SUPPORTING NOTICING OF STUDENTS' MATHMATICAL THINKING THROUGH 360 VIDEO AND PROMPT SCAFFOLDING

Julie M. Amador | Tracy Weston | Karl Kosko

University of Idaho | Middlebury College | Kent State University

360 video records a complete, spherical view of a scenario and allows the viewer to manipulate what is viewable in each frame. We incorporated 360 video into a teaching mathematics course and used prompts that directed prospective teachers' attention to students' mathematical thinking. Results indicated that prospective teacher noticing was more specific when they responded to prompts about students' thinking as compared to more general prompts. With focused prompts, prospective teachers had increased attention to students' mathematical thinking and were more likely to make interpretations about students' mathematical thinking. The findings show promise for the combination of 360 video and student-focused prompts to support prospective teacher noticing.

INTRODUCTION

During the last twenty years, the research on teacher noticing has spanned contexts and continents as mathematics education researchers and teacher educators have focused efforts on how teachers attend to and interpret students' thinking (Dindyal et al., 2021). Drawing from Mason (2011) and van Es and Sherin (2002), noticing refers to the process of sensitizing oneself to act intentionally in situations, without habit, with the purpose of making sense of how students reason. Teachers who sufficiently notice are more likely to implement teaching practices considerate of students' thinking, a process Jacobs and Spangler (2017) consider a core teaching practice. Dindyal and colleagues (2021) recently outlined the current state of teacher noticing, with a focus on how noticing is conceptualized, studied, and with emphasis on the contexts within which studies of teacher noticing are situated. They conclude that using records of teaching to support the development of noticing is common practice in many teacher education contexts (e.g., Jacobs et al., 2010; Schack et al., 2013; van Es et al., 2017). Despite the focus on noticing, and identification of ways noticing is supported, learning to notice is challenging for prospective teachers (e.g., Ivars et al., 2018; Llinares & Valls, 2010; Roth McDuffie et al., 2014). And consequently, researchers and teacher educators have focused on means to support prospective teacher noticing (Schack et al., 2013).

Given the challenges to support prospective teachers to notice, many teacher educators have implemented instructional practices in teacher education courses to support the development of noticing (Amador et al., 2021). Video is one common tool used in teacher education courses to show a representation of practice and support noticing (Gaudin and Chaliès 2015; Santagata et al., 2021). In a recent review of international

2022. In C. Fernández, S. Llinares, A. Gutiérrez, & N. Planas (Eds.). *Proceedings of the 45th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 11-18). PME.

studies, Santagata et al. (2021) found that many researchers call for an increased use of technologies to support noticing. Consequently, knowing that ‘learning to notice’ is often challenging (van Es, 2011), we designed modules in teacher education courses that would capitalize on recent video technology and aim to scaffold prospective teacher noticing.

In our teacher education courses, we incorporated a recent technological advance in video, that of *360 Video*, which records a complete, spherical view of a scenario, and allows the viewer to manipulate what is viewable in each frame by “dragging” the screen or moving their head when wearing an appropriate headset (Amador et al., 2021; Roche & Gal-Petitfaux, 2017). Researchers have found that the prompts that are used to elicit noticing and promote learning to notice matter for prospective teacher development (Estapa & Amador 2021; Stockero et al. 2017; Weston & Amador, 2021). Therefore, we paired the 360 video clips of mathematics lessons with prompts containing an intentional focus on students’ thinking to support the development of noticing. Santagata et al. (2021) wrote, “the nature of the prompts matters and is consequential for teacher learning (p. 128).” Given that noticing is a core practice, yet difficult to learn, and knowing that video is a tool to support noticing and that the prompts given matter, we designed and implemented a multi-part learning process for prospective teachers as part of mathematics pedagogy. We were interested to know whether or not providing the 360 video support and purposeful prompts resulted in more advanced prospective teacher noticing (van Es, 2011). We answered the research question: *What* and *how* do prospective teachers notice when supported with 360 video and prompts that direct attention to students’ mathematical thinking?

THEORETICAL FRAMING

Noticing is central to the work of teaching (Mason, 2011) and encompasses attending to, interpreting, and making decisions about how to respond, based on students’ thinking (Jacobs et al., 2010). Attending means an ability to pay attention to how students’ think and reason about particulars of mathematics content. Interpreting refers to one’s ability to make sense of what has been attended to and then to draw conclusions about the meaning of the foci in ways that make sense of students’ thinking. Therefore, we consider noticing as a skillset, but as also a way to conceptualize higher order thinking of teachers that is important for effective mathematics teaching. Specific to mathematics, prospective teachers need to learn to notice students’ mathematical thinking and mathematics teacher educators need to purposefully select tasks in their pedagogy courses to support this learning (Roth McDuffie et al., 2014). Increased attention on teacher noticing has resulted in attempts to improve prospective noticing utilizing a variety of platforms within methods courses. Researchers have found that viewing videos can improve prospective teacher noticing (Jacobs et al., 2010). However, the content of video matters for learning to notice (Superfine & Bragelman, 2018).

RELATED LITERATURE

Video is a useful tool to support teacher learning because it allows users to slow down the process of teaching, and closely examine aspects of teaching and learning that may be missed during live observation (Santagata et al., 2021). However, what is viewable in traditional video is often dictated by the person managing the camera, leaving other aspects of the classroom and student learning offscreen. Teacher educators are beginning to use “360 video,” wherein a prospective teacher viewing a 360 video may adjust the perspective to focus on a small group of students to the left, view the students to the right, etc. Prospective teachers who view 360 videos report a greater sense of immersion (Roche & Gal-Petitfaux, 2017), and attend to more specific aspects of mathematics pedagogy (Kosko et al., 2021). Kosko et al. (2021) recently found that prospective teachers who watched 360 video attended to more student actions than peers who watched traditional video. Weston and Amador (2021) demonstrated that the use of 360 video plus prompts can elicit and support professional noticing. However, research on 360 video viewing and noticing is only beginning to emerge, and researchers call for increased studies on how noticing may be supported with the use of 360 video. Given that novice teachers attend to less specific aspects when viewing videos of teaching than more experienced educators (Stockero et al., 2017), and are in the process of learning to notice (van Es, 2011), the use of 360 video in teacher education holds significant promise.

Video is a valuable tool in teacher education; however, how teacher educators use video also affects the learning opportunities for prospective teachers. Estapa and Amador (2021) conducted a qualitative meta-synthesis of the prompts that teacher educators use when eliciting noticing and found that the level of specificity of prompts can influence response to prompts. They noticed that when teacher educators use specific prompts along with video, noticing can be developed. Likewise, Sherin and Russ (2014) note that prompts moderate the learning opportunities that accompany videos. In a close example of prompts, Roth McDuffie et al. (2014) found that the prompts used alongside video supported an increased depth of noticing and prospective teachers were able to attend to students’ thinking and make interpretations based on their thinking, aspects indicative of more advanced noticing. Weston and Amador (2021) demonstrated that the combined use of 360 video and prompts revealed growth in or presence of advanced prospective teacher noticing. Therefore, we were interested in understanding the outcome of the intersection of 360 video and purposeful specific prompts—both of which researchers have identified as supporting noticing (Kosko et al., 2021; Roth McDuffie et al., 2014; Weston & Amador, 2021).

Method

Data were collected from students (n = 173) enrolled in one of two university undergraduate mathematics pedagogy courses (one course had multiple sections). Two of the authors taught one of the courses within an education program at their U.S.-based institution, where prospective teachers worked towards initial licensure to teach. All data were collected during the 2019-2020 academic year (August 2019 through May 2020). One course took place in both Fall 2019 and Spring 2020 (with multiple sections each semester) and focused on PreK through grade 3 (ages 3 to 9). The second course took place in Spring 2020 and had a K-6 (ages 5 to 12) focus.

All prospective teachers were first-time users of 360 video and were provided with the same tutorial for how to watch 360 video, which was a one-and-a-half-minute 360 video the three authors made. The data-collection task, which was about multiplication, took place before the prospective teachers read or learned about that topic. Participants were asked to watch a seven-minute 360 video of a grade 3 (ages 8-9 years) class. In the video, students used Cuisenaire rods to explore the commutative property of multiplication.

Although prospective teachers all watched the same video, by virtue of the 360 feature they were able to observe students at more than one location in the classroom by pivoting their field of view from the camera placement. This meant multiple third-grade students' actions were observable throughout the recorded classroom episode, and likewise many student verbal comments were audible while students worked to complete the task. After watching the 360 video, prospective teachers were asked two questions about the device they used to watch the 360 video. They were next asked two questions about their noticing: Prompt 1: "What did you notice about teaching and learning?" and Prompt 2: "Describe an important student action or statement in the video. Why was that important?" In both cases, prospective teachers responded in writing, using a blank text box with no length limit. The remainder of the questions and prompts in the assignment were about their use of 360 video and are not the focus of this report. Responses were collected using either Google Forms or Qualtrics (depending on the course), with identical wording used in both platforms.

Analysis & Results

We conducted a convergent mixed-methods analysis in which qualitative analysis was conducted to examine prospective teachers' written noticings and then themes were quantitized for statistical analysis (Creswell & Plano Clark, 2018). To begin, the first two authors used van Es (2011) framework for learning to notice student mathematical thinking to independently code a subset of data for both noticing prompts about what and how prospective teachers noticed. The two researchers then met to reconcile codes and further discuss code application, before independently coding the entire data set. The following are examples from the data based on the framework. (see van Es, 2011 for framework)

Code	Example
	What was Noticed
Level 1 Baseline	The classroom setup encouraged collaboration and the teacher was physically moving around the class to observe how the students were

	working with the rods for the math problem.
Level 2 Mixed	I noticed that the teacher was asking thoughtful questions and expanding upon the ideas of the children…I also noticed that many of the children who didn't originally understand the concept were able to get it after using the manipulatives and being able to see it visually.
Level 3 Focused	… Children showed their mathematical thinking with manipulatives (colored rods)…One child used eight rods of seven (black rods). Another child used seven rods of eight (brown rods). The children were encouraged to put the rod on top of each other to see if they fit…They were asked how does it fit? Then they were asked why they fit? This encouraged the children to think about multiplication, and explain their thinking.
Level 4 Focused	No example
How PTs Noticed	
Level 1 Baseline	Teaching was very interactive, the teacher left many things up to the students. They were able to figure things out for themselves by testing their ideas with the rods and with each other.
Level 2 Mixed	An important statement in the video was when the student made the connection between the rods and the numbers. He connected how changing the position of the rods made them the same size and the numbers 8 and 7, which the rods represented, can change position and they are still the same.
Level 3 Focused	One thing that interested me that a student said was towards the end of the video when the teacher was talking about the different rods. One child said, "the numbers are the same, but one is on the other side so you just have to flip it to the other side." This was when he noticed that the numbers are the same in each problem…
Level 4 Focused	I noticed that some students were taking the rods out of their rectangular groups and trying to create a different set up of groups. [The teacher] then had to facilitate and give them more specific directions. Then they were able to see that the rods of each group would exactly fit. This is important because it shows the different thinking processes going on. Some of the students were on the right track, others were taking a different approach and trying to rearrange them. When students struggle it is okay, but if it becomes an unproductive struggle it is important for a teacher to recognize this and step in…

Table 1: Examples of coding

Table 1 shows excerpts from different prospective teachers for Prompts 1 and 2. Many prospective teachers had higher levels of noticing when answering Prompt 2 as compared to Prompt 1; their level of noticing for what they noticed were also sometimes connected with their level of noticing for how they noticed. The following is one example, coded at a Level 1 for both what and how they noticed:

> I took interest in the ending of the video when [the teacher] was letting students share their ideas and thoughts on the question. [The teacher] would ask them to further their thinking and this showed great benefits. I think it is vital to allow ample time for students to work with manipulatives like this.

This was coded as Level 1 for what was noticed because, despite being asked about an important student action or statement, the prospective teacher focused on the teacher and the whole class of students, describing them as a general group. This response was also coded as Level 1 for how the prospective teacher noticed, because there was a general description without any specific instances.

Following qualitative analysis, codings were quantitized as ordinal variables to determine whether the prospective teachers' level of noticing differed between type of prompt (see Table 2). We used a Wilcoxon Signed Ranks test to examine the difference in level of what prospective teachers attended to when provided each prompt. The Wilcoxon Signed Ranks test is a nonparametric statistic used to calculate the magnitude of differences between two paired ordinal variables (Siegel & Castellan, 1988). Results indicated a statistically significant difference ($W = 9.100$, $p < .001$) with prospective teachers demonstrating higher ranks, on average, on the second prompt than the first. Table 2 illustrates the difference in distribution. Notably, when prospective teachers were asked to describe what they noticed "about teaching and learning," responses were overwhelmingly general. When the prompt instead asked for "an important student action or statement," the level of specificity in their noticing increased dramatically.

	Level 1	Level 2	Level 3	Level 4
Prompt #1	91.3% *n* = 158	7.5% *n* = 13	0.0% *n* = 0	1.2% *n* = 2
Prompt #2	52.3% *n* = 90	32.6% *n* = 56	2.9% *n* = 5	12.2% *n* = 21

Table 2: Distribution of what PTs' level of responses by prompt.

Following the comparison with the Wilcoxon Signed Ranks test, we sought to understand how the degree of specificity for what prospective teachers attended to corresponded to how they interpreted what they noticed. We focused our analysis only on the second prompt, as the first prompt was heavily skewed to a Level 1 noticing (91.3%). The Gamma statistic was ideal for this comparison since it "is appropriate for measuring the relation between two ordinally scaled variables" (Siegel & Castellan, 1988, p. 291). Results indicated a statistically significant relationship between what and how prospective teachers attended to mathematics pedagogy in the 360 video (γ =

.499, $p < .001$). Thus, the ordinal relationship between the prospective teachers' descriptions of what and how they attended were 49.9% more likely to agree than to disagree, meaning there was a positive association between what and how they noticed.

Discussion

Findings indicate that when prospective teachers used 360 video and then responded to prompts to elicit their noticing, levels of noticing were higher for both *what* and *how* they noticed when the prompt was specific to students' thinking. Data indicate that from watching the 360 video, prospective teachers were able to focus on students' mathematical thinking. Although we do not make claims that the 360 video (as compared to standard video) is the reason for the higher levels of noticing, we note that using a combination of 360 video and prompts focused on students' mathematical thinking resulted in advanced levels of noticing from prospective teachers, which is uncommon for novice educators.

References

Amador, J., Bragelman, J., & Castro Superfine, A. (2021). Prospective teachers' noticing: A literature review of methodological approaches to support and analyze noticing. *Teaching and Teacher Education*, *99*(4).

Dindyal, J., Schack, E. O., Choy, B. H., & Sherin, M. G. (2021). Exploring the terrains of mathematics teacher noticing. *ZDM - Mathematics Education*, *53*, 1–16.

Estapa, A., & Amador, J. (2021). A qualitative metasynthesis of video-based prompts and noticing in mathematics education. *Mathematics Education Research Journal*.

Gaudin, C., & Chaliès, S. (2015). Video viewing in teacher education and professional development: A literature review. *Educational Research Review*, *16*, 41–67.

Ivars, P., Fernández, C., Linares, S., & Choy, B. H. (2018). Enhancing noticing: Using a hypothetical learning trajectory to improve pre-service primary teachers' professional discourse. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(11).

Jacobs, V. R., Lamb, L. L. C., Phillip, R. A. (2010). Professional Noticing of Children's Mathematical Thinking. *Journal for Research in Mathematics Education*, *41*(2), 169–202.

Jacobs, V. R. & Spangler, D. A. (2017). Core practices in K-12 mathematics teaching. In J. Cai (Ed). *Compendium of research in mathematics education* (pp. 766-792). Reston, VA: National Council of Teachers of Mathematics.

Kosko, K. W., Ferdig, R. E., & Zolfaghari, M. (2021). Preservice teachers' professional noticing when viewing standard and 360 video. *Journal of Teacher Education*, *72*(3), 284-297.

Llinares, S., & Valls, J. (2010). Prospective primary mathematics teachers' learning from on-line discussions in a virtual video-based environment. *Journal of Mathematics Teacher Education*, *13*(2), 177–196.

Mason, J. (2011). Noticing: Roots and Branches. In Sherin, M. G., Jacobs, V. R., & Philipp, R. A. (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 35-50). Routledge.

Roche, L. & Gal-Petitfaux, N. (2017, March 5). (2016). *Using 360° video in physical education teacher education* [Conference session]. Society for Information Technology & Teacher Education International Conference, Austin, TX, United States.

Roth McDuffie, A., Foote, M. Q., Bolson, C., Turner, E. E., Aguirre, J. M., Bartell, T. G., Drake, C., & Land, T. (2014). Using video analysis to support prospective K-8 teachers' noticing of students' multiple mathematical knowledge bases. *Journal of Mathematics Teacher Education*, *17*, 245-270.

Santagata, R., König, J., Scheiner, T., Nguyen, H., Adlef, A.-K., Yang, X., & Kaiser, G. (2021). Mathematics teacher learning to notice: a systematic review of studies of video-based programs. *ZDM – Mathematics Education*, *53*, 119–134.

Schack, E. O., Fisher, M. H., Thomas, J. N., Eisenhardt, S., Tassell, J., & Yoder, M. (2013). Prospective elementary school teachers' professional noticing of children's early numeracy. *Journal of Mathematics Teacher Education, 16,* 379-397.

Sherin, M.G., & Russ, R. (2014). Teacher noticing via video: The role of interpretive frames. In B. Calandra & P. Rich (Eds.), *Digital video for teacher education: Research and practice* (pp. 3-20). Routledge.

Stockero, S. L., Rupnow, R. L., & Pascoe, A. E. (2017). Learning to notice important student mathematical thinking in complex classroom interactions. *Teaching and Teacher Education*, *63*, 384-395.

Superfine, A., & Bragelman, J. (2018). Analyzing the impact of video representation complexity on preservice teacher noticing of children's thinking. *Eurasia journal of Mathematics, Science and Technology Education, 14*(11), em1650.

van Es, E.A. (2011). A framework for learning to notice student thinking. In Sherin, M. G., Jacobs, V. R, & Philipp, R. A., (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 134-151). Routledge.

van Es, E. A., & Sherin, M. G. (2002). Learning to notice: Scaffolding new teachers' interpretations of classroom interactions. *Journal of Technology and Teacher Education*, *10*(4), 571-597.

Weston, T. L. & Amador, J. M. (2021). Investigating student teachers' noticing using 360 video of their own teaching. *Journal of Technology and Teacher Education*, *29*(3), 311-340.