Shifting Perspectives on Preservice Teachers' Noticing of Children's Mathematical Thinking

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Abstract Noticing children's mathematical thinking is an important aspect of what teachers need to know. Researchers generally agree that noticing involves two main processes, namely attending to and making sense of particular events in an instructional setting. We report on our work involving preservice teacher noticing and our efforts to scaffold their noticing. We argue for a shift in perspective on preservice teacher noticing, a perspective that considers interpreting classroom events as an important first step for preservice teachers in their development of noticing, which then positions preservice teachers to attend to important and noteworthy events.

Keywords Preservice · Elementary · Mathematics · Videocases · Noticing

Introduction

The use of video to support teacher learning, in both inservice and preservice contexts, has grown considerably in the field of teacher education (see Brophy, 2008). Video provides a medium in which teachers can critically analyze teaching practice in ways that are safely distanced from their own teaching experiences. In addition, such a medium affords more time for teachers to respond to and reflect on what they are

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observing, and also provides a narrower view of classroom interactions and thus a more focused investigation of children's thinking (Ball & Cohen, 1999; Sherin, 2001). To understand what and how teachers learn from such uses of video, researchers have focused on what events and interactions teachers attend to in video and how they make sense of those events and interactions, using the construct of *teacher noticing* to describe such questions (c.f., Sherin, Jacobs, & Philipp, 2011). Teacher noticing is generally defined as attending to and making sense of particular events in an instructional setting (Sherin, 2011). Indeed, "[effective] teaching involves observing students, listening carefully to their ideas and explanations…and using the information to make instructional decisions" (NCTM, 2000, p. 19). If the expectation for teachers is to attend to and understand children's thinking, then preservice teachers (PSTs) need to learn to productively notice children's thinking (Erickson, 2011).

Much of the extant research focused on PST noticing presents a mixed picture of effectiveness. For example, some research studies indicate that PSTs can develop the ability to notice with structured support (Fernandez, Llinares, & Valls, 2012; Star, Lynch, & Perova, 2011; Star & Strickland, 2008). In contrast, in our own work, we often found no significant improvements in PSTs' noticing in courses involving a videocase curriculum (Castro Superfine & Li, 2011; Castro Superfine, Li, Bragelman, & Fisher, 2015). We conceptualized our earlier research studies, however, without considering how intrinsically interrelated the components of teacher noticing are, and how the relationship among components may look different for PSTs who typically do not have the same wealth of teaching experiences and knowledge that inservice teachers draw on when viewing video. Expert teachers, for example, are able to recognize which features of classroom practice warrant attention and generate hypotheses about children based on available information (Carter, Cushing, Sabers, Stein, & Berliner, 1988). Novices, on the other hand, describe what they see but not with the same depth or accuracy as experts (Carter et al., 1988; Jacobs, Lamb, & Philipp, 2010). Thus, it seems reasonable to expect that novices, such as PSTs, may struggle to notice children's thinking in video.

In this chapter, we report on our work involving PST noticing and our efforts to scaffold their noticing. We begin by arguing for a shift in perspective on PST noticing, a perspective that considers interpreting classroom events as an important first step for PSTs in their development of noticing, which then positions PSTs to attend to important and noteworthy events. We focus on the following research questions: (1) To what extent can PSTs' interpret children's mathematical thinking after it is explicitly identified for them? and (2) To what extent can PSTs attend to CMT following scaffolding to support their interpretations?

Defining Teacher Noticing

While researchers generally agree that noticing involves two main processes, namely attending to and making sense of particular events in an instructional setting, researchers have conceptualized noticing in quite different ways (Sherin,

Jacobs, & Philipp, 2011). For example, van Es and Sherin (2008) and Sherin and van Es (2005) define noticing as comprised of three components: identifying what is important in a teaching situation, interpreting what is noticed, and linking noticed events with broader principles of teaching and learning. In their work, they are concerned with teacher noticing of a broad range of events and interactions, including teacher instructional moves and children's thinking, among others. In contrast, other researchers focus on noticing a particular feature of teaching, and are concerned with a more narrow focus of what is noticed. Jacobs et al. (2010), for example, focus on the professional noticing of children's mathematical thinking (CMT), which is comprised of three components: attending to children's strategies, interpreting children's understandings, and deciding how to respond on the basis of children's understanding. Still, other researchers narrowly define noticing as what is and is not attended to in an instructional setting, where a broad range of classroom events and interactions are noticed (e.g., Sherin, Russ, & Colestock, 2011; Star & Strickland, 2008; Star et al., 2011). All of these conceptualizations of noticing not only have methodological implications but were derived to support the researchers' goals and particular settings in which researchers were working with teachers (e.g., inservice teacher professional development, teacher education coursework). This is not to say that one conceptualization or foci of teacher noticing is better suited or more mutually agreed upon than another, but rather different conceptualizations of noticing make visible different aspects of teacher learning and decision-making.

In our own work with PST noticing, we define noticing as attending to and interpreting particular features of classroom practice. Drawing from Star and Strickland (2008) and Star et al. (2011), we argue that PSTs need to learn to productively attend to pertinent features (e.g., students working collaboratively, teacher asking students certain types of questions) of an instructional setting. Furthermore, PSTs need to be able to make sense of and understand the features to which they attend. At the same time, we are concerned with a narrow noticing of particular features of classroom practice. Similar to Jacobs et al. (2010), we focus on PSTs' noticing of CMT, as the noticing of such features of classroom practice are part of what PSTs will be called upon to do in their future work as teachers of mathematics. In short, we conceptualize PST noticing as attending to and interpreting CMT.

Expert–Novice Differences in Noticing

There are considerable differences between what experts and novices notice about teaching practice in video. One difference between experts and novices is an awareness of what is important to react to and what to ignore (Miller, 2011). Experts, for example, are able to recognize which features of classroom practice warrant attention and generate hypotheses about children based on available information, often drawing on their past experiences in, and knowledge of, the classroom (Carter et al., 1988). In their study of teacher professional noticing of CMT, Jacobs et al.

(2010) found that teachers with more expertise were better able to recall details of children's strategies, a finding that is consistent with expertise research on how experts hold knowledge (Donovan, Bransford, & Pellegrino, 2000).

Novices, on the other hand, describe what they see, but not with the same depth or accuracy as experts (Carter et al., 1988; Jacobs et al., 2010) and struggle in determining which features of classroom practice warrant attention (Lampert & Ball, 1998). For example, in their study of the use of video conferencing with classroom lesson clips, Sharpe et al. (2003) found that PSTs struggled to make sense of a three minute video clip and thus had to watch the clip several times in order to understand what was being viewed. Novice observers, particularly PSTs, also focus on the more ritualistic aspects of teaching practice [e.g., teacher moves, classroom management (Star & Strickland, 2008)] and less on understanding children's thinking. Indeed, despite having spent years in the classroom as learners, PSTs have limited conceptions of what the work of teaching entails and have not been privy to decisions and actions teachers make to support children's learning (Lampert & Ball, 1998).

Preservice Teachers' Noticing of CMT

Research specific to noticing of CMT indicates PSTs have difficulty attending to salient moments of CMT and often struggle to interpret these events (Morris, 2006; Star & Strickland, 2008; Star et al., 2011). Morris (2006), for example, focused on PSTs' abilities to analyze CMT and support their analysis with evidence. Findings indicated that PSTs could analyze cause and effect of instructional strategies related to learning, but lacked the ability to collect evidence to support their interpretations about children's thinking. In related work focused on PSTs noticing CMT, Fernandez et al. (2012) studied the noticing of PSTs to understand how the professional practice could be developed. At the onset of the study, PSTs had a difficult time attending to or interpreting CMT. They commonly described CMT without mentioning significant aspects about the situation or children's strategies, further illuminating the importance of developing these skills among PSTs. Related studies also support the notion that PSTs often have difficulty noticing the mathematical content and children's mathematical understandings within lessons (Star & Strickland, 2008; Star et al., 2011). For example, Amador and Weiland (2015) engaged PSTs in a structured lesson study process to support their noticing of CMT and noted that of all utterances considered to be noticing (i.e., attending and interpreting), only 6% were specific to CMT. These findings support the notion that PSTs struggle in attending to and interpreting CMT.

Similarly, in the first phase of our work, we examined the effectiveness of a videocase curriculum for supporting PST noticing. We conducted a quasi-experimental study of changes in PSTs' knowledge of, beliefs about, and ability to notice CMT to understand the overall effectiveness of the videocases. In one study, we found no significant differences in PSTs' knowledge of, beliefs about, or noticing of CMT between control and treatment groups (Castro Superfine

& Li, 2011; Castro Superfine et al., 2015). These findings suggested that the use of videocases to support PSTs' ability to notice children's thinking, in particular, seemed ineffective. Other findings from our work also suggested minimal changes in PSTs' noticing children's thinking over time with the videocases (Castro Superfine & Groza, 2012; Li & Castro Superfine, 2011, 2012).

In short, our work with PST noticing builds on more narrow conceptualizations of teacher noticing, and draws from expert–novice research and extant research on PST noticing. An assumption underlying our work is that, like novices, PSTs need support in noticing. Because PSTs struggle to make sense of children's thinking (e.g., Castro Superfine et al., 2015; Fernandez et al., 2012), we scaffold PSTs' interpretations by asking PSTs questions that are targeted to the substantive mathematics underlying children's thinking. As we scaffold their interpretations of children's thinking, we are implicitly, and simultaneously, scaffolding their attending by directing their attention to the noteworthy aspects of CMT. Indeed, developing expertise in noticing is as much about what is noticed as it is about what is not noticed. As PSTs develop their interpretation skills, and the scaffolding is removed, they are able to attend not just to CMT, but are able to attend to substantive aspects of CMT. Our focus in this chapter is to provide empirical evidence for such a theoretical shift in our understanding of PST noticing.

Situating Our Perspective on Noticing

Our data suggests that when scaffolded in their interpretations first and then in their attending to what is in video, PSTs are able to notice CMT in more robust ways. We first situate our perspective on noticing by describing the evolution of our work on PST noticing, and then elaborate on these findings and discuss the implications of our work for research on PST noticing.

The VPEM Project

The goal of the Videocases for Preservice Elementary Mathematics (VPEM) Project is to support PSTs noticing through the implementation of a collection of videocases designed to highlight aspects of CMT. The VPEM Project began with a collection of videocases focused on CMT, initially designed for use with PSTs in mathematics content courses. Our Phase 1 research suggested that the use of videocases to support PSTs' ability to notice children's thinking seemed ineffective. However, we hypothesized that with more support in viewing the videocases, they could still be effective in supporting PSTs' noticing, including their skills at both attending to and interpreting CMT. Following this initial phase of our work, we developed the VPEM online platform whereby PSTs view the videocases online, and their viewing of the videocases is scaffolded with different features.

VPEM Online Platform

Developed with funds from the National Science Foundation and the University of Illinois at Chicago, the VPEM platform is uniquely designed to scaffold PSTs' noticing of CMT in video format. The design framework for the VPEM online platform is presented in Figure 1.

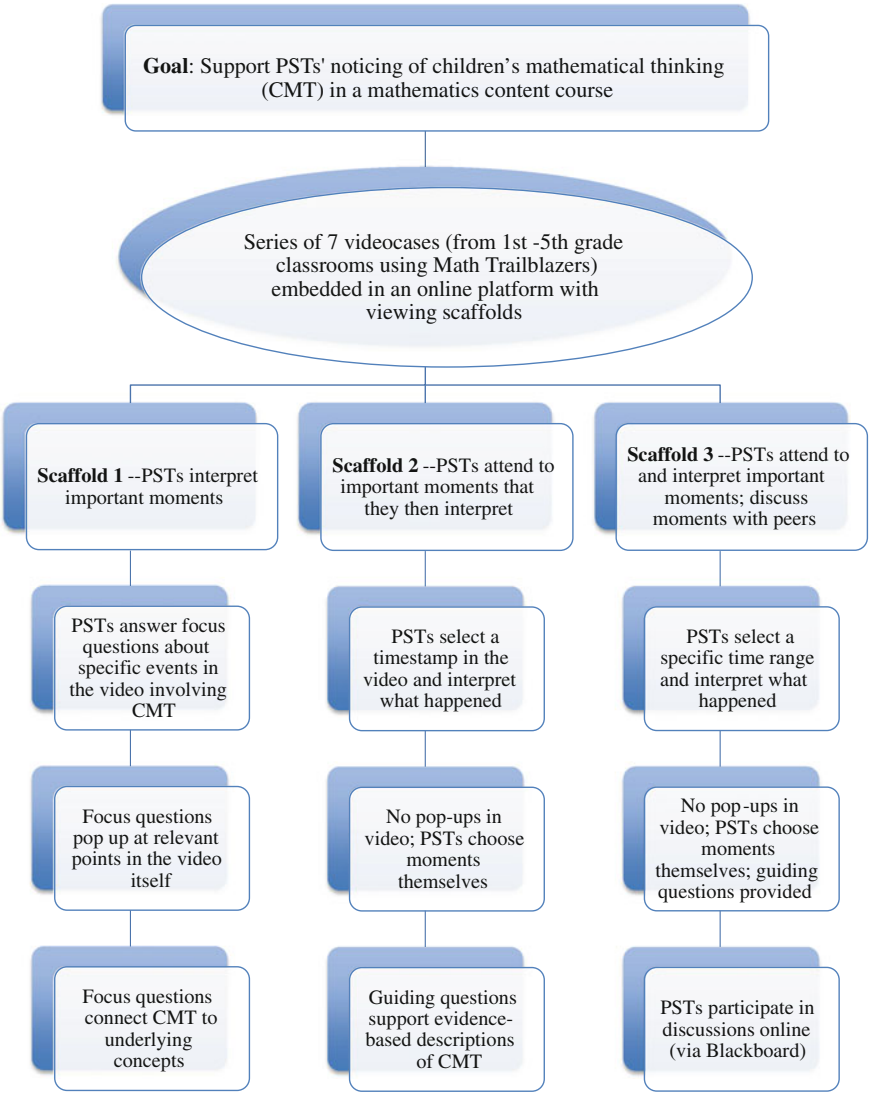

Figure 1. VPEM online platform framework.

Drawing from Vygotsky's (1978) notion of zone of proximal development and Wood, Bruner, and Ross's (1976) work on scaffolding, the VPEM online platform includes a series of scaffold levels that support a shift across noticing levels, moving from providing non-evidence-based descriptive comments to highlighting noteworthy events that attend to CMT as described by van Es (2011). In this way, we draw from van Es (2011) to inform the design of the different scaffold levels. Further, in accordance with van Es (2011) we recognize that the development of noticing may not always be linear and PSTs may shift among different levels of noticing as they develop the component skills (Figure 2).

The first scaffold level is designed to support PSTs' transition from baseline level of noticing, in which they form general impressions, to a mixed level of noticing (i.e., descriptive comments with some interpretation). The videos in this scaffold include pop-up questions that appear when a notable moment is happening, prompting PSTs to respond to those questions in the platform. This is typically an out-of-class assignment. The instructor then downloads the responses and uses those responses to structure the related in-class discussions. This format allows opportunities for PSTs to discuss important moments in the videos without expecting PSTs to highlight noteworthy events on their own. Highlighting noteworthy events is a hallmark of mixed level noticing and higher (van Es, 2011), and thus we do not expect PSTs to be able to do so in the first scaffold level. Also during the first scaffold, the instructor can focus the in-class discussion on comments that are most related to the mathematical goals of the lesson featured in the video, offering PSTs opportunities to move away from the baseline noticing of the classroom environment (Figure 3).

Figure 2. Example of pop-up question in the video.

Figure 3. Platform comment section for PST responses for first scaffold level.

The second scaffold level requires PSTs to take over the selection of important moments, rather than having important moments predetermined by the pop-ups in the video. By the time they encounter the second scaffold, PSTs have had multiple opportunities to view important moments that are preselected and have responded to multiple focus questions that are targeted to CMT. When the instructor downloads the comments on PSTs' selections, it is possible to sort the comments by start time and arrange the in-class discussion around particular moments (Figure 4).

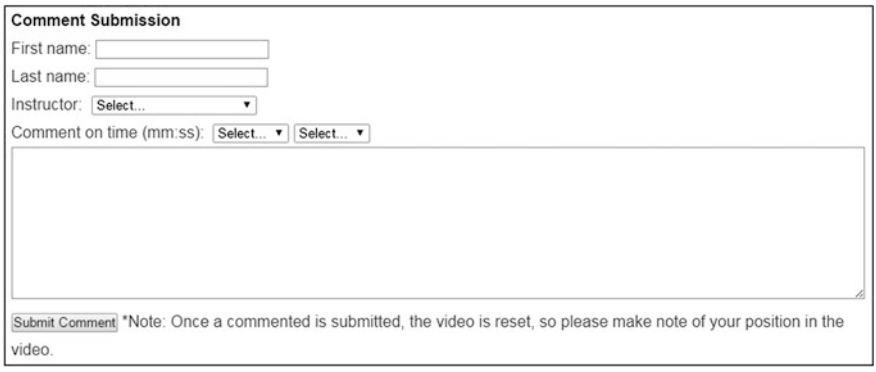

Figure 4. Platform comment section for PST responses for second scaffold level.

Finally, in the third scaffold level, the in-class discussion portion is shifted to an online discussion, thus promoting interactions among PSTs in the course and removing the instructor as an intermediary in the discussion of the videocase (Figure 5).

Figure 5. Platform comment section for PST responses for third scaffold level.

Evidence of Noticing

A two-stage coding scheme was followed to explore whether PST responses to videos from scaffold levels two and three attended to CMT. The first stage assessed whether PST responses described some aspect of what the children were doing or saying about mathematics. This was an initial attempt to see if PSTs could focus in on important moments without being directed to them via pop-ups. Two coders were assigned to each videocase, and for each case there was greater than 90% reliability. Final codes were agreed upon by the two coders before moving on to the next coding stage. Results for this stage are in Figure 6. In scaffold two, 93.63, 90.00, and 97.42% of PST responses discussed CMT in some way. In scaffold 3, 94.94% discussed CMT. Recall that the mathematical content in the videocases for the scaffold levels were intentionally different.

Video	Number of Comments	CMT
Scaffold 2		
Representations	144	97.92%
Remainders	200	90.00%
Fractions	204	93.63%
Scaffold 3		
Patterns	99	94.64%

Figure 6. Percentage of PST responses discussing CMT.

The second stage of coding explored the degree of evidence in the PST response for attending to CMT. Following from the coding scheme developed by Jacobs et al. (2010), we identified three categories that describe the depth of attending to CMT: no evidence of attending, limited evidence of attending, and robust evidence of attending. We purposely drew from this coding scheme because it was specific to CMT and fit with our definition of noticing, whereas other coding schemes for noticing (e.g., van Es, 2011) were not specific to CMT. A PST response with no evidence of attending did not describe any details about the children's solution strategies or how children solved the problem. A PST response with limited evidence of attending included some aspect of the children's solution strategy or how the children solved the problem. Finally, a PST response with robust evidence of attending included children's solution strategies and some interpretation or inference that attempted to explain why the children did or did not understand the mathematical concept or factors that contributed to the children's understanding. In other words, a response with limited evidence included evidence of only attending while a response with robust evidence included evidence of both attending and interpreting. Doing so allowed us to examine the relationship between these component skills of noticing, and specifically, to examine whether an interpretation always followed attention to CMT or vice versa. A distribution of PST responses for one videocase can be seen in Figure 7, and examples of PST responses coded at each level of attending follow.

Videocase & Evidence Level	**Percentage**
Fractions	
No Evidence	15.18%
Limited Evidence	38.74%
Robust Evidence	46.07%

Figure 7. Distribution of PST attending responses displaying evidence of CMT in one videocase.

The following, Figure 8, represents a series of PST response categories by the evidence of attending in the response. The responses are separated by scaffold and videocase.

	No Evidence of Attending to CMT	Limited Evidence of Attending to CMT	Robust Evidence of Attending to CMT
Scaffold 2--Fractions	Ali did not show the correct solution the teacher asked for, but came up with another solution - 1 1/2. Then changes his mind when he is told his answer is correct.	Rebecca wrote out her word sentence the expanded form. She wrote out 1/3 + 1/3 + 1/3 which she knew added up to 3/3 and then added 8/12 because she knew that simplified down to 2/3 and when you added it all up you got 5/3.	In minute 2:20 it seems that Alex has a good understanding of what pieces can make a whole and what is the relationship/proportion of those pieces to the whole. Alex also shows to know how to write the representation in a mathematical sentence and adds the fractions having as a guide the representation. In the other hand the girl that went up and tried to do another representation in minute 4:30 shows to have more difficult time when making a representation with smaller pieces like twelfths. This can show that to the students its easier to make a representation and add smaller denominator fractions like 1/3 than bigger ones like 1/12.
Scaffold 2--Remainders	The boy had a clear picture of how many tables were needed to fit the people in each table. He then kept insisting that there were 3 remainders. He also tried to ask his friend what	Shanna kept trying to make Anthony understand that the remainder was 1 and contradicted herself a couple of times. At times Shanna did explain correctly	The girl is using what she knows about multiplication [to] elaborate a different strategy to solve the problem. She considers 15 as 16-1 because she can easily figure out that 16:4=4, but she calls the extra person a reminder of 1. Her strategy is effective; it is the concept of reminder

Figure 8. PST response categories by the evidence of attending in the response.

	they had to do with the 3 remainders. They are basically looking for the number of people in each table, but they are supposed to see how many total tables they need not how many people in each table. They basically sort of misinterpreted the problem.	how there were 15 people that needed to be seated and kept saying that there is 1 remainder which she stated as being one person to be taken out and then as being one seat left. (8:20) Anthony and Shanna were more focused on finding which was the remainder that they went off a little from what the question was asking which was how many tables did Tina need if she were to use tables that seat four.	that is not clear. Both students find the same answer, which is four tables. For example, the boy finds is four tables by using the method of counting up since there are three people standing. However, the girl find the number of tables by using multiplication. She knows that 16 people fit on 4 tables, and she knows that she only needs 15 spots; therefore, she knows that 4 tables are needed. It shows that children have their own way of thinking depending on how advanced they are on their knowledge on math
Scaffold 2--Representations	I think that the boy is very smart when he puts it in terms of 100. I believe that it is easier to understand in terms of 100 because 100 is the whole when figuring out percents. The students are using their previous knowledge of halves in order to	So the students are given a task to show using the centiwheel how 1/20 is written as a decimal. At the time 00.59 the students yells "cinco, cinco, cinco" he knew the answer, but the other students continued on doing what they thought was the correct method. The other student ignores the	The boy was explaining to the other boy that if you looked at 1/20 as a decimal it would be 5. He pointed out the equation on the board (1/10) and said that if you replaced the 1 with a 2, you would have 2/10, which would give you 5. Even though that is technically not true, you would actually get 1/5, which as a percent would be 20%. But we are trying to represent 1/20 as a decimal and percent. I think the boy thinks that 1/20 is equal to 0.2 or 20% because he sees that 2/10 is 0.2,

Figure 8. (continued)

	solve the problem and explain. It helps that the numbers are easy to divide.	student who is clearly giving them the answer saying, "1/20 is 5". They continue to discuss why 1/20 as a decimal is 0.2 or 20 and the percent is 20% which is incorrect.	which is incorrect.

Figure 8. (continued)

Our first stage in the coding showed the PSTs were indeed attending to CMT but it was clear that not all PSTs were attending to the same degree and that some PSTs provided more evidence of their attending than others. Some PSTs were attending to CMT by providing a restatement of actions while others attended to and interpreted CMT. Thus, the second stage of coding attempted to clarify how robustly the PSTs were attending to CMT. We found that in certain videocases such as Fractions, the PSTs were able to provide robust evidence that they are attending to CMT more often than they provided limited or no evidence. Overall, our findings suggest that the theoretical shift in perspective described above can be supportive for PSTs. In other words, when PSTs are first asked to interpret without attending and then asked to attend on their own, they are able to identify and describe important moments for understanding CMT and are also able to interpret those moments.

Issues Emerging from Our Research

Throughout the evolution of our work on PST noticing, several issues have emerged that we argue are important for researchers to consider as the field continues to refine the construct of teacher noticing. We discuss each of these issues in the following sections, and suggest directions for researchers moving forward.

Interrelationship Between Attending and Interpreting

One issue emerging from our research relates to the difficulty in distinguishing attending from interpreting and identifying the role of evidence as either a support of interpretation or as evidence of attending. Many definitions of noticing (e.g., Jacobs et al., 2010; van Es & Sherin, 2008) have distinguished between these two

components of noticing, attending and interpreting, and research studies have measured attending and interpreting skills independently of each other. However, in our work, identifying parts of PST responses as one or the other has proved problematic, as these two components of noticing are closely related, meaning at what point does attending to CMT involve interpretation and at what point does interpretation of CMT result in further attending. Given research that suggests novices do not identify important events and that they struggle to provide evidence-based descriptions of events, we posit that PSTs' attending and interpreting are inextricably linked.

To further understand the interrelatedness of attending and interpreting, consider the following excerpt from a PST, "The students are using their previous knowledge of halves in order to solve the problem and explain. It helps that the numbers are easy to divide." We determined that there was an interpretation made by the PST without explicit attending. This PST neglected to include evidence to support the claim that children were using previous knowledge and it is unclear how this PST arrived at that interpretation. It is possible that the PST attended to the children's thinking about halves, but was not explicit in making such a statement.

In contrast, this example of a PST response includes evidence of both attending to and interpreting CMT:

> At this point, the students are trying to show 1/20 on their centiwheels. It seems like the student closest to the camera is having trouble interpreting what fractions would look like. In the video he tries to show 1/30 and 1/40 as well but instead of making those pieces smaller he makes them larger. From this, it seems as though this student doesn't understand that the larger the denominator in a fraction the smaller that piece is … When he sees 1/30 and 1/40 he assumes 1/40 is larger because he already knows 40 is larger than 30, but when they are put into the denominators of fractions the 1/40 becomes smaller than 1/30.

In this response, we determined the PST included an interpretation with evidence related to that which had been attended to, noting what the child did in the video (i.e., attending) and forming conclusions about what the child knew (i.e., interpreting).

Finally, PSTs are able to attend to important events without necessarily making interpretations about what they attended to. The following PST response serves as an example: "In this part of the video, the students took the example from the board to make the fraction (1/20) into a decimal. The example on the board was a fraction that was out of 100, so when he got the decimal 0.2, his answer was wrong." In this response, the PST described what occurred, but did not make interpretations about what the children knew or did not know. Thus, PSTs expressions of attending and interpreting are complex, with some responses including evidence of attending to children's thinking and others void of any evidence of attending to CMT.

As researchers, the interrelatedness of attending and interpreting presented a unique challenge as we examined PSTs' development of these component skills of noticing. Initially, we were interested in determining whether or not PSTs were interpreting and then whether or not they were interpreting and supporting their claims with evidence. We were careful to note whether or not the evidence provided was directly linked to the interpretations. Some PSTs made interpretations and

included descriptions of what students said or did, but the two components were not related. Thus, we concluded that they attended to CMT, but did not interpret that thinking on which they had explicitly attended. This process became problematic as we considered the extent to which their evidence of attending was lacking or robust. Recall that we parsed this into three categories: no evidence of attending, limited evidence of attending, and robust evidence of attending, similar to Jacobs et al. (2010); however, this became difficult in the instances when interpretations occurred without any evidence of attending to children's thinking or in cases when the PSTs were evaluative instead of objective. We situate this within our aforementioned definition of noticing as attending and interpreting to make sense of how PSTs were noticing, but argue that existing frameworks, and our modified frameworks for analysis may not fully capture all intricacies of noticing. Specifically, the van Es (2011) framework for learning to notice situates attending and interpreting on a continuum, which was not fully supported with our data (i.e., instances when interpreting occurred without explicit evidence of attending). This raises further questions about the chronology of components of noticing and the order in which attending and interpreting occur for PSTs, and how we analyze noticing as a research field.

From our research, we have concluded that Jacobs et al.'s (2010) definition of the components of noticing as interrelated skills may suggest difficulty for researchers attempting to disaggregate these two components of noticing to determine order of occurrence when analyzing PSTs' noticing of children's thinking. In other words, evidence from PSTs that include attending or interpreting do not necessarily suggest chronological order, rather it is possible that interpretations occur before attending in some cases and in others, attending likely occurs before interpretations are made. However, we argue that if PSTs are provided with scaffolds that support their attending and provide for a clear focus on CMT, they can in fact begin to interpret children's thinking. They do not need to explicitly attend to CMT in order to interpret, as evidenced by the examples presented. The interpretation can take place prior to any attending with the proper supports. Following this, PSTs can learn to support their interpretations with evidence through attending to children's thinking and later attend and interpret on their own. Thus, being able to interpret classroom events is an important first step in being able to later attend to and interpret CMT.

Complexity of Video Representations

Another issue emerging from our research is that not all video is created equal, which has considerable implications for scaffolding PSTs' noticing. Indeed, there are a variety of types of video that are used in teacher education, including commercially produced videos, videos of teachers' own classrooms, and videos of other teachers' classrooms. When used in teacher education, these different types of videos are often edited for different purposes and foci, thus highlighting certain aspects of teaching and learning in the captured events while masking others.

Incorporating video clips that are more or less complex in terms of the nature of the teaching and learning events is particularly important for novices, such as PSTs, who often struggle to pay attention to children's thinking in video (Jacobs et al., 2010), and tend to focus on aspects of pedagogy or classroom management rather than CMT (Star & Strickland, 2008).

We have started to examine the nature of the captured events in the VPEM videocases. Drawn from a large database of elementary classroom footage, our videocases were initially developed and edited to focus explicitly on classroom events where CMT was the focus of the scene. Yet, our prior research indicated that, despite various revisions to the video clips, accompanying focus questions, and viewing scaffolds built into the video clips, PSTs still struggled to attend to children's thinking in robust ways (Castro Superfine et al., 2015). These results pointed us to consider the nature of the teaching and learning events captured in the video clips used in the project. Video is a type of representation of complex teaching and learning practices, which highlights the salient teaching and learning events and at the same time fails to capture other events related to the represented events (Hatch & Grossman, 2009). We define this simultaneous highlighting and masking as the *complexity* of the video clips.

We developed a framework for analyzing the complexity of the salient teaching and learning events captured in video clips. While other researchers have proposed frameworks for understanding the nature of the captured teaching and learning events (e.g., Sherin & Es van, 2009), such frameworks are used to characterize video clips that focus on both teaching and learning events. The VPEM video clips were edited to focus explicitly on CMT. In addition, such frameworks do not account for the presence of nonmathematical or non-pedagogical aspects of captured events, what we define as *noise*. Considering the noisiness of a video clip is particularly important for novices, such as PSTs, as they often do not know what features warrant attention. For these reasons, we needed a framework that was applicable to a particular type of video clip (i.e., of other teacher's teaching), that made salient a particular foci of video clips (i.e., CMT), and that accounted for the *noisiness* of video clips (i.e., presence of nonimportant events).

While our research on the complexity of video representations is only in its initial stages, our findings thus far suggest that the videocases in scaffold level 2 are more complex with respect to the mathematical thinking displayed by children in the clip (i.e., several strategies are being discussed, children's thinking is not transparent) and are less noisy (i.e., the presence of nonmathematical and non-pedagogical events is minimal). Thus, it may not be surprising that PSTs attended to substantive aspects of CMT in scaffold level 2 because there were not many other events in the video clips to which to attend. Perhaps more importantly, our initial findings suggest that scaffolding PST noticing of children's thinking may be more effective when the nature of the video representations used do not include many distracting events (e.g., teacher discussion) or are less noisy. As research on PST noticing continues to evolve, researchers should consider the nature of the video representations used in their work, and the relationship between what PSTs are attending to and how they are interpreting the captured events.

Concluding Thoughts

Though the use of video in teacher preparation appears to have multiple advantages, as a field we must work to understand this rather complex tool for effectively supporting teacher learning. As we have discussed in this chapter, PSTs may not be able to effectively notice CMT in video unless appropriate supports are implemented, such as the type of scaffolding we implemented in the VPEM online platform or effective instructor facilitation. How best to design the scaffolding will likely depend on the complexity of the video, as we are only just starting to explore, as well as careful consideration of how to order PSTs' introduction to the components of professional noticing.

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