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ORIGINAL ARTICLE

A qualitative metasynthesis of video-based prompts and noticing in mathematics education

Anne Estapa[1] · **Julie M. Amador**[2]

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Abstract

We conducted a qualitative metasynthesis of research focused on prompts used to elicit noticing following video observations within mathematics education. Forty-nine, peer-reviewed articles were selected based on specific criteria and analyzed using a defined approach to better understand the variations in the prompts mathematics teacher educators used as they supported teacher noticing. We also focused on research findings from articles with different types of prompts. Forty-five percent of articles included a general prompt and 55% a specific prompt. Findings based on articles in which authors used specific prompts reported the following: (a) video is a helpful tool to support the learning of noticing, (b) noticing is a skill that can be developed, (c) noticing ability differs between novice and expert teachers. Findings from articles with general prompts indicate the following: (a) teachers experienced a shift in noticing, (b) how teachers' noticed changed, (c) video selection is critical for influencing teacher noticing.

Keywords Mathematics education · Metasynthesis · Noticing · Prompts · Video

Video use within mathematics education research continues to increase. Video affords opportunity for classroom observation and subsequent discussion around both pedagogy and student learning. Through the analysis of responses to video, researchers can focus on the ways in which teachers think rather than on the ways in which teachers behave (Sherin, 2007; Star et al., 2011). Sherin (2007) reviewed the landscape of video to gain understanding for the variety of uses and subsequently outlined major uses of video to include micro-teaching, interaction analysis, modeling expert teaching, video-based cases, hypermedia program, and field recordings of prospective or practicing teachers' own practice. Video provides a means

✉ Anne Estapa
anne-estapa@uiowa.edu

[1] Department of Teaching and Learning, University of Iowa, N291 Lindquist Center, Iowa City, Iowa 52240, USA

[2] University of Idaho, 1031 N. Academic Way, Coeur d'Alene, ID 83814, USA

to support teacher learning as it preserves the real-time aspect of classroom teaching (Brophy, 2004) within a medium that can be paused, re-watched, analyzed, and discussed. Baecher et al., (2018) reviewed video analysis for teacher development across disciplines and reported the frequent use of video in mathematics education. Researchers have claimed video use can improve teaching practice, affording teachers and students increased opportunities to learn (Seago, 2004). However, the role of video and how one uses video makes a difference in teachers' ability to focus on particular aspects of teaching. Baecher et al., (2018) express that "without understanding how video analysis is being conducted, it makes the work impossible to replicate" (p. 186). Ultimately, video does not produce learning (e.g., Ball, 1992), but the use of video can promote specific learning goals (Seago, 2004, p. 263).

Recent research in mathematics education has pointed to the importance of teaching prospective teachers to notice (Jacobs et al., 2010; van Es, 2011; van Es & Sherin, 2008). In other words, teaching prospective teachers to notice is a specific learning goal for teacher education programs across the globe (e.g., Kaiser et al., 2015; Llinares, & Valls, 2010). Within mathematics teacher education, noticing has been defined commonly in alignment with van Es and Sherin's, (2008) three interrelated constructs: (a) identifying what is important in a teaching situation, (b) using what one knows about the context to reason about a situation, (c) making connections between specific events and broader principles of teaching and learning. Similarly, but with a focus specific to children's mathematical thinking, Jacobs et al., (2010) defined professional noticing as attending, interpreting, and deciding how to respond to students' thinking. Many research studies have built from these seminal works to better illuminate the affordances related to teachers' noticing; video has been a common tool to teach noticing.

We consider noticing to encompass the key ideas of van Es and Sherin (2008), along with Jacobs et al., (2010) collectively, recognizing that the noticing refers to attending to students' thinking, making interpretations on the basis of students' thinking, and then making connections and decisions to respond on the basis of what was noticed. Baecher et al., (2018) report that "the Learning to Notice framework and professional vision were mentioned in relation to almost every [video] study from the mathematics education field" (p. 199). Researchers studying noticing have shown evidence for effective noticing practice (i.e., attending to student thinking, interpreting, and making decisions in response to noticing) resulting in changes in teacher attention (Sherin & van Es, 2005) and changes in teacher practice (Estapa et al., 2016). However, these studies have raised questions about how researchers elicit and work to develop noticing. Erickson (2011) states simply encouraging prospective teachers to pay attention to details of practice is not sufficient to improve practice, yet results of many studies indicate noticing can be developed with the use of video (Star & Strickland, 2008). So, what is happening in the *process* of using video to support teacher noticing that may be influencing the outcomes? Baecher et al., (2018) focus on the importance to understand promising practices with the use of video with the movement towards "practice-based, clinically-rich teacher education" (p. 186). With this importance in mind, we aimed to better understand the minutia of video-based research within mathematics education to determine practices specific to how noticing is elicited. Specifically, we answered the following research

questions: (1) What prompts are used to elicit noticing within video research in mathematics education? And (2) What outcomes are reported in studies that use prompts as a methodological process to elicit noticing? We consider a prompt to be an ask, elicitation, or signal for an action or response, similar to a question.

Related literature

Video has been used to support teacher learning, such as developing effective teaching practices (Estapa et al., 2017), supporting reasoning about the complexities of teaching (Star et al., 2011), and encouraging the analysis of student mathematical thinking (Carpenter et al., 1989; Jacobs et al., 2010; Krupa et al., 2017; van Es, 2011). Used in this way, video has become a tool to enhance or develop learning. For example, Estapa et al., (2016) used video as tool to enhance novice teacher noticing of the mathematical thinking of English language learners within the elementary classroom. Further, van Es and Sherin, (2008) used video within a video club structure to analyze teacher discourse and noticing of student mathematical thinking. Results of studies focused on the use of video to support learning indicate that changes occurred in both what the teachers discussed and how the topics were addressed (Borko et al., 2008), but little focus has been placed on the methodological processes for using video to engender noticing. Further, teachers who participated specifically in *video club* discussions aimed at developing noticing shifted from a primary focus on the teachers' decisions and actions to increased attention on students and their mathematical ideas, further suggesting the power of video for teacher learning (van Es & Sherin, 2008; Wallin & Amador, 2018). Stemming from the increased use of video, researchers have studied facilitation moves (van Es et al., 2014) and focused on how video is implemented, but a close analysis of how noticing is elicited related to video has yet to be studied. Sherin and van Es (2009) claim that the ability to *notice* is a key feature of teaching expertise and researchers should focus on how to support the development of *this* ability—we are interested in how the process of video use occurs, meaning the specifics of how video and noticing are linked through teacher educators' processes and delivery.

Video and noticing

van Es and Sherin, (2002) highlight that teacher change is encouraged when teachers' pay attention to what is important, make theory to practice connections, and use what they know about their own teaching context to reason about a given situation. Video-based reflection within learning experiences has the power to influence such change and support teacher learning at varying phases of their teaching. However, video must be used with a clear purpose and a focused attention on specific instructional components (Borko et al., 2008). Grossman et al., (2009) suggest a need to select video clips strategically, being mindful of what is shown and what is hidden and setting norms regarding how practice is discussed. Despite its proven impact, video alone is insufficient to help teachers learn about their practice or learn to notice. Specific to

prospective teachers, Schworm and Renkl (2007) note that scaffolds, such as prompts that direct the learners' attention when viewing the video, help to decrease overload for prospective teachers. These findings support researchers who have found expert and novice teachers differ in what they notice in video without instructional support (Berliner, 1986; Sabers et al., 1991). Similarly, van Es and Sherin (2008) and van Es et al., (2014) outline specific facilitator moves and questions that can support teacher viewing of video, such as asking about particular student ideas from the video. Although such scaffolds or prompts can support teacher viewing of the video, how noticing is elicited after the viewing is also important.

These studies indicate that viewing video to support noticing is not a trivial task and the specific process or mechanisms teacher educators employ as they use video influence outcomes. For example, Roth McDuffie et al., (2014) found that the prompts used within an activity (after video viewing) supported prospective teachers by increasing their depth of noticing and their foci in noticing, moving from attending primarily to teacher moves (and merely describing what they saw) to becoming aware of significant interactions (and interpreting effects of these interactions on learning). As such, a prompt moderates what one might learn from a video representation (Sherin & Russ, 2014). However, despite the widespread enthusiasm for incorporating video into learning experiences for teachers, there has been relatively little research on the scaffolding used to support noticing from video use, or more specifically, research on the prompts used within video research to elicit teacher noticing. Therefore, we sought to understand what prompts were used following video representations to elicit noticing within a mathematical context. We also wanted to explore how the prompts used relate to the research findings among studies.

Method

A qualitative research synthesis approach was conducted to uncover patterns and commonalities with respect to prompt inclusion in professional development opportunities, mathematics methods or content courses, or other teacher support interactions in an effort to deepen understanding of evidence-based practices (Yore & Lerman, 2008). This qualitative approach builds from the work of Thunder and Berry, (2016) who describe the process of qualitative metasynthesis as related to mathematics education and call for such studies as a way to move the field beyond "knowledge generation" to "knowledge application" (p. 335). We consider this methodological approach a viable method for illuminating the elicitation of noticing and practice of prompt use.

Methodological rationale

More specifically defined, a qualitative metasynthesis is "an analysis and interpretation of the findings from selected studies" (p. 319). We purposely implemented a qualitative metasynthesis for three main reasons, in accordance with Erwin et al., (2011). First, the process of deeper analysis of previously conducted qualitative

research results in a more collective understanding and greater contribution of a given topic within the field. In this case, this deeper analysis results in an increased understanding about the practices of mathematics teacher educators with respect to supporting noticing—a methodological area that has not been widely studied. Second, this method expands more traditional research methodologies in a way that provides information on how knowledge can be generated and applied. In this case, understanding the prompts that mathematics teacher educators use and the resulting research findings provides the mathematics education field with an increased understanding of application of processes used to elicit noticing. Third, this process permits recognition of "gaps and omissions in a given body of research" (Thunder & Berry, 2016, p. 320). In this case, the process illuminates the extent to which exact prompts are used or not used and the extent to which mathematics teacher educators are scaffolding or guiding noticing (Erwin et al., 2011). Of the variations of metasynthesis, the present study is a metastudy and a cross-case analysis in which the topic is a priori, detached, includes a more exhaustive literature search, has a formal appraisal criterion, and follows a somewhat linear procedure (Finlayson & Dixon, 2008).

Qualitative metasynthesis approach

To initiate the metasynthesis approach, we first identified the central phenomenon to be studied as a means for arriving at a specific research metaquestion and followed an iterative process of research question determination (Thunder & Berry, 2016). The focal intent of the study was to understand the variations in the prompts mathematics teacher educators used as they supported teacher noticing to identify the extent to which prompts were open-ended or funneled noticing. Second, we were interested in the resulting findings from different types of prompts. In following an iterative process to determine the exact research question, we first considered the content (what) of teacher educators in eliciting noticing (van Es, 2011). However, after initial exploration of prompts within research articles, we recognized that many published articles did not have one specific prompt, but rather described the questions or types of questions asked and how they asked was not readily apparent. As a result, we modified our initial question idea to result in the research question employed in the study. This process adhered to the first step of the qualitative metasynthesis approach.

The next process in the metasynthesis approach included conducting a comprehensive search for studies to include in the results for the overall study, in which we recorded each decision point made to create an audit trail and to specific directions for future replication (Thunder & Berry, 2016). Before searching for articles, the authors created inclusion criteria that would direct decision-making about which articles would be included or not included in the final results. Decisions were based on (a) topical parameters, (b) population parameters, (c) temporal parameters, and (d) methodological parameters, again in accordance with recommendations of Thunder and Berry (2016). Table 1 outlines the search criteria based on these parameters.

For the article to be included for consideration, all descriptors in the "Exact search terms/criteria" column must have been satisfied, otherwise, the article or study was disregarded.

Following the creation of the aforementioned decision rules, to initiate the literature search process, the two authors intentionally and collectively devised a plan that would diminish tension about the role of the authors in any bias in the literature search and would elevate a reflexive or detached role of the authors at this point in the process (Finlayson & Dixon, 2008). To do this, each of the two authors identified a researcher who was not an author on this manuscript or any other manuscript on noticing, but who had knowledge of literature in the area of professional noticing. These two researchers, one at each of the respective institutions of the authors, became the literature review searchers, as to minimize any unnecessary decisions about inclusion or exclusion of certain articles and bias. This step was intentionally followed because the authors of this manuscript knew they themselves may have self-authored manuscripts that would arise as meeting the search criteria and wanted to mitigate any thoughts of coercion about inclusion or exclusion.

The two researchers searching for the articles (again not the authors) each worked independently, using multiple indices to conduct their comprehensive searches (Thunder & Berry, 2016). The searches for both researchers initially began with ERIC and JSTOR as the database. Search terms used included: "Mathematics," "Noticing," "Video," "Teacher." The Table of Contents from prominent journals within mathematics education, technology, and teacher education were also reviewed. For this review, every article title and abstract were read and considered against inclusion criteria. Following this, the reference lists from two prominent books on teacher noticing were reviewed for articles that adhered to the criteria (Schack et al., 2017; Sherin et al., 2011). We limited the search to journal articles appearing since 2002, as this allowed us to focus on research conducted after initial landmark studies related to noticing (i.e., van Es & Sherin, 2002). This process for date inclusion criteria is similar to methods of other researchers in mathematics education (i.e., Turner & Drake, 2016). We outline the criteria used for article searches in Table 2 below.

The search result lists from both researchers were combined, at which point, the two authors reviewed each of the articles suggested to ensure compliance with the criteria outlined in Table 1. This process follows the suggestion of Thunder and Berry III, to validate the article selections. Within this process, the authors of this manuscript independently reviewed each suggested article and then met to reconcile differences in agreement about whether or not specific articles should be included. At this point, they decided that three of the referenced studies would be excluded on the basis that they were not empirical in nature. Forty-nine articles were considered, in total, for the metasynthesis. Appendix includes all articles ($n = 49$) that were considered in the metasynthesis, which constitute the entire data set.

Table 1 Literature criteria parameters

Parameter category	General description	Exact search terms/criteria
Topical parameters	Topic must be on noticing based on video in a mathematics setting	-Word "noticing" or "notice" must be present in the title or abstract -Participants in the study must be viewing video at some point in the study -Mathematics must be a specific content area focus of the work; the work could include other content areas as well
Population parameters	Analysis of teacher education (inservice/practicing or preservice/prospective) focused on grades K-12	-Population being worked with must be inservice/practicing or preservice/prospective teachers -The focus of the practicing or prospective teachers must be on grades K-12
Temporal parameters	Study had to be conducted between 2002 and 2017	-Publication date of 2002 or later
Methodological parameters	Study must be an empirical study in peer reviewed journal article; dissertations or conference proceedings were not included	-Empirical study in a journal; could be qualitative or mixed-methods*

*We recognize that the consideration of slightly different methodological designs may fall outside the realm of traditional qualitative metasynthesis; however, the major aspects of the methods for the articles fully studied were similar given that all used video as a tool to elicit teacher noticing based on a mathematics classroom episode. This similarity resulted in the inclusion of studies that were methodologically comparable on a broad scale

Table 2 Article inclusion search

Database	Search terms/contents considered	Articles reviewed
ERIC	Mathematics, noticing, video, teacher	All articles that were peer reviewed, 2002–2017
JSTOR	Mathematics, noticing, video, teacher	All articles that were peer reviewed, 2002–2017
Journal for Research in Mathematics Teacher Education	All titles and abstracts read	All articles 2002–2017
Journal of Mathematics Teacher Education	All titles and abstracts read	All articles 2002–2017
Mathematical Thinking and Learning	All titles and abstracts read	All articles 2002–2017
Journal of Technology and Teacher Education	All titles and abstracts read	All articles 2002–2017
Sherin, M., Jacobs, V., & Philipp, R. (2011). *Mathematics teacher noticing: Seeing through teachers' eyes*. New York: Routledge	Reviewed table of contents and reviewed references for each chapter	All contents of reference list
Schack, E., Fisher, M., & Wilhelm, J. (Eds.). (2017). *Teacher noticing: Bridging and Broadening perspectives, contexts, and frameworks*. New York: Springer	Reviewed all chapters in the book	Reviewed all chapters in the book

Data analysis

To analyze the articles, both authors initially took a small subset of the articles ($n=5$) and read the method section to determine whether or not, or how, participants in the study were prompted for noticing. The authors found that some prompts were clearly stated and others were ambiguous. Further, in some articles in the subsample, there was no specific prompting related to video. As a result, the authors decided they would initially sort articles based on whether or not participants were specifically prompted for noticing related to video. After this, decisions were made about the clarity of prompts in an effort to differentiate between the various approaches described in the articles. The authors devised an initial framework for categorizing the articles, applied the framework to a different set of five articles and found that some details were still not fully clear enough to distinguish some approaches from others. As a result, the authors continued to refine a framework for data analysis. After analyzing another subset of five articles, the authors arrived at a final flow chart for initial coding of the articles (Fig. 1).

We defined a prompt as the mathematics teacher educator asking for an action. To be categorized as a code A, code B, or code C, the prompt had to be in response to watching a video. To be categorized as a code D, code, E, or code F, participants were either not prompted or there was no connection to video or noticing. If a given article

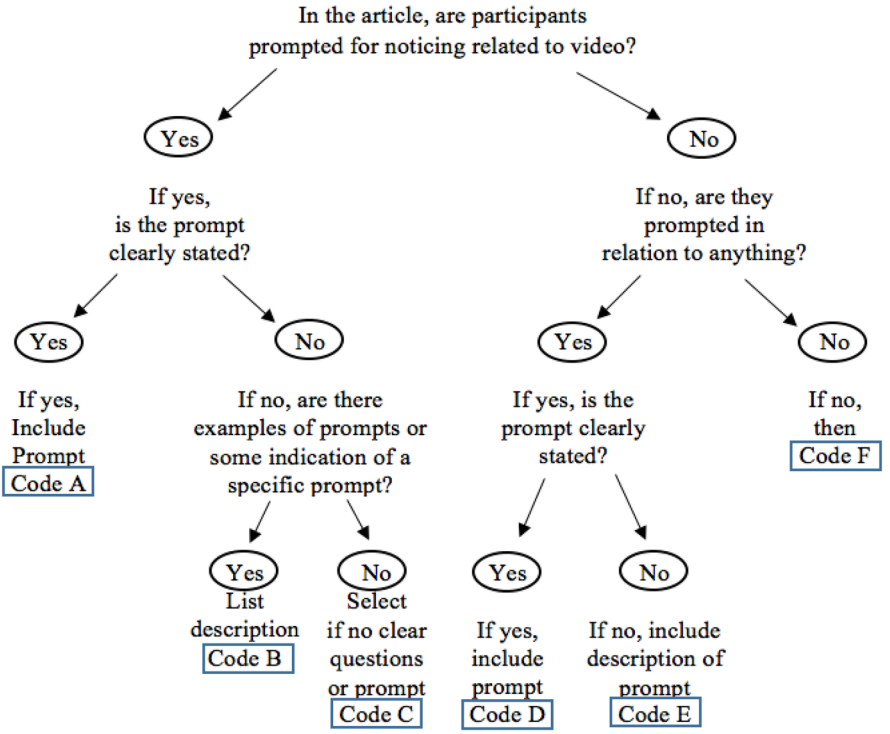

Fig. 1 Data analysis flow chart for categorizing noticing related to video

had more than one prompt, the prompt with the greatest level of specificity was coded and the article was given that code. Further, in some instances, only a summary of the prompts was provided in the article (although specific prompts may have been utilized in the study) but since the specific prompts were not provided in the article, those articles were coded as general. This process of coding for the most specific, or highest level attainable, is followed in other research (e.g., Jacobs et al., 2010).

After arriving at the aforementioned method for categorizing noticing related to video, the authors each independently coded ten of the forty-nine articles. Following this, they met to reconcile any differences and talk through their codes. Of the ten, the authors agreed on codes for nine. They discussed and reconciled the code for the one article to which they disagreed on categorization. At that point, the authors determined the process was reliable and the flow chart was appropriate for the given task. The authors then each independently coded the remaining 39 articles and met to reconcile differences. There were three additional differences in codes between the two authors, resulting in agreement on 36 of 39 total studies or on 92.3% of the studies. The authors discussed their disagreements and arrived at a consensus code for all manuscripts.

Once all prompts had been coded according to Fig. 1, an additional analysis process was conducted to further examine the prompts to determine whether or not they were prompting something *general* or something *specific* (de Araujo et al., 2015). A prompt was considered general if there was a "focus on general teaching strategies, pedagogy, content of a lesson, context of a problem" or a "focus on general actions, aspects, ideas, topics, lesson structure or contextual features (e.g. physical environment, home environment, dispositions, behavior, etc.)" (de Araujo, et al., 2015, p. 31). A prompt was considered specific if there was a "focus on a connection between the teacher and another person(s) or aspect (e.g., pedagogical strategies, interactions with others, or students' thinking)" or a "focus on a connection between a student and another person(s) or aspect (e.g. his/her mathematical thinking, his/her interactions with others, or specific teaching strategies)" (de Araujo, et al., 2015, p. 31). Following the determination of whether or not the prompts that were code A or code B were specific or general, all findings of studies in this subset ($n=33$), either code A or code B, were analyzed to determine the subsequent noticing/learning that resulted. As an example of the coding, Osmanoglu et al., (2015) stated in the methods of the study that the participants were asked to answer the question "What did you see/notice in the video and what aspects did you think stood out?" (p. 34). Given that the participants of the study were asked a specific prompt this study was coded A (Fig. 1). In another study, Carter and Amador (2015), the researchers did not clearly state the prompt, but stated that participants were prompted about their observations by reporting that, "discussion of observed students' actions and words, as well as revisions to the lesson and implications for the proceeding lesson occurred during the lesson study analysis meeting in order to connect classroom occurrences to broader theories of teaching and learning and to use the context to reason about the situation" (p. 1346). We coded this article as code E (Fig. 1) as the researchers used a prompt within the study, but the prompt was specific to participants' observation and not directly following a video representation.

To analyze the findings for these studies, coded as general or specific ($n=33$), the researchers created a spreadsheet and reread each article in entirety. In the process, they noted the following: (a) the prompt, (b) whether the research was qualitative or mixed methods, (c) research question(s), (d) participant numbers and whether practicing or prospective, (e) how video was used in the study, (f) camera perspective, (g) how noticing was elicited, (h) study findings. Once each of these criteria were determined for each study, the researchers analyzed for themes or similarities in both the methodological processes and the results, being cognizant of differences in the studies as evidenced by the other categories considered (i.e., participant numbers). Themes from the findings were open coded (Corbin & Strauss, 2008), and codes were compared to arrive at noticing results within the article set that had specific prompts and within the article set that had general prompts.

Findings

We coded and analyzed prompts used within video-based research to elicit mathematical noticing in response to a video. Our initial review of the articles ($n=49$) resulted in 38 of the 49 (77.5%) including or describing the use of a prompt to elicit mathematical noticing (code A, code B, and code C). Within these studies, researchers noted whether the authors of the study stated the exact prompts used within the study, made mention that prompts were used within the study, or did not include or allude to the use of prompts following a video representation. Through this coding effort, we were able to determine which of the studies employed a prompt following a video representation of teaching and provided the prompt asked of participants to allow us to further analyze such prompts. We outline these results in Table 3 below.

Level of specificity

In an effort to determine not only if prompts were used (answer research question one), but also what kind of prompts was asked, we determined the level of specificity of the prompts. Within this analysis, we found that authors of 33 (67%) (code A or code B) of the 49 total articles included a prompt when eliciting teacher noticing after reviewing video. Of this subset of 33 articles, 54.5% ($n=18$) used a specific prompt and 45.5% ($n=15$) used a general prompt (see Table 3 for specific articles). Of the 18 studies coded as using a specific prompt 9 focused on prospective teacher participants, 4 in-service teachers, 4 both prospective teachers and in-service teachers, and 1 teacher educators were the participants. Of the 15 studies coded as using a general prompt, 12 focused on prospective teachers and 3 engaged with in-service teacher participants. Castro Superfine et al., (2015) asked prospective teachers the following prompts as part of a video activity: "(1) What do you notice about children's mathematical thinking in the video? (2) identify the different strategies used by children in the video, and (3) How are children's strategies different?" (p. 147). The provided prompt (code A) was coded as specific given that the questions asked to participants connected teacher noticing to specific aspects (children's mathematical thinking and

Table 3 Analysis of articles for the use of prompts

Code A ($n=17$)	Code B ($n=16$)	Code C ($n=5$)	Code D ($n=5$)	Code E ($n=3$)	Code F ($n=3$)
Amador, (2017)	**Averill et al.,** (2015)	Barnes and Solomon, (2013)	Amador, (2016)	Carter and Amador, (2015)	Amador et al., (2016)
Castro Superfine et al., (2015)	**Castro Superfine et al.,** (2017)	Choppin, (2011)	Amador and Weiland, (2015)	Lobato et al., (2013)	Gotwals et al., (2015)
de Araujo et al., (2015).	**Chao et al.,** (2016)	Kaiser et al., (2015)	Dreher and Kuntze, (2015)	Stockero and van Zoest, (2013)	Sun and van Es, (2015)
Ding and Domínguez, (2016)	Estapa and Amador, (2016)	Scherer and Steinbring, (2007)	Fernandes, (2012)		
Estapa et al., (2017)	Estapa et al., (2016)	Vondrová and Žalská, (2015)	Teuscher et al., (2017)		
Huang and Li, (2012)	**Llinares and Valls,** (2010)				
Jacobs et al., (2010)	**Males,** (2017)				
Mitchell and Marin, (2015)	**Sherin and van Es,** (2009)				
Osmanoglu et al., (2015)	**Star and Strickland,** (2008)				
Roller (2016)	*Star et al.,* (2011)				
Roth McDuffie et al., (2014)	*Taylan* (2017)				
Schack et al., (2013)	**van Es and Sherin,** (2008)				
Schäfer and Seidel, (2015)	*van Es and Sherin,* (2002)				
Sherin and Dyer, (2017)					
Sherin and van Es, (2005)	*Vondrová and Žalská,* (2012)				
van Es et al., (2017)	**Wager,** (2014)				
van Es and Sherin, (2006)	**Walkoe,** (2015)				

Bolded articles coded specific prompt(s) ($n=18$). Italicized articles coded general prompt(s) ($n=15$)

children's math strategies). In contrast, Mitchell and Marin (2015) asked participants "What did you notice?" (p. 561) (code A) after watching a video representation. The researchers repeated this question until the participant had reported everything they noticed in the video. We coded this prompt as general as it did not connect or focus participant noticing to any given aspect of teaching or learning. We report the results for the number of studies that employed general or specific prompts across the categories of code A and code B in Table 4 below.

Focus of prompts

After determining which of the prompts were general or specific, we wanted to further analyze the prompts as they were provided in the studies. In a review of the general prompts ($n=15$), a majority were descriptive in nature with researchers asking participants *what was noticed* or *what did you notice that was pivotal to learning or teaching*. For example, in van Es and Sherin (2006) after watching a video clip, teachers were asked "What do you notice?" After the teachers responded to this question, the researchers asked repeatedly, "Is there anything else you noticed?" Over half (53%) of the general prompts were similar to this in an effort to elicit what the participant was noticing upon viewing the video representation shown to them. The other general prompts (47%) asked participants to write about or make a list of "pivotal" or "noteworthy" moments in the video.

The final analysis of the prompts was to code all of the specific prompts across code A and code B ($n=18$) to determine what aspects they scaffolded participants to focus on or connections they made. Table 5 includes these findings. For each category of who and what, the results are reported for each code A and B followed by a combined percentage to allow analysis within and across codes. Some prompts were specific to more than one aspect (i.e., what do you notice about student thinking and teacher questioning?) and resulted in more than one code for the prompt. For studies that included more than one prompt, we coded for contents of all prompts mentioned in the study. Categories in Table 5 were not mutually exclusive.

When specific prompts were used, the focus of prompts was often on the student or students in over half of the articles (65%). For example, van Es and Sherin (2008) described prompts used in their study that focused on the student. Specifically, they report that, "in each meeting, the facilitator's goal was to help teachers learn to notice and interpret students' mathematical thinking. Thus, the facilitator prompted the teachers to examine students' ideas about the mathematics, to use evidence to support claims they made about students" (p. 248). In other articles, the prompts

Table 4 General or specific prompts

	General prompts	Specific prompts
Code A ($n=17$)	9	8
Code B ($n=16$)	6	10

Table 5 The focus of specific prompts, $n = 18$

		Code A	Code B	Total
Who	Teacher	5	2	35%
	Student	7	6	65%
What	Teacher actions	5	3	32%
	Teacher knowledge	1		4%
	Student knowledge/understanding	1		4%
	Student math thinking/strategies	5	4	36%
	Math	2	1	12%
	Participation		1	4%
	Lesson	1		4%
	Classroom environment		1	4%

provided focused the participant noticing to the student and teacher. For example, Schack et al., (2013) asked the following prompts: "Please describe in detail what you think this child did in response to this problem, please explain what you learned about this child's understanding of mathematics, and pretend that you are the teacher of this child—what problems or questions might you pose next" (p. 385). Through such prompts, the participant noticing is first focused on the student and his or her thinking. However, the last prompts then focus back on the teaching and moves of the teacher to support student learning. Thirty-six percent of the articles included prompts that employed a focus on students' mathematical thinking and/or strategies. And, slightly less (32%) of the articles included prompts focused on teacher actions within the video representation (i.e., what is the teacher/presenter doing and why do you think he/she is doing this?). In three articles, the specific prompt used focused on the mathematics within the video representation. For example, van Es et al., (2014) described a prompt used within the study that asked participants to describe and evaluate mathematics within the video, asking them, "What interesting mathematical moments stood out to you?" (p. 347).

After gaining a better understanding of the prompts used for code A and B, both general and specific prompts, we then synthesized the findings from these studies to determine the noticing or learning that resulted from use of the prompts. We analyzed the 33 articles constituting the subset, based on general ($n = 15$) or specific ($n = 18$) prompts to understand themes within the results these studies produced. The resulting themes from our analysis of the findings from articles with prompts coded as general or specific are outlined in the section below.

Findings from general and specific prompts

Beyond analysis of the prompts, we were interested in the overall findings of the research studies that were the focus of our analysis. The following reports the response to research question two. In a true metasynthesis, findings are considered collectively when the methodological processes are seemingly parallel. In our work, the details of methods followed in the studies varied slightly; however, the overarching process of using video followed by a prompt was similar for within the subset of

articles analyzed. As a result, we find value in reporting the findings on these works, as we believe the mathematics education field would benefit from a greater understanding of the relationship between prompts and outcomes related to prospective teacher noticing.

Because the methodological processes used in the studies were not completely similar, we report findings based only on research with prompts coded as code A or code B, meaning the prompt was in response to video. We believe that the analysis and discussion of the findings from these works provides the most insight, as compared to including the other articles. Additionally, results from these studies can more similarly be compared because the authors were explicit enough about their methods and how they elicited noticing in the way they described their prompts or listed them verbatim.

We report the findings based on whether or not the prompts were general or specific in nature in the following section. In an effort to maintain the integrity of the various research studies, the findings can only be reduced to a certain point without losing the intent of the authors and the true essence of the research. As a result, we report findings based on the themes identified in the data analysis process and do not necessarily address every single study.

Specific prompts

Of the 18 articles coded as code A or code B and specific, 15 had a somewhat similar process for collecting data—there was some process in which participants watched video of teaching and then responded in *writing* about what was noticed. However, the populations studied varied significantly. Some studies focused on prospective teachers, some on practicing teachers, some compared novice versus expert teachers, and others included a focus on mathematics teacher educators. Additionally, of the 18 studies, 11 focused on assessing and developing noticing, 4 assessed noticing at a given time, and 3 focused on developing noticing without a clear focus on assessment. Despite these differences, there were three main themes that were evident: (a) video is a helpful tool to support the learning of noticing, (b) noticing is a skill that can be developed, (c) noticing ability differs between novice and expert teachers.

Video to support learning to notice

Among the studies, Sherin and van Es (2005, 2009) and Schack et al., (2013) highlight the value of video for supporting teachers' ability to notice, as measured from teacher responses to their prompts. Sherin and van Es (2005) used specific prompts to focus teachers' attention to student thinking, the role of the teacher, and classroom discourse. With their work, they found changes in what teachers noticed and how teachers noticed; the specificity of their prompts afforded opportunities for them to use analytic tools that would provide insight about the noticing. In their work with video, Schack et al., (2013) provided prospective teachers three specific prompts, "(1) Please describe in detail what you think this child did in response to

this problem, (2) Please explain what you learned about this child's understanding of mathematics, and (3) Pretend that you are the teacher of this child. What problems or questions might you pose next? Provide a rationale for your answer" (p. 385–386). Using these prompts provided opportunity for these researchers to conclude that video supports learning to notice. In fact, they found that professional noticing capacities are attainable for prospective teachers and pedagogies of practice, such that video representations of practice (Grossman et al., 2009) are a viable avenue to develop professional noticing. Again, the specific prompts afforded opportunities for the researchers to understand whether or not video played a role in the development of noticing about a provided concept or idea.

Noticing developed

As the researchers of the studies under consideration implemented their data collection processes, many included specific prompts at the beginning of their study and again at the end—in essence, prompts were used to elicit data for a pre-post measure. These researchers (e.g., Star & Strickland, 2008) gained enough information from using specific prompts to conclude that noticing can be developed. For example, van Es and Sherin (2008) note, "the teachers who participated in the video club meetings began to talk about classroom interactions in new ways over time" (p. 261–262). Similarly, Walkoe (2015) found that participating in a video club helped teachers more consistently to attend to substantive student algebraic thinking and to reason about this thinking they noticed in deeper ways. Again, this researcher used specific prompts as an instrument to come to these conclusions. In implementing these prompts, Star and Strickland (2008) refer to this process as an assessment, meaning they were deliberate in using prompts as a pre and post assessment. Their findings indicated that prospective teachers showed significant improvements in their ability to notice classroom events as a result of the course in which they participated—the prompts allowed for comparable measures of noticing.

Novice versus expert noticing

Finally, the use of specific prompts afforded opportunities for researchers to compare noticing across various populations—most commonly, novice and experts. Huang and Li (2012) and Jacobs et al., (2010) both identified marked differences when analyzing the noticing practices of novices and experts. Huang and Li (2012) found significant differences in noticing between expert and novice teachers, noting the sampled expert teachers were most likely to be aware of developing students' mathematics thinking and ability while in the process of helping students develop mathematics knowledge. Using specific prompts also provided Jacobs et al., (2010) with information on novice versus expert educator noticing. They found professional noticing is challenging for novice educators, but expertise can be learned and is supported by both teaching experience and professional development. These researchers were able to analyze results to come to these conclusions from specific prompts including, "Please describe in detail what you think each child did in response to

this problem" (attending) (p. 178). "Please explain what you learned about these children's understandings" (interpreting) (p. 179). "Pretend that you are the teacher of these children. What problem or problems might you post next?" (deciding to respond) (p. 179). They then used an analytic process to code the responses to the prompts to come to their conclusions.

Specific prompts conclusion

Ultimately, researchers who used specific prompts were able to make claims about teacher noticing. Most notably, data analysis results from researchers of these studies suggest that specific prompts afforded opportunities for measurement that unveiled the possibility of video for supporting noticing. Additionally, similar data indicate that noticing can be developed and noticing abilities differ between novices and experts. This is not to suggest that using specific prompts resulted in developed noticing or affected noticing or that specific prompts must be used to make claims about teacher noticing. Rather, we report that these prompts supported researchers in coming to conclusions in their own research about the noticing abilities of participants.

General prompts

Of the 15 articles coded as code A or code B and *general*, all had a somewhat similar process for collecting data—there was some process in which participants watched a video, either of their own teaching or someone else's, and were then asked to record what was noticed within the video. However, when and how they recorded their noticing varied across the studies. Participants either watched the video and then: were asked, "What did you notice" at the end of the video (e.g., Estapa et al., 2016), or marked/coded their noticing while watching or teaching the lesson (e.g., Estapa & Amador, 2016), or were interviewed following the lesson or viewing of the video (e.g., Taylan, 2017). Despite differences in when noticing was elicited, there were three main themes that were evident: (a) teachers experienced a shift in noticing, (b) how teachers noticed changed, (c) video selection is critical for influencing teacher noticing.

Shift in teacher noticing

Studies that used a general prompt often reported a shift in teacher noticing. This shift was in some cases on who teachers noticed or what teachers noticed. For example, Estapa et al., (2017), reported that teacher noticing shifted from student focused to teacher focused depending on the medium used to illustrate the noticing (written versus animation). Further, Osmanoglu et al., (2015) reported that "The prospective teachers started to see new points of view and gained new perspectives on effective teaching as they participated in video case-based discussions and interacted with each other" (p. 42). In some studies, the findings reported that teachers focused more on student thinking, others became more focused on teacher actions or moves

within the classroom, but when researchers used a general prompt to elicit noticing, shifts in who and what were noticed were reported. It appears these types of prompts provided researchers an opportunity to identify shifts in the focus of noticing.

Change in how teachers noticed

Within the noticing research, who, what, and how teachers notice have been researched and reported (e.g., Estapa et al., 2017). Researchers of many studies that utilized general prompts reported a change in how teachers noticed or the analytic stance of the noticing. For example, Mitchell and Marin (2015) found that teachers adopted a more interpretive stance to their noticing with a greater focus on salient features of mathematical instruction. Similarly, Estapa et al. (2016), analyzed teacher noticing across a 2-year time frame and found that teachers shifted from descriptive noticing (recalling of events) to evaluative and interpretive stances of noticing across the study. Also, van Es and Sherin (2002) found that participants no longer described their practice over time; rather, they organized and connected noteworthy events to principles of teaching and learning. A use of a general prompt provided opportunity for researchers to compare how teachers were noticing; researchers found that the use of these prompts unveiled data suggesting changes in how teachers noticed. This therefore allowed for an opportunity for teachers to not only recall what was noticed, but process and build connections from such noticing.

Importance of video selection

Across the research studies with general prompts, the process in which noticing was elicited centered on the use of a video clip(s) from classroom teaching. In some instances, the video was collected from the participant classroom or generated from previous endeavors such as TIMSS or Annenberg video series. Regardless of how the video was captured, the clip was intentionally selected for teachers to view. Schäfer and Seidel (2015) stated that the video chosen "contained specific information on goal clarity and learning climate" (p. 42), to provide a focus on two general teaching principles. In other studies, the video selected showcased a typical classroom structure, or focused on a certain mathematical concept (Estapa et al., 2017). Across all the studies including general prompts, most of the authors described how video selection was intentional and critical to support teacher noticing. This is not to imply that every researcher who used general prompts was intentional with a specific purpose in their video selection, but in the studies analyzed, there was a focus on deliberate video choice.

General prompts conclusion

The researchers who elicited noticing using a general prompt were able to articulate the noticing of those with whom they worked. In doing this, the researchers were allowed an opportunity to understand teacher noticing as articulated from watching the video. The findings suggest that teachers shifted noticing or changed their stance

of noticing during the research studies providing them with a way to notice the complexity of teaching or an aspect of it. The general prompts afforded opportunity for open-ended responses that gave way to responses that were then analyzed for shifts.

Discussion

Prompts were employed in either a general or specific fashion when used as a methodological process within a research study to elicit noticing. Each type of prompt resulted in varying findings, yet both had a direct impact on conclusions drawn specific to noticing. These conclusions become critical differences as teachers are asked to enact responsive practice to which noticing is necessary to actualize (Richards & Roberston, 2015; van Es & Sherin, 2021). We do not claim that one type of prompt is superior to the other. Instead, we highlight that the conclusions drawn from research are different based on the prompts used. In other words, researchers should be cognizant of the intended noticing outcomes and conclusions they will or will not be able to draw based on their prompt selection.

Prompt use expands what we know about noticing

Noticing within mathematics education has become a prevalent construct to better understand teacher learning. Analysis of noticing practices affords opportunity to research what a teacher attends to, interpretations the teacher makes, and decisions the teacher generates (Jacobs et al., 2010). Our metasythensis expands what is known about noticing by providing insight for the video-based noticing that result when a general or specific prompt is used. Extant research has demonstrated that noticing can be developed, enhanced, and assessed (e.g., Star & Strickland, 2008; van Es et al., 2017). But how noticing is elicited through various types of prompts provides different starting points for the research.

The characteristics of various prompts to elicit video-based noticing afford researchers different opportunities for increased knowledge around the benefits and challenges of using video. Video allows a moment to be reimagined, out of the classroom, therefore, illuminating teacher decision-making in response to the video. Using a specific prompt following video directs the attention to a specific aspect within a video, and therefore, the resulting noticing is commonly about that specific aspect. Likewise, using a general prompt, one can see what is noticed more broadly, which unveils who, what, and how a teacher is conceptualizing aspects of the video without being directed. In these instances, the teacher's focus can be on a specific topic, agent, or mathematical idea within the video; however, this idea was not predetermined with a specific prompt. In essence, our findings may be apparent—if the prompt is specific, the noticing is likely more specific, and if the prompt is general, the noticing often focuses on different aspects. We highlight the synergy between the video being shown, the prompt(s) being asked, and the resulting learning outcome for teachers. We stress the importance of intentionality with making decisions and argue that those implementing professional support should not take lightly their

considerations and decisions about the prompts used. Teacher educators or those using video to support noticing should be intentional about the prompts they use and have an intended purpose and outcome for using certain prompts. This intentionality will provide a more nuanced way of understanding noticing and ways to develop, enhance, or elicit the professional practice.

Implications and future considerations

Within mathematics education, researchers and teacher educators continue to work to improve the noticing of prospective and practicing teachers. Researchers have indicated such learning experiences can enhance noticing. However, if professional noticing is considered to be a precursor for responsive teaching (Richards & Roberston, 2015) and a process that allows one to *see* or *not see* aspects of classroom teaching, should our methods used to analyze such learning be more transparent and intentional? As reported in our findings, the most prevalent specific prompts focused on students and their mathematical thinking. Using a specific prompt does not mean that noticing will develop; rather, the prompts seemed to provide researchers with a way to measure noticing, so they could come to conclusions about the levels of noticing, development of noticing, or variations in noticing of differing populations. Although these focus areas align to what is needed and known from the field, should they be the most prevalent? van Es and Sherin, (2002) expressed that when teachers are prompted to begin their analysis of a video excerpt by responding to the question, "What do you notice?" they are allowed to begin their analysis with what they find significant, rather than being prompted as to what is noteworthy. On the other hand, Yang and Ricks, (2012) highlight the use of a framework for teachers to examine key events and provide a useful frame for teachers to focus on aspects associated with both content and students' thinking, emphasizing a more directed viewpoint for scaffolding noticing. Research focused on connecting these ideas specific to teacher learning and classroom enactment will better our purposes for methods of eliciting noticing. Specifically, are we asking enough of teachers after they view a video representation to elicit noticing or are we scaffolding noticing too much by the use of specific prompts? Future research could support similar questions to better clarify the relationship between prompts and teacher educators' intended outcomes.

We suggest that there are affordances and constraints for using each type of prompt (general and specific) within the teacher education context and perhaps more appropriate or necessary times to scaffold learning with the use of prompts. Sherin and Russ, (2014) state that

> Research has purposefully included scaffolds, in the form of facilitators and peers who build on one another's noticing to support the noticing of student thinking. In that sense, one can understand these environments as zones of proximal development (ZPD) for eliciting and studying teacher noticing. It is just as important that we understand what teachers notice without such scaffolds or prompts as this is more realistic to the classroom environment.

Star and Strickland, (2008) report an improvement in teachers' ability to notice more instructional events; however, neither study tested whether it would be better to provide participants a focus for noticing. Goldsmith and Seago, (2011) determined that the use of classroom artifacts, such as students' work, encouraged teachers to notice specific mathematics in students' reasoning. They stated that the use of an artifact, as a scaffold, directed teachers to focus on specific aspects and justify their claims. However, as Choy, (2014) expressed, even when teachers are given a focus—such as students' strategies—to notice, it is still challenging for them to sieve out critical incidents amongst the "buzz" in the classroom, and to reflect productively about them. Therefore, being able to "highlight noteworthy events" (van Es, 2011, p. 139) and make connections between these events is an indication of noticing expertise (Yang & Ricks, 2012). As a result, we, as a mathematics education field, need to consider and question when prompts and what prompts are used and how they may support learning. Are teacher educators cognizant and intentional about the prompting they use when incorporating video into the classroom? We need to better understand what is noticed with general, open prompts and then perhaps work to support teacher learning with more scaffolded and specific prompts—working within each teacher's zone of proximal development for noticing (Sherin & Russ, 2014).

Conclusion

We encourage those designing learning experiences for teachers to be purposeful in deciding the questions they will ask teachers in response to video, as the generality or specificity of the prompt will likely influence the responses generated. Based on the findings, we consider specific prompts to be a method to scaffold teacher noticing and support a focus on a certain aspect of video. In contrast, we see open prompts as a way to gather an understanding more broadly about teacher noticing. We consider this article as a starting point to generate conversation about the outcomes of noticing related to the prompts and contend that subsequent research should highlight the relationship between the type of prompt used and the resulting development of noticing and impact on teacher decisions and practices that enhance student mathematical learning.

Appendix

All articles included in the analysis ($n = 49$)

Amador, J. (2016). Professional noticing practices of novice mathematics teacher educators. *International Journal of Science and Mathematics Education, 14*, 217–241.

Amador, J. M. (2017). Preservice teachers' video simulations and subsequent noticing: a practice-based method to prepare mathematics teachers. *Research in Mathematics Education, 19*(3), 217–235.

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Declarations

Ethical approval We confirm that we followed the ethical principles for doing research.

Conflict of interest The authors declare no competing interests.

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