

Specific responses (*a subset of them*):

PSTs prompt	*Response*
What did you do first?	I saw that I needed to change the fractions.
Why did you need to change the fractions?	Because you can't compare fractions when they don't have something in common
Why did you decide that 6/15 is bigger?	Because 15 is greater than 14.

Fig. 2 An excerpt from the standardized student profile

numerator of six. After the fractions are rewritten as 6/14 and 6/15, the student concludes that 6/15 is greater because 15 is greater than 14. Then, the student changes the fractions back to the original fractions and concludes that 3/7 < 2/5. This student understands the meaning of equivalent fractions and why the process for generating equivalent fractions works. She believes that 6/15 is greater than 6/14 because it has more pieces—a common misconception.

Each PST's interaction with the standardized student is video recorded and scored using checklists with the criteria for proficient performance (see Table 3). Criteria for eliciting are keyed to specific parts of the task (e.g., probes the student's understanding of why 6/14 < 6/15) as well as how the PST takes up specific things that the student does or says. Because the student's process is known to the scorer, it is possible to articulate the exact steps of the process and the understandings that would need to be elicited to display strong eliciting skills. PSTs are told that they will be evaluated on their skill with key aspects of the decomposition of eliciting student thinking (e.g., probing student thinking) but are not provided with the scoring checklist.

What does a simulation assessment allow us to see about PSTs' eliciting?

To examine what the simulation assessment allows us to be able to see about individual PSTs' eliciting, we analyzed the performances of Ms. Bernstein, Ms. Marzilli, and Ms. Smith. Table 4 contains a summary of key aspects of their demonstrated skills.

Table 3 Simulation assessment: observational checklist for appraising performance

Component	Exemplar
Launches the interaction with a question that is neutral, open, and focused on student thinking	T: So, can you walk me through how you did this problem?
Elicits the student's process	
Launching the interaction by asking the student a question that is neutral, open, and focused on student thinking	*T:* What was your first step when you saw this problem? *S:* I wanted to change the fractions so that there would be something in common"
Eliciting how the student generated 6/14	*T:* How did you change the 3/7? *S:* Oh, I multiplied the 3 and the 7 by 2
Eliciting how the student generated 6/15	*T:* How did you get 6/15? *S:* I multiplied the 2 and the 5 by 3"
Eliciting how the student concluded that 6/14 < 6/15 (15 is greater than 14)[a]	*T:* How did you decide that 6/15 is bigger than 6/14? *S:* Because 15 is greater than 14
Probing the student's understanding of the steps and underlying mathematical ideas	
Probing the student's understanding of equivalent fractions	*T:* What does it mean for fractions to be equivalent? *S:* Equivalent fractions are different names for the same number
Probing the student's understanding of the process for generating equivalent fractions	*T:* Why does is work to multiply the top and bottom number by the same number? *S:* Because when you do that, you have twice as many pieces, but each piece is half as big
Probing the student's understanding of why 6/14 < 6/15	*T:* And why is 6/15 bigger than 6/14? *S:* Because the numerators are the same so you can just look at the denominator. The bigger denominator is the bigger fraction
Attending to the student's ideas by	
Asking questions tied to specific student actions	*Student has already written 3/7 = 6/14.* *T:* Can you tell me how you figured out that 3/7 = 6/14?
Attending to and taking up specific ideas that the student talks about	*S:* I was able to compare them once I renamed them. *T:* Okay, how did you rename them?
Deploying other moves that support learning about student thinking	
Refraining from asking the student to use a different process (in a way that competes with the student's initial process)[b]	*T:* You should find common denominators. Can you do that?
Refrains from making evaluative comments	*S:* I multiplied the top number and the bottom number by 2 to get 6/14. *T:* That is correct. What did you do next?
Prompting the student fluently	Refrains from long pauses in posing questions OR restarting the posing of a question more than once

[a]The student incorrectly concludes that 6/14 < 6/15

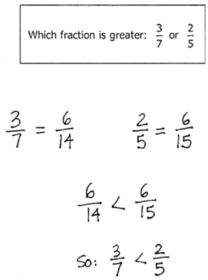
[b]We chose to frame this move and the one that follows as "refraining" from a particular move in order to have consistency in how the moves are later interpreted (i.e., the presence of a move is considered positive). The examples that are provided for these two moves are both the negative example (i.e., the PST does not refrain)

Table 4 Simulation assessment: summary of the three PSTs' demonstrated skills

Eliciting Component	Ms. Bernstein	Ms. Marzilli	Ms. Smith
Launches the interaction with a question that is neutral, open, and focused on student thinking	Yes	Yes	Yes
Elicits the specific steps of the student's process			
How the student generated 6/14	Yes	Yes	Yes
How the student generated 6/15	Yes	Yes	Yes
How the student concluded that 6/14 < 6/15 (15 is greater than 14)	Yes	Yes	Yes
Probes the student's understanding of the steps and underlying mathematical ideas			
Equivalent fractions	Yes	Yes	No
The process for generating equivalent fractions	No	Yes	No
Why 6/14 < 6/15	No	No	Yes
Attends to the student's ideas			
Asks specific questions about what the student did	Yes	Yes	Yes
Attends to and takes up specific ideas that the student talks about	Yes	Yes	Yes
Maintains a focus on eliciting student thinking			
Refrains from directing the student to a different process	Yes	Yes	Yes
Refrains from making evaluative comments	Yes	Yes	Yes
Prompts the student fluently	Yes	Yes	Yes

Ms. Bernstein's performance. Ms. Bernstein began the interaction by asking the student to talk about her process.

Ms. Bernstein	I was looking at this problem and I would like you to just go through your process for me a little bit about how you solved it
Student	Okay. So, I renamed the fractions so I was able to compare them



The student revealed that she had renamed the fractions to compare them and Ms. Bernstein pressed to learn what the student meant by "renaming fractions" and how she had renamed them.

Ms. Bernstein	Okay. Renaming the fractions. What do you mean by that?
Student	I changed three-sevenths to six-fourteenths and two-fifths to six-fifteenths
Ms. Bernstein	Okay, and then how did you change those fractions? You can use a marker if you'd like
Student	Okay. I multiplied the three and the seven both by two
Ms. Bernstein	Okay
Student	And then I got six-fourteenths. And then I multiplied the two and the five both by three and got six-fifteenths

After the student described her process for renaming fractions, Ms. Bernstein probed the student's understanding of that process.

Ms. Bernstein	Okay. So, why did you multiply the fractions by the same number, the numerator and the denominators by the same number?
Student	Because I knew that I could create like another name for the same fraction
Ms. Bernstein	Okay. And do you know what that's called when you create-
Student	Yeah, it's an equivalent fraction

Ms. Bernstein continued to pose questions related to the student's process for comparing the "renamed" fractions (6/14 and 6/15).

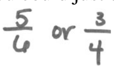
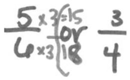
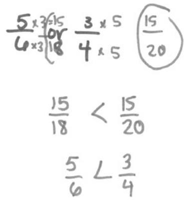
Ms. Bernstein	Okay, an equivalent fraction. So now you have your two equivalent fractions, and then how did you use those fractions to answer the main question?
Student	So-
Ms. Bernstein	Like your step here I guess
Student	Right. Since the six was the same for both fractions, I could compare just by looking at the denominators. So, yeah
Ms. Bernstein	Okay. So, compare by the denominators. What do you mean? How did you determine that six-fifteenths would be greater than six-fourteenths?
Student	Fifteen is greater than fourteen, so I knew that six-fifteenths would be greater

After eliciting the student's process for comparing the two fractions, Ms. Bernstein posed a question focused on whether the strategy was dependent on the numerators being the same.

Ms. Bernstein	Okay, okay. And then you said you had both of them six, so was your intention to make the numerators the same number or could this process work if they were different numbers?
Student	Well, I did want to make the numerator both six
Ms. Bernstein	Okay
Student	What was the second part of your question?

Ms. Bernstein	Just do you think that this would work if you had two numerators that weren't the same by just looking at the denominator?
Student	Oh, no, you couldn't like- I couldn't compare these, there wasn't anything in common
Ms. Bernstein	Okay. And then could you just explain this final step for me, please?
Student	Sure. So, I'd already figured out that six-fourteenths is another name for three-sevenths, so I was just able to substitute like back in the original fraction so that I could solve this

Then, Ms. Bernstein posed another problem and asked the student to explain her process as she worked through the problem.

Ms. Bernstein	Okay. So then if I were to give you another problem, do you think you could show me how you would solve that?
Student	Yeah
Ms. Bernstein	Okay. So, the two fractions I'll give you is which is greater: five-sixths or three-fourths? And then if you could just explain-maybe if you use a different color- your process as you go through it 
Student	Okay. Okay. So, I want to make my numerators the same, I like to do it that way, so I'll multiply five times three equals fifteen and multiply six times three and that's eighteen. So fifteen- 
Ms. Bernstein	And why are you making the numerators the same again?
Student	I just like to use that like- I like to- Something has to be the same and I like to use the numerators.
Ms. Bernstein	Okay
Student	So that's- Three times five is fifteen, and then four times five is twenty. So, I'm comparing fifteen-eighteenths and fifteen-twentieths 

Finally, Ms. Bernstein probed how the student concluded that 15/20 is greater than 15/18.

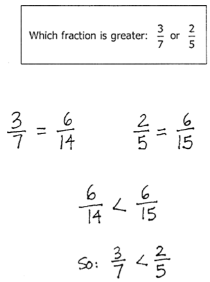
Ms. Bernstein	Okay. So then how did you know again that fifteenth-twenties is greater than fifteen-eighteenths?
Student	Because- So, I made the numerators the same and twenty is greater than eighteen
Ms. Bernstein	Okay. And then just this last process, how did you get to the end again?
Student	I just- I knew that I had like renamed three-fourths as fifteen-twentieths, so I put it back to three-fourths and it seemed the same thing

The interaction ended with the student describing how she had arrived at the final answer of 5/6 < 3/4.

In this interaction, Ms. Bernstein demonstrated skill with launching the interaction by posing a question that invited the student to talk through the process she used to solve the problem and skill with eliciting the specific steps of the student's process. This included asking the student to write to show how she "changed" the fractions. She demonstrated some skill in probing the student's understanding of the steps and the underlying mathematical ideas. Specifically, she probed the student's understanding of the meaning of an equivalent fraction. However, she did not ask questions focused on learning about the student's understanding of the process for generating equivalent fractions, the common numerator method for comparing fractions, or why 6/14 < 6/15. Ms. Bernstein posed a follow-up problem during the interaction—the comparison of 3/4 and 5/6. She posed questions to the student about her process as she worked on this problem. Across the interaction, Ms. Bernstein demonstrated skill with attending to a student's ideas by asking specific questions about what the student did (e.g., the student recorded how she generated the equivalent fraction and Ms. Bernstein asked, "why did you multiply the numerator and the denominator by the same number?") and by attending to and taking up specific ideas that the student talked about. Throughout, she maintained a focus on eliciting student thinking.

Ms. Marzilli's performance. Ms. Marzilli began the interaction by asking the student about his first step when he solved the problem.

Ms. Marzilli	Okay, Tim, so can you tell me what was your first step when you tried to figure out if three-sevenths was bigger than two-fifths?
Student	I knew I needed to change the fractions



After the student indicated that he knew that he needed to change the fractions, Ms. Marzilli asked questions focused on how and why the student changed the fractions.

Ms. Marzilli	Okay. Can you explain that a little bit more? How did you change three-sevenths for example?
Student	So, I changed three-sevenths by multiplying the top and the bottom by two to get six-fourteenths
Ms. Marzilli	Okay. Why did you do that?
Student	Because, well, I know that I can rewrite the number three-sevenths in lots of different ways just by multiplying the top and the bottom by the same number, so this is just another name for this fraction
Ms. Marzilli	Okay. So then you set them- You said that they were equal? Okay. So, why does it work that you can multiply the top and the bottom by the same number to get a bigger number?

Student	Because when you do that, you have twice as many pieces, but each piece is half as big, so you get, you know, two times the number of pieces makes the, you know-
Ms. Marzilli	Okay. Why did you choose two and not another number like three?
Student	Well, actually, I did use three over here. So, I chose two here because I knew that I wanted the top to get to be six
Ms. Marzilli	Okay. And why did you want that?
Student	Because I could make both of those fractions have a numerator of six and that makes it easier to compare them
Ms. Marzilli	Okay. So then you multiplied by three over three here?
Student	Yes, I did

Then, Ms. Marzilli asked a question focused on the comparison on 6/14 and 6/15 and the student revealed that he compared the denominators to determine the greater fraction.

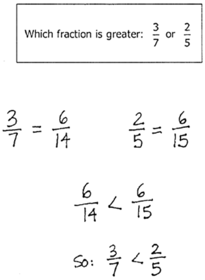
Ms. Marzilli	Okay. How did you decide if six-fourteenths was bigger than six-fifteenths?
Student	So, once the numerators are the same, then I just looked at the denominator and this is fifteen and this is fourteen, and fifteen is more than fifteen
Ms. Marzilli	Fifteen is more than-
Student	Fifteen is more than fourteen, yes. Sorry
Ms. Marzilli	Okay. So, would you say that one-fifteenth is bigger than one-fourteenth?
Student	Yes, I would

The interaction closed with Ms. Marzilli asking whether the student believed that 1/4 is bigger than 1/14.

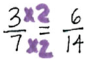
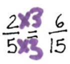
In this interaction, we were able to see Ms. Marzilli's skills around multiple components of the practice. She demonstrated skill with launching the interaction by posing a question which invited the student to talk through the process he used to solve the problem and skill with eliciting the specific steps of the student's process. This included asking the student to explain how he changed the fractions after the student said, "I knew I needed to change the fractions." She focused first on the case of 3/7. Later, she asked about 2/5, specifically whether the student always multiplied the top and bottom number by two. She demonstrated some skill in probing the student's understanding of the steps and the underlying mathematical ideas. She probed the student's understanding of the meaning of an equivalent fraction and the student indicated that "you can write the number 3/7 in lots of different ways" and that 6/14 is just another way to write the fractions. She also probed the student's understanding of the process for generating equivalent fractions. However, she did not ask questions which pressed on learning about the student's understanding of why $6/14 < 6/15$. Across the interaction, she demonstrated skill with attending to a student's ideas by taking up specific ideas that he talked about. For example, the student said, "I knew I needed to change the fractions." Ms. Marzilli responded by saying, "Okay can you explain that a little bit more? How did you change 3/7 for example?" She also asked specific questions about what the student had already written. In this interaction, Ms.

Marzilli did not ask the student to write. Throughout, she demonstrated skill with maintaining a focus on eliciting student thinking.

Ms. Smith's performance. Ms. Smith began the interaction by asking the student to walk her through what she had done to solve the problem and indicated that the student could use a marker if she wanted to write.

Ms. Smith	So, can you just walk me through how you did this problem? If you want to write on it you can use some markers	
Student	Okay. So, let's see. I figured out first that I need to rename the fractions, and I then was able to compare them once I renamed them	

The student revealed that she "renamed" the fractions to compare them. Ms. Smith continued to ask questions focused on the student's process for renaming the fractions.

Ms. Smith	Okay, how did you rename them?
Student	Like what did I do?
Ms. Smith	Yeah. Uh-huh
Student	Here, I multiplied the three and the seven both by two, so three times two is six and seven times two is fourteen 
Ms. Smith	Okay
Student	And then over here I multiplied the numerator and denominator by three so two times three is six and five times three is fifteen 
Ms. Smith	And why did you choose those numbers to write them down?
Student	Because fractions are easier to compare if there is something in common
Ms. Smith	Okay
Student	So I made a common numerator of six

At this point, the student had shared her process for generating the equivalent fractions and why she wanted to rename the fractions. However, she had not yet revealed what she knew about the meaning of equivalent fractions or why she believed that the process that she was using to generate equivalent fractions worked. Ms. Smith continued to ask the student about her process:

Ms. Smith	Okay. And so then you have them written as six-fourteenths and six-fifteenths. And how did you decide which was bigger?
Student	Well, since the numerators were the same, I could just look at the denominators and fifteen is bigger than fourteen, so I figured out that six-fifteenths was bigger

The student revealed that because the numerators are the same, she compared the denominators and that because 15 is bigger than 14, she determined that 6/15 is bigger. Ms. Smith then asked questions that pressed on the student's understanding of the numerator and denominator.

Ms. Smith	Okay. And in a fraction, like what does the six represent? And what does the fourteen represent?
Student	The six is like the number of pieces that you're- So if it's like a circle it's the number of pieces that are shaded and the fourteen is like how many pieces you have all together

After the student revealed her understanding of the numerator and denominator of a fraction, Ms. Smith asked the student to draw a picture.

Ms. Smith	Okay. Could you actually draw that picture for me?
Student	It's hard for me to draw like these kinds of denominators, so-
Ms. Smith	Because there are so- Is it because there are so many of them or why is that hard?
Student	Yeah, I mean it's just hard in general for me to like actually make my pictures look right, so-
Ms. Smith	Okay. Would it be easier with smaller fractions?
Student	I guess so

After the student indicated that it would be hard to draw a picture, Ms. Smith posed an additional comparison problem, one with common numerators.

Ms. Smith	Could you try comparing these fractions for me? (Writes the fractions 3/4 and 3/5)
Student	Okay. (Circles 3/5, and writes a less-than sign indicating that 3/4 is less than 3/5) 
Ms. Smith	Okay. And why is that one bigger?
Student	Because the numerator is the same, and so I'm just looking at the number of pieces. Five is bigger than four

Then, Ms. Smith asked questions which appeared to be focused on whether the student would use the same strategy when two fractions have a common denominator.

Ms. Smith	And what if the denominator had been the same and the numerator were different?
Student	Then I could compare the numerators
Ms. Smith	And would it be the same where the bigger numerator is bigger? Or would it be different?
Student	Yeah- Like if the denominators are the same then the bigger numerator is the bigger fraction
Ms. Smith	Okay. And could you have come up with any different renamed fractions for those? That would have been easier to compare to?
Student	Yeah, I mean anything to find like a common numerator, but since six is the least common multiple-
Ms. Smith	Okay
Student	That's what I figured out
Ms. Smith	All right, that's great, thanks

By the end of the interaction, the student had revealed that if two fractions have the same denominator, she believes that the fraction with the bigger numerator is the bigger fraction.

In this interaction, we are able to see evidence of Ms. Smith's skills with launching interactions with a question that is neutral, open, and focused on student thinking. She demonstrated skill with eliciting the steps of the student's process, including asking about the generation of the two equivalent fractions as well as how the student compared 6/14 and 6/15. She demonstrated skill with probing the student's understanding of some of the key ideas underlying the process (i.e., the student's understanding of why 6/15 > 6/14); however, she did not probe the student's understanding of other ideas, including the meaning of equivalent fractions and the process for generating equivalent fractions. Across the interaction, Ms. Smith demonstrated skill with attending to a student's ideas by asking specific questions about what the student did. For example, after Ms. Smith posed a follow-up problem, the student wrote that that 3/4 is less than 3/5. Ms. Smith asked, "Okay. And why is that one bigger?" She also demonstrated skill with attending to and taking up specific ideas that the student talked about during the interaction. For example, after the student said, "I figured out first that I need to rename the fractions, and I then was able to compare them once I renamed them." Ms. Smith asked, "Okay, how did you rename them?" Similar to Ms. Bernstein and Ms. Marzilli, Ms. Smith demonstrated skill with maintaining a focus on eliciting student thinking.

Summary. There were similarities and differences in the observed skills of the three PSTs. All three launched the interaction with a question that was neutral, open, and focused on student thinking. They also elicited the specific steps of the student's process and probed the student's understanding; however, there was variation in the probing that was done. All three PSTs probed some key ideas, but not all probed the comparison of the fractions using the common numerator method. Ms. Bernstein focused on the student's understanding of equivalent fractions, Ms. Marzilli focused on both the student's understanding of equivalent fractions and the student's understanding of the process for generating equivalent fractions, and Ms. Smith focused her probing on the common numerator method and why the student believed the 6/14 < 6/15. All three PSTs attended to and took up specific ideas that the student talked about; however, only two of them demonstrated skill with asking specific questions about what the student had written. All three PSTs maintained a focus on eliciting student thinking.

Comparing the performances on the two types of assessment

We next turn to comparing what we were able to see about the three PSTs' skills on the two assessments.

Comparing Ms. Bernstein's demonstrated skills on both assessments

Ms. Bernstein demonstrated similar skills with respect to eliciting student thinking on both assessments. However, one difference arose in the demonstration of skill with probing student thinking; while she demonstrated skill with probing student thinking on both assessments, on the simulation assessment, the probing did not focus on the central part of the student's process (i.e., why the student believed that $6/15 > 6/14$). These findings are summarized in Table 5.

Comparing Ms. Marzilli's demonstrated skills on both assessments

Ms. Marzilli also demonstrated many skills on both assessments; however, there were three main differences. Ms. Marzilli probed the student's understanding of the process on the field assessment; however, on the simulation assessment, her probing focused on the student's understanding of an equivalent fraction and the process for generating equivalent fractions and did not result in learning about the student's understanding of the comparison of 6/14 and 6/15. Second, although she had asked specific questions about the student's written work on the field assessment, she did not do so on the simulation assessment. Third, on the field assessment, she may have been trying to get the student to use a different process. This was not the case on the simulation assessment. These findings are summarized in Table 6.

Comparing Ms. Smith's demonstrated skills on both assessments

Ms. Smith demonstrated similar skills on some—but not all—aspects of eliciting student thinking on the two assessments also some important differences. In both assessments, she launched the interaction with a question that was neutral, open, and focused on student thinking. She also refrained from directing the student to a different process, refrained from making evaluative comments, and prompted the student fluently.

But there were also substantial differences. For several components of the field assessment, Ms. Smith did not demonstrate her skills. For instance, on the field assessment, Ms. Smith did not demonstrate skill with eliciting the specific steps of the student's process, nor did she demonstrate skill with probing the student's understanding of the steps. However, when we looked at the student's response to her initial question, we believed that there was enough information about the student's process and understanding that it was plausible for Ms. Smith to believe that she had secured the desired insights and did not need to elicit further. On the simulation assessment, she demonstrated skill with eliciting the student's process and showed some skill in probing the student's understanding of the steps. Further, because the field assessment interaction did not require any follow-up questions to learn about the student's process and understanding, Ms. Smith did not have an opportunity to demonstrate skills related to attending to the student's ideas. She did, in fact, demonstrate these skills in the simulation context. In summary, in the case

Table 5 Ms. Bernstein's demonstrated skills on the field and simulation assessments

Component	Field	Simulation
Launches the interaction with a question that is neutral, open, and focused on student thinking	Yes	Yes
Elicits the specific steps of the student's process	Yes	Yes
Probes the student's understanding of the steps	Yes	To some extent
Attends to the student's ideas		
Asks specific questions about what the student did	Yes	Yes
Attends to and takes up specific ideas that the student talks about	Yes	Yes
Maintains a focus on eliciting student thinking		
Refrains from directing the student to a different process	Yes	Yes
Refrains from making evaluative comments	Yes	Yes
Prompts the student fluently	Yes	Yes

Table 6 Ms. Marzilli's demonstrated skills on the field and simulation assessments

Component	Field	Simulation
Launches the interaction with a question that is neutral, open, and focused on student thinking	Yes	Yes
Elicits the specific steps of the student's process	Yes	Yes
Probes the student's understanding of the steps	Yes	To some extent
Attends to the student's ideas		
Asks specific questions about what the student did	No	No
Attends to and takes up specific ideas that the student talks about	Yes	Yes
Maintains a focus on eliciting student thinking		
Refrains from directing the student to a different process	No	Yes
Refrains from making evaluative comments	Yes	Yes
Prompts the student fluently	Yes	Yes

of Ms. Smith, the simulation assessment confirmed and complemented the findings from the field assessment. These findings are summarized in Table 7.

Summary

In the simulation assessment, the student had a standardized way of reasoning, but the PSTs learned different information about the student's thinking because they focused their questions on different parts of the student's work. In all three cases, the PSTs were required by the situation, specifically due to the "student's" way of interacting, to exhibit their skills

Table 7 Ms. Smith's demonstrated skills on the field and simulation assessments

Component	Field	Simulation
Launches the interaction with a question that is neutral, open, and focused on student thinking	Yes	Yes
Elicits the specific steps of the student's process	NA	Yes
Probes the student's understanding of the steps	NA	Yes
Attends to the student's ideas in follow-up questions		
Asks specific questions about what the student did	NA	Yes
Attends to and takes up specific ideas that the student talks about	NA	Yes
Maintains a focus on eliciting student thinking		
Refrains from directing the student to a different process	Yes	Yes
Refrains from making evaluative comments	Yes	Yes
Prompts the student fluently	Yes	Yes

with eliciting student thinking. The opportunity afforded by the simulation context to see novices' skills was particularly striking in the case of Ms. Smith, where the field assessment provided limited insight into her eliciting skills because of the ways in which the student responded in the assessment situation. Both the field and the simulation assessments provided opportunities to see PSTs probing understanding, but because the simulation context provided more aspects to probe than the field prompt, assessors were able to see more nuance in the ways that understanding could be probed. While one might argue that the simulation assessment is superior to the field assessment because it confirmed PSTs' skills and expanded the number of skills that could be assessed, we believe that there are reasons why both types of assessments are crucial and that the two serve complementary roles.

Considering affordances and challenges of the assessment types

The analysis focused on the question: What can be learned about PSTs' skill in eliciting student thinking through field and simulation assessment contexts? We used three case studies to probe what each assessment afforded for learning about novices' skills. We now turn to considering the affordances and challenges of each type of assessment for assessing PSTs' skills.

Field assessment affordances and challenges

Field assessments, those happening in actual elementary school contexts, have a number of affordances for assessing PSTs' skills with eliciting student thinking. The experience is likely to have greater face validity to PSTs since they may feel that they are being assessed on the real work of teaching in a real context. A second affordance is that PSTs often have resources that can be used to enhance their teaching. They are interacting with real students with whom they typically have a relationship, they have studied the tasks and know how they want to use them, and they know about language and routines that are used in the classroom and could be drawn upon in interaction with the student.

At the same time, assessing PSTs' practice in the field presents a major challenge in that teacher educators have little control over the interaction, including children's understanding of the content and their willingness to respond to particular questions. Variation in children's understandings and methods is a challenge when such interactions are used for assessment purposes because PSTs are in different situations, which impacts the difficulty of work required to elicit thinking and the extent to which the situations allow PSTs to demonstrate their skills. The result is that field assessments do not reliably allow one to make claims about individual PSTs. Further, making claims about the skills of a group is complicated by the need to account for differences in the situations and what those differences imply for aggregating insights.

Other features of field assessments offer affordances and challenges simultaneously. The role of shared understanding is one such feature. Over time, teachers and students in the same classroom context develop shared understandings of vocabulary, ideas, and other ways of working with content. Such understandings influence the ways in which interactions happen in classrooms as they point to what can be taken as "shared" and not asked about, and what deserves further questioning and discussion. When field assessments are situated in real classrooms where PSTs have relationships with children, PSTs and children may have shared understandings that influence the decisions PSTs make in the interaction. This closely mirrors real teaching practice in which such understandings enable the efficient use of time. However, in assessment situations, shared understandings also have a downside. In many contexts, teacher educators do not have access to the prior interactions in which shared understandings develop. This becomes an assessment challenge when a PST does not follow up on a student's response because of shared understandings that are not known to the teacher educators. For example, in an interaction around a child's strategy for comparing fractions, a PST may not press on the child's understanding of a process used to generate equivalent fractions because the PST had asked the child a question about such work earlier in the day.

Because the field assessment is situated in a classroom with real students, it captures the degree to which PSTs can tailor their teaching to the needs of particular students. For instance, if a PST works with an emergent bilingual learner, it is possible to see whether a PST can adjust his or her skills to the unique demands of the situation. Similarly, if a child is reluctant to share his or her thinking in words, it is possible to see whether a PST can employ alternative moves to get a student to share his or her thinking. Both of these contexts could be viewed by PSTs and teacher educators as "more challenging" elicitation contexts. Even when teacher educators provide PSTs with specific guidance for selecting a student with whom to interact (e.g., choose a student about whom you know little, a student whose culture is different from yours, a student whose first language is not English, a student recommended by your mentor teacher), there is still tremendous variability across students—even those chosen for exact same reason. Students similar in many ways may still share different amounts of information about their thinking. Some students will share strategies that are well known, while others will share invented strategies. The demand of eliciting in these contexts is different and it is not possible to equate the situations, which by definition creates assessments that are different. These differences can put subsets of PSTs at a disadvantage when compared with their peers, and they also prevent teacher educators from being able to learn the same things about the practices of all PSTs and from having a stable context in which to apply scoring criteria.

When looking at the skills of a large group of PSTs, the variation in situation, if known, can provide important information to teacher educators about the range of cases with which the group as a whole can demonstrate skill or lack thereof. This can provide insight into next steps that could support the group in skillfully working with a range of students. At the same time, teacher educators have limited insight into the actual thinking of the students in these situations and that impacts their ability to assess novices' skills.

Simulation assessment affordances and challenges

The simulation assessment also has a number of affordances and a number of challenges. A key feature of the simulation is the control that a teacher educator has over the child's understanding, process, and way of responding to questions. In this way, a teacher educator can design the profile of the student's thinking such that there will be something of interest to observe about a novice teacher's skills with the focal teaching practice. This can be used to great advantage when the teacher educator wants to see how PSTs respond to an important situation that would otherwise be relatively rare for *all* PSTs to encounter in the field (e.g., a student using a particular alternative method for solving a problem). Second, because the student's thinking is completely known, the observational tool can be designed to assess whether specific aspects of the student's process and understanding are elicited. Third, because the student's thinking can be standardized, all of the PSTs have the same opportunities to demonstrate their skill with the practice. When an absence of skill is noted, it can be attributed to lack of skill in the situation rather than to a lack of opportunity to demonstrate the skill. Fourth, because a group of PSTs can be placed in an identical situation, it is possible to make claims about the skills of a group of PSTs in a particular situation.

But standardization also has drawbacks. When a group of PSTs interact with the same "student," the group is exposed to only one pattern of student thinking. Thus, the assessment experience cannot be leveraged as a means to learn about the different ways that children might understand the same content and that the same questions might be differentially useful in particular situations. Further, the assessment limits opportunities to understand how the PSTs as a group are positioned to elicit in a range of situations. Yet another challenge is that PSTs may perceive the situation as artificial. Although the simulation is close to practice, the PST is interacting with an adult rather than an elementary school student. This may feel "inauthentic" to a PST, in that it is not a real student with whom they have a relationship. That inauthenticity may cause PSTs to elicit in ways that they would not in the field.

As was the case with field assessment, some features present both affordances and challenges. All of the PSTs have the same familiarity with the student. In this case, they have no prior relationship with the student. This feature helps make the assessment fair, as the PSTs are not able to differentially leverage past work with the student. But, it also presents a challenge in that leveraging shared understandings is foundational to the work that teachers do when eliciting student thinking. In the simulation assessment, PSTs are in a situation in which little can be assumed beyond what one would typically expect children at the given grade level to know and understand.

The use of the simulation is efficient in that it does not require travel to elementary school classrooms, coordination with classroom teachers and the elementary school calendar, and permission from families to video record. These are all major challenges in conducting field assessments. At the same time, it does require work to train adults to be the standardized student in the simulations.

Conclusion

Assessment plays a crucial role in the design, enactment, evaluation, and improvement of teacher education. Teacher educators need sound ways to assess novices' developing skills with specific teaching practices. This requires knowledge of the skills that a novice can demonstrate in a valued context. This study examined two types of assessments—field and simulation—and sought to examine the skills with one teaching practice, eliciting student thinking, that novices were able to demonstrate in the context of each assessment. The three PSTs had differing opportunities to demonstrate their skills in the context of the field assessment, but similar opportunities in the context of the simulation assessment. The purpose of this study was to better understand the affordances and constraints of each assessment type and the ways in which the two assessments might function in tandem.

The study provides an important contribution to thinking about ways of assessing novices' skills with practices of teaching. At the outset of the paper, we presented a likely hypothesis: that a simulation assessment lacks the authenticity to assess the skills of PSTs and that a field assessment would more reliably present the need to enact core teaching practices. However, our analysis showed that, even with its inauthentic elements, the simulation allowed PSTs to demonstrate their skills with eliciting student thinking. In the case of Ms. Smith, in fact, the simulation assessment provided more opportunities than the field assessment to demonstrate certain kinds of skills. In some ways, these findings are not surprising, but are in line with Ball and Cohen's (1999) argument that situating in practice does not necessarily entail being situated in a classroom in real time and that the complexities of being in the midst of a real classroom can limit opportunities to learn. Interestingly, this study suggests that the inauthentic elements of simulations can help solve a vexing shortcoming of assessments happening in actual contexts of practice—namely the variability in students and situationally specific demands on teaching practice. Situating assessments in real classrooms opens up particular opportunities, but at the same time can limit what is learned about novices' skills. We believe that the findings suggest that simulation and field assessments are complementary, and when used together, they can provide useful confirmatory evidence and expand what can be observed about novices' skills.

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