DESIGNING OPPORTUNITIES TO SUPPORT PRE-SERVICE TEACHERS IN NOTICING AND UNDERSTANDING HOW TO POSITION STUDENTS COMPETENTLY: A CRITICAL OVERVIEW OF SUPPORTING LITERATURE

HAILEY ALEECE IACONO, McGill University

ABSTRACT. Learning to notice interactions that can lead to opportunities to position students as competent learners is a crucial aspect of current educational reforms and can impact students' ability to learn and affect their dispositions towards mathematics (Ball, 1993; Boaler & Selling, 2017; Kazemi & Hintz, 2014; Lampert, 2003). Primary school mathematics classes built on reform models are proven to support student achievement and cultivate more positive associations with mathematics (Boaler, 1998; Boaler & Greeno, 2000; Boaler & Selling, 2017; Cribbs & Linder, 2013). However, in teacher education programs, pre-service teachers often have limited opportunities to focus on specific theories linked to authentic examples of practice (Grossman & McDonald, 2008; Grossman et al., 2009). This article critically reviews selected pieces from two bodies of literature that suggest guiding principles for designing environments to help pre-service teachers learn to notice how to position students competently. The guiding principles identified in the review establish a need for more research on teacher noticing of interactions relating to positioning students competently.

RÉSUMÉ. Apprendre à remarquer des interactions qui peuvent mener à des opportunités pour positionner les élèves en tant qu'apprenants compétents est un aspect critique des pédagogies actuelles, pouvant avoir un impact sur leur capacité à apprendre et affecter leur disposition envers les mathématiques (Ball, 1993; Boaler et Selling, 2017; Kazemi et Hintz, 2014; Lampert, 2003). Les cours de mathématiques au primaire basés sur des modèles cohérents avec les réformes actuelles ont démontré qu'ils appuient la réussite des élèves et cultivent plus d'associations positives avec les mathématiques (Boaler, 1998; Boaler et Greeno, 2000; Boaler et Selling, 2017; Cribbs et Linder, 2013). Toutefois, au fil de leur formation, les enseignants n'ont souvent qu'un nombre limité d'occasions de se concentrer sur des théories spécifiques liées à des exemples de pratiques authentiques (Grossman et McDonald, 2008; Grossman et al., 2009). Cet article propose une recension critique des écrits choisis parmi deux corpus de littérature qui mettent en avant des principes pour concevoir des environnements qui aident les enseignants en formation à apprendre à observer comment positionner des élèves en tant qu'apprenants compétents. Les principes identifiés dans cette recension mettent en évidence l'importance de poursuivre la recherche sur l'enseignant observant les interactions liées au positionnement des élèves de façon compétente.

Keywords: Teacher noticing, positioning students competently, pre-service teacher learning, mathematics education, video representations.

INTRODUCTION

In North America, current educational reforms advocate for learning environments that are student centered, where students actively participate in authoring their learning (National Council

of Teachers of Mathematics, 2000, 2014; Québec Ministère de L'Éducation, 2001; van Es, Cashen, Barnhart, & Auger, 2017). New models for teaching put forth by reform initiatives encourage teachers to use various teacher moves, orchestrate whole class discussions, position students competently, and foster deeper understandings by exploring alternative solutions (van Es et al., 2017). This is an important consideration, especially for mathematics teachers, since it is easy to fall back on traditional methods, such as relying on textbooks and teaching to the exam (Lampert & Ball, 1990). Currently, two main types of mathematics classrooms persist (Boaler, 1998; Boaler & Selling, 2017). First, there are those where teachers create an engaging environment that invites students to discuss mathematics, by using an array of methods to solve mathematical tasks. In this context, teachers value students' ideas and collaborate with them to co-construct knowledge (Ball, 1993; Boaler & Selling, 2017; van Es et al., 2017). This form of teaching positions students as competent learners in the sense that students are taught to value all contributions and work alongside one another and the teacher to reach consensus (Kazemi & Hintz, 2014; van Es et al., 2017).

Alternatively, there are classes where students are seated individually. They are taught from the textbook and discussions often take place to correct solved problems using a standard method (Boaler, 1998; Boaler & Selling, 2017). In this environment, it is difficult to position students as competent learners due to limited opportunities. Further, in this context, teachers often focus discussions on right answers (e.g., also known as IRE – initiation response evaluation), which can discredit and sideline alternative ideas that are important in supporting deep understandings of mathematical concepts (O'Connor & Michaels, 1993; O'Connor & Michaels, 1996). Students generally perform better and relate more positively with mathematics in classes that use the former approach compared to the latter (Boaler, 1998; Boaler & Selling, 2017). Boaler and Selling (2017) conducted an investigation on how students are positioned in either of the class models. They found that students who experience traditional teaching viewed mathematics as irrelevant to their life experiences. In contrast, students in classes based on reform models, not only went on to identify more positively with mathematics, but also had greater successes "in their work and lives" (p. 98).

Positioning students competently is a teacher practice that is important for supporting students in reform classes (Kazemi & Hintz, 2014). Positioning students as competent learners requires that teachers respect students' contributions and acknowledge their competence in acquiring and transmitting knowledge (Franke, Kazemi, & Battey, 2007). A teacher might have a strong foundation in mathematics, but some students may not come to appreciate and enjoy mathematics or believe in their own competence if they are not positioned competently. This can negatively impact their disposition towards, and achievement in mathematics (Kazemi & Hintz, 2014). Accordingly, positioning students competently is a key for success as it can support diverse learners' achievements in mathematics. However, this reform-based practice is relatively new. Often, pre-service teachers have deep-rooted notions of teaching built on the traditional education they received during their own primary and secondary school (Lampert & Ball, 1990; van Es et al., 2017).

Considering that pre-service teachers' understanding is grounded in traditional models of mathematics education, it is crucial for them to develop noticing skills early on. Noticing how teachers position students competently, as well as noticing interactions that serve as opportunities to do so is a crucial first step in understanding the practice itself. Noticing generally refers to a teacher zooming in on specific aspects of a learning environment to make sense of those moments (Sherin, Jacobs, & Philipp, 2011). Goleman (1985) stated that, "[t]he range of what we think and do is limited by what we fail to notice" (p. 24). If pre-service teachers do not develop their ability to notice interactions that can be mobilized to position students competently, this can negatively impact students' dispositions. Noticing entails that pre-service teachers can "attend to noteworthy features of instruction, to reason about what is observed in meaningful ways, and to decide how to respond" (van Es et al., 2017, p. 167). This can support pre-service teachers in developing their professional vision. Professional vision refers to "socially organized ways of seeing and understanding events that are answerable to the distinctive interests of a particular social group" (Goodwin, 1994, p. 606). Such shared ways of knowing are a crucial first step to support pre-service teachers in developing a common language that can support them in accessing their knowledge repertoires (Grossman & McDonald, 2008; Santagata, Zannoni, & Stigler, 2007).

Learning to notice is often situated in video representations of practice (McDuffie et al., 2014; Santagata, 2011; Santagata & Angelici, 2010; Santagata et al., 2007; Seago, 2003; Seidel, Blomberg, & Renkl, 2013; Star & Strickland, 2008), meaning that by watching videos of either their own or others' teaching, pre-service teachers are supported in furthering their practice. Videos offer a detached view of the classroom, where pre-service teachers can focus on what is important without needing to teach and manage classroom events. This allows them to focus on significant aspects of the interaction and the environment and understand them better. In this paper, I critically review the literature on how pre-service teachers notice through video representations to deepen their understanding of positioning students competently.

Past research studies have focused either on positioning students competently or noticing. In this article, I aim to bridge these two frameworks to understand how ideas brought forward through the noticing literature inform the creation of a learning environment to deepen pre-service teachers' understanding of positioning students competently. More specifically, I discuss the guiding principles for designing environments that help pre-service teachers learn to notice how to position students competently. This will include a review of key articles from the noticing literature and from what I consider "ambitious instruction literature." The latter includes articles that explore a form of teaching that incorporates positioning students competently, as it prioritizes student ideas and uses a variety of approaches meant to challenge and actively engage students (van Es et al., 2017). Considering how teaching environments can affect students' dispositions towards, and achievement in mathematics, it is essential that pre-service teachers gain deep understandings of practices they may not experience in their fieldwork or subsequent teaching career. Learning to teach principles or notice important interactions is not an easy task, thus it is important to consider new approaches for optimizing pre-service teacher learning. Acknowledging these challenges, I aim to shed light on principles that can be used to support pre-service teachers in positioning students as sense makers. I posit that supporting pre-service teachers to notice

through video-analysis can support a more in-depth understanding of when and how to position students competently.

THEORETICAL UNDERPINNINGS

Positioning Students Competently

Positioning students as competent learners requires that teachers respect students' contributions and acknowledge their competence in acquiring and transmitting knowledge (Franke et al., 2007). Acknowledging students as competent calls on teachers to attend to student thinking and use teaching moves that encourage student contributions. Drawing from Davies and Harré (1990), teachers would actively choose to use utterances and speech acts that position students to feel competent. The aim is to create an environment where students take up this position and feel validated and assert confidence in their mathematical ability moving forward. For this review, I define positioning students competently as "a means to value all contributions by acknowledging them and using teaching moves to provide students with opportunities to make sense and author mathematical ideas."

At the heart of this practice is the view that all student responses should be valued regardless of their mathematical correctness (Kazemi & Hintz, 2014). For instance, Ball (1993) drew attention to a moment when a student named Sean expressed that six was both an even an odd number. Despite the incorrect claim, she decided not to correct the student. Instead, inspired by the student's error, she referred to "Sean numbers" (p. 387). Students experimented with this idea and tried to make sense of it. In the end, students' exams revealed that despite having an experimental and mathematically incorrect notion, they were still able to reason logically about even and odd numbers. Ultimately, Ball (1993) used Sean's response as a means of exploring the mathematical concept more deeply, and without discrediting Sean, she was able to position him competently. Lampert (2003) similarly shared her experience with a student named Richard who provided a mathematically incorrect answer. Rather than correcting or dismissing it, she wrote it on the board and used it as an opportunity to show students the value of using manipulatives to solve problems. Similarly, O'Connor and Michaels (1996) explored the usefulness of revoicing, and how it could be used to position students competently regardless of whether their response was correct or not. This is because revoicing allowed the teacher to restate or reformulate a student's contribution, providing students with an opportunity to agree or disagree with the teacher's alternative formulation. Revoicing can help label student ideas as valid, including those from more reluctant students (O'Connor & Michaels, 1996).

I consider positioning students competently to be a teaching practice, while the tactics the teacher employs in class to effectively position students are moves. Similar to van Es, Tunney, Goldsmith, and Seago (2014), I make this distinction to highlight the fact that a variety of moves can be used to implement any practice, while there is not one correct way to do so. For example, revoicing is a move where the teacher restates or reformulates a students' response to support their learning. Through this, students' responses are either validated or students are given the opportunity to reconsider and articulate their understanding (O'Connor & Michaels, 1996). When considering the

aforementioned articles in relation to other pieces that discuss teacher moves, the ideas used to position students competently can be described as: (a) representing student ideas on the board, but not limited to this medium (Aki & Chana, 2017), (b) highlighting student responses (van Es et al., 2014), (c) pressing on student thinking (van Es et al., 2014), and (d) revoicing (Kazemi & Hintz, 2014; O'Connor & Michaels, 1996). Representing student ideas is when the teacher uses a different medium (i.e., the board, manipulatives, number lines, etc.) to explore a mathematical idea with students. This move provides students with a new lens to consider when solving mathematical tasks (Aki & Chana, 2017). Similarly, highlighting involves the teacher bringing attention to student ideas and is often used to praise or validate student thinking (van Es et al., 2014). Pressing on student thinking calls on the teacher to ask students to explain or expand on their understandings—this move is usually used as a question that prompts students to justify or explain their thinking (van Es et al., 2014).

Learning is Situated

As suggested by Lampert, Beasley, Ghousseini, Kazemi, and Franke (2010), learning does not take place in a vacuum; rather it takes place in various contexts and is influenced by various contextual features (Peressini, Borko, Romagnano, Knuth, & Willis, 2004). Pre-service teachers, therefore, need to participate in specially designed activities that can promote their growth and cultivate their understandings of mathematical ideas and teaching techniques. Although the situatedness of teacher learning can occur outside the classroom, such environments need to include resources (i.e., student work, teaching video footage, lesson plans, etc.) that can yield practical understandings (Putnam & Borko, 2000). Relating to this, an approximation of practice occurs when a pre-service teacher engages in a practice that would take place in a classroom. Approximations can vary in their proximity to authentic practice. For instance, reviewing artifacts in a university classroom is less proximal compared to lesson enactments within a classroom setting (Grossman et al., 2009).

However, each approximation has its tradeoffs. Artifacts of student work can reveal a great deal about student thinking, while enactments can refine pre-service teachers' ability to act in the moment with teacher moves. Unlike other approximations, videos can uniquely support pre-service teachers in noticing specific teaching practices and moves despite being considered less proximal. Related to this, a situated perspective posits that learning is extended or distributed across the learner, other individuals, and artifacts (Greeno, 1998; Putnam & Borko, 2000). Learning occurs in activity, where individuals interact with a variety of stimuli to forge understandings (Greeno, 1998; 2006). Such an emphasis directs researchers to consider the various levels in the environment that simultaneously impacts their learning. These levels are governed by representations, which refer to socially distributed "signs and aspects of situations" that are mediated and interpreted by those engaged in an activity (Greeno, 2006, p. 86). As such a complex environment affects learning, for generalizability, it is important to examine each component (Greeno, 2006). These perspectives informed how I conceptualize each of the following design principles that can be used to create an environment that cultivates more in-depth understandings of how and when to position students competently.

DESIGN PRINCIPLES

Designing an environment that can support pre-service teachers to notice and deepen their understanding of positioning students competently is no easy feat. In what follows, I present four guiding principles from the literature that facilitate the creation of such an environment (Table 1 below). Each principle is accompanied by a list of relevant literature. Articles are then grouped together. Literature from both noticing and ambitious instruction are included, with a focus on noticing. Within the noticing sections in the table, articles are sorted into either a section titled "converging" or "section specific." This simply indicates which articles are used with other principles (i.e., converging) and which only support one principle (i.e., section specific).

Design Principles		Supporting Noticing and Ambitious Instruction Literature	
1	Using video to support noticing	Noticing	**Converging (i.e., literature that re-emerges in subsequent principles):** Barnhart & van Es, 2015; Borko, Jacobs, Eiteljorg, & Pittman, 2008; Grossman, 2009, McDuffie et al., 2014; Rosaen, Lundeberg, Cooper, Fritzen, & Terpstra, 2008; Santagata, 2011; Santagata & Angelici, 2010; Santagata et al., 2007; Seago, 2003; Star & Strickland, 2008; Van Es & Sherin, 2002) **Section specific (i.e., literature that is explicitly discussed in a single principles):** Seidel et al., 2013
		Ambitious Instruction	Aki & Chana, 2017; Kazemi & Hintz, 2014; O'Connor & Michaels, 1996; van Es et al., 2014
2	Noticing with purpose	Noticing	**Converging:** Borko et al. 2008; Horn, Garner, Kane, & Brasel, 2017; McDuffie et al. 2014; Santagata 2011; Santagata & Angelici, 2010; Santagata & Guarino, 2011; Santagata et al., 2007; Star & Strickland, 2008; Van Es & Sherin, 2002 **Section specific:** Borko, Koellner, Jacobs, & Seago, 2011; Kersting, Givvin, Sotelo, & Stigler, 2010; Santagata & Yeh, 2014; Star, Lynch, & Perova, 2011; van Es & Sherin, 2006
		Ambitious Instruction	Ball, 1993, Kazemi & Hintz, 2014; Lampert, 2003; O'Connor & Michaels, 1996

3	Envisioning new ways of proceeding to deepen understandings	Noticing	**Converging:** Horn, Garner, Kane, & Brasel, 2017; Santagata & Angelici, 2010; Santagata & Guarino, 2011
		Ambitious Instruction	Franke et al., 2007; Kazemi & Hintz, 2014
4	Decomposition of practice to support noticing	Noticing	**Converging:** Grossman et al., 2009 **Section specific:** Goodwin, 1994
		Ambitious Instruction	Aki & Chana, 2017; Ball (1993); Franke et al., 2007; Kazemi & Hintz, 2014; Lampert, 2003; O'Connor & Michaels, 1996; van Es et al., 2014 *(Note: Although foundational to this section, these pieces are not explicitly mentioned, as positioning students competently is discussed generally)*

Table 1: Design Principles and Supporting Literature

Using Video to Support Noticing

Representations of practice refer to any medium (e.g., video, lesson enactments, transcripts from classroom interactions, artifacts from classrooms: student work and lesson plans) used in teacher education that to some degree reflect elements existing in the teaching profession, which can in turn support pre-service teachers to gain new understandings about teaching (Grossman et al., 2009). Grossman (2009) explained that the nature of the representation directly affects which aspects of teaching are visible to pre-service teachers. Video for instance can support the noticing of ongoing interactions, teacher moves, and routines that take place in an authentic setting (Grossman et al., 2009). Further, video is commonly discussed in noticing literature as it has proven to improve teachers' ability to notice and reflect on teaching and their practice.

Within the noticing literature, video analysis has been deemed an approach that can support pre-service teachers in learning to notice (McDuffie et al., 2014; Santagata, 2011; Santagata & Angelici, 2010; Santagata et al., 2007; Seago, 2003; Seidel, Blomberg, & Renkl, 2013; Star & Strickland, 2008). Such analysis consists of watching clips of either your own teaching or that of others to support the ability to notice. Through this activity, teachers can deepen their understandings of key ideas related to education and teaching.

Video has many benefits for supporting pre-service teachers in learning to notice. First, video can be used to hone in on specific moments of interaction (e.g., Barnhart & van Es, 2015; Rosaen,

Lundeberg, Cooper, Fritzen, & Terpstra, 2008; Van Es & Sherin, 2002; Boroko, Jacobs, Eiteljorg, & Pittman, 2008; Santagata, 2007). Such a focus directs pre-service teachers' attention away from student behaviour and instead towards instruction (Rosaen et al., 2008). Since video can be reviewed and stopped by the viewer as many times as needed for certain moments to be focused upon (van Es & Sherin, 2002), this provides pre-service teachers with opportunities to reflect more deeply than possible during a live observation (Santagata, 2007). Second, video is a way for pre-service teachers to ground their claims in specific evidence (Borko et al., 2008; Santagata & Guarino, 2011; van Es & Sherin, 2002), as pre-service teachers will substantiate their claims with excerpts from the footage they review. This can in turn foster a "systematic analysis of teaching" (Barnhart & van Es, 2015, p. 85). Third, video has been shown to support pre-service teachers in bridging knowledge learned in their teacher education program to authentic contexts displayed through video clips (Santagata et al., 2007). This highlights the fact that theories or teaching practices in teacher education programs are often taught in isolation and, as a result, pre-service teachers may not fully grasp what it means to put theory into practice. Therefore, by accompanying theory with video representations of authentic teaching contexts, pre-service teachers can gain deeper understandings and better prepare themselves for teaching students.

Noticing interactions, although achieved through video, would be considered an approximation of practice, as this is something teachers do when teaching and facilitating discussions (McDuffie et al., 2014). Since this noticing will only take place through video representations, it should be noted that although the authenticity of this task will be present, the ways in which it reflects opportunities that would exist in non-simulated environments vary, thus affecting its level of authenticity. For example, while video clips will support pre-service teachers in noticing interactions, their viewing and understandings will be partially constrained as they are disconnected from the teacher's planning and the various environmental and social features that have been built through daily classes and ongoing interactions (Grossman et al., 2009).

Such constraints are important, but do not affect the usefulness of video in supporting pre-service teachers in deepening their understandings of how and when students can be positioned competently. Positioning students competently is a very specific practice that may or may not become apparent to pre-service teachers when undergoing field work. Video can mediate this, as the selected clips relate specifically to positioning students competently and can showcase teaching moves relating to this practice (e.g., moves discussed in: Aki & Chana, 2017; Kazemi & Hintz, 2014; O'Connor & Michaels, 1996; van Es et al., 2014). Pre-service teachers' learning would be situated in this activity (i.e., video analysis), as they can then review this practice and the associated teaching moves to cultivate deeper understanding.

Noticing with Purpose

For video to effectively support pre-service teachers' learning to notice, it must be viewed with a purpose (Santagata & Angelici, 2010; Santagata et al., 2007; Star & Strickland, 2008; Van Es & Sherin, 2002). Having a viewing focus calls on pre-service teachers to take an "interpretive stance," which involves noticing with the intent of understanding various influential factors that affect classroom interactions and student understandings, rather than simply passing judgment (van Es

& Sherin, 2002, p. 575). This stance ultimately affects how pre-service teachers interpret their reflections (van Es & Sherin, 2002). Through the review of literature, the following supports were identified and can be used to create a learning environment that guides pre-service teachers in noticing with purpose.

Video clips accompanied by transcripts can create an ideal learning environment for pre-service teachers, as transcripts have been shown to support more in-depth understandings (Borko, Koellner, Jacobs, & Seago, 2011; Kersting, Givvin, Sotelo, & Stigler, 2010; Santagata & Yeh, 2014; van Es & Sherin, 2002). As stated by van Es and Sherin (2002), often those who view video may recall variations of actual events and thus not base their claims on evidence. To avoid this and focus viewing, pre-service teachers should be prompted to substantiate all their claims with evidence, and video transcripts will support them in doing so.

Within the literature on video noticing, several studies have used frameworks comprised of various questions to guide pre-service teachers in noticing and developing more in-depth analyses of classroom events (McDuffie et al., 2014; Santagata & Angelici, 2010; Santagata & Guarino, 2011). Frameworks are considered a tool that can further support pre-service teachers in maintaining focus when viewing video. In current literature on supporting pre-service teachers to notice through video, Santagata (2011), Santagata and Angelici (2010), and McDuffie et al. (2014) have developed frameworks that could support pre-service teachers in noticing and reflecting more deeply. These frameworks have been proven successful, and held many merits as they have been found to: (a) focus on pre-service teacher learning (McDuffie et al., 2014; Santagata & Angelici, 2010; Star, Lynch, & Perova, 2011), (b) support pre-service teachers to notice “at higher levels” (McDuffie et al., 2014, p. 267; Santagata et al., 2007) and (c) provide pre-service teachers with more guidance and scaffolding which in turn supports them to focus on what is important (Star & Strickland, 2008).

The facilitator’s role has been alluded to in several articles (Borko et al., 2008; Horn, Garner, Kane, & Brasel, 2017; van Es & Sherin, 2006). For example, Borko et al. (2008) emphasized the active role of the facilitator in focusing viewing and supporting teachers in reaching their goals. To do this, facilitators can ask specific questions to orient teachers towards their task and guide discussion (van Es & Sherin, 2006). Borko et al. (2008) showed that facilitators can also direct conversations in ways that encourage teachers to develop “a more critical stance” (p. 433). Further, facilitators can bring attention to the underlying tenets for video noticing: (a) discerning what is important in classroom discussions; (b) understanding how these important “classroom interactions” connect to “broader” ideas in mathematics (p. 573); (c) taking into consideration contextual features to make sense of classroom interactions (van Es & Sherin, 2002).

Although noticing with purpose has proven successful, there remains limited knowledge on how teachers can be supported in the noticing and learning of positioning students competently. However, the literature on positioning students competently suggests the specific interactions that facilitators, frameworks, and video clip transcripts may focus on. These include a focus on: (a) student thinking rather than what a student does wrong, and (b) how teachers articulate student

ideas and ask questions (Ball, 1993; Kazemi & Hintz, 2014; Lampert, 2003; O'Connor & Michaels, 1996).

Envisioning New Ways of Proceeding to Deepen Understandings

Scholars have found that envisioning and proposing new ways of proceeding contributes significantly to a pre-service teacher's effectiveness (Santagata & Angelici, 2010; Santagata & Guarino, 2011). A study conducted by Horn et al. (2017) highlights how the most productive teacher meetings that supported more in-depth learning included dialogue around future practices, in which teachers "(re)imagine" their actions (p. 43). The authors argue that in such moments it is important for teachers to connect theory to practice. Taking this into consideration, frameworks that encourage pre-service teachers to make such reflections can support more focused understandings. By learning to notice specific teaching moments, pre-service teachers can make connections to more general theoretical principles.

Relating to positioning students competently, through such reflections, it is hoped that pre-service teachers can delve deeper into what it means to position students as competent learners. In that, they will need to consider the theoretical principles in positioning students competently, which include: (a) supporting students in authoring their learning, (b) respecting students' ideas to support their confidence, and (c) encouraging students as sense makers (Franke et al., 2007; Kazemi & Hintz, 2014). Further, frameworks that guide pre-service teachers to envision alternatives are crucial, as by doing this they will need to carefully assess how and why their selected teaching strategies best position the student considering the various contextual features at play (e.g., content knowledge to be learned, comments made, their expressed understanding of content knowledge).

Decomposition of Practice to Support Noticing

As stated earlier, video can be a useful tool in supporting pre-service teachers' learning to notice teacher moves that position students competently. In addition to representation and approximation, video analysis can also serve as a decomposition of practice (Grossman et al., 2009), which can support pre-service teachers in developing a professional vision. These three terms refer to providing novices (e.g., pre-service teachers) with opportunities to engage in practices that resemble those found in a professional setting (Grossman et al., 2009).

Parsing practice into its constituent parts is key in supporting pre-service teacher understandings and is what Grossman et al. (2009) referred to as a decomposition of practice. Examples of this include teaching pre-service teachers a specific practice or how to create a lesson plan. Through this parsing, individual practices can be taught to pre-service teachers with more ease and as with representations of practice, it can also support pre-service teachers in focusing on what is important in a lesson. Ultimately, it can foster more in-depth understandings, as pre-service teachers are given the opportunity to master one aspect of teaching more thoroughly than possible when viewing teaching as a whole. Building from Grossman et al., (2009) and Goodwin (1994), it is thus important to describe individual practices to pre-service teachers and

subsequently provide them with opportunities to identify each in practice or in representations of practice. Decomposition of practice can support pre-service teachers in learning to notice and "interpret what is observed" (Grossman et al., 2009, p. 2069). This consideration is vital, as through a tailored framework and facilitator guidance, pre-service teachers will be supported to notice specific interactions that relate to positioning students as competent learners.

Coding and highlighting (Goodwin, 1994) are practices that can help pre-service teachers make sense of decompositions (Goodwin, 1994; Grossman et al., 2009). Coding refers to describing classifications, while highlighting entails bringing attention to what is salient (Goodwin, 1994). When considering frameworks tailored to the idea of positioning students competently, frameworks that include definitions connected to teacher moves that support pre-service teachers in positioning students can be considered coding. Alternatively, to highlight, frameworks can include prompts for pre-service teachers to identify and reflect on specific instances/interactions that relate to positioning students as competent learners. Through such frameworks, pre-service teachers will break down the video representation to notice significant moments and through this deepen their understanding of how to position students competently.

IMPLICATIONS AND CONCLUDING REMARKS

The literature on noticing and ambitious practice can shed light on ways to support pre-service teachers in understanding how and when to position students competently. Building on previous principles, video coupled with transcripts, a framework, and facilitator guidance, will assist pre-service teachers in fostering their professional vision as they will have opportunities to learn what it means to position students as competent learners. When used simultaneously, each support can be considered a deliberate practice, in which pre-service teachers pursue one activity in isolation repeatedly to better understand a specific practice (Ericsson, Krampe, & Tesch-Römer, 1993; Grossman & McDonald, 2008).

Considering how critical it is to implement reform education ideals, a greater emphasis should be placed on teaching models that target specific practices to support more in-depth understandings. There is a clear need for more empirical research that explores the potential learning outcomes such a focus and approach can yield. Positioning theory, although discussed in mathematics literature, has often been used to understand and classify classroom interactions. However, more work is needed in studying how teacher moves can position students (Herbel-Eisenmann, Wagner, Johnson, Suh, & Figueras, 2015). This is imperative, as the positions students assume (e.g., competent) in class are largely affected by the way they were initially positioned by the teacher (Davies & Harré, 1990; Harré, Moghaddam, Cairnie, Rothbart, & Sabat, 2009). The guiding principles identified in this review will hopefully encourage more research to be done on noticing and positioning students competently. To date, many mathematics classes are still taught using traditional styles of instruction. Considering that pre-service teachers often identify with this model, they are more prone to perpetuate it once in the field. Research that details the conditions needed to support pre-service teachers in positioning students can tremendously impact how teacher educators design opportunities for learning in their courses. Mathematics education is crucial for primary students' future academic success (Stokke, 2015). Likewise, igniting in students

a love for the topic and cultivating positive dispositions is tremendously important in supporting future achievement and sustained interest in mathematics (Boaler & Selling, 2017).

REFERENCES

Aki, M., & Chana, S. (2017). Facilitating mathematical practices through visual representations. Teaching Children *Mathematics, 23*(7), 404-412. doi:10.5951/teacchilmath.23.7.0404

Ball, D. L. (1993). With an eye on the mathematical horizon: Dilemmas of teaching elementary school mathematics. *The Elementary School Journal, 93*(4), 373-397. doi:10.1086/461730

Barnhart, T., & van Es, E. (2015). Studying teacher noticing: Examining the relationship among pre-service science teachers' ability to attend, analyze and respond to student thinking. *Teaching and Teacher Education, 45*, 83-93. doi:10.1016/j.tate.2014.09.005

Boaler, J. (1998). Open and closed mathematics: Student experiences and understandings. *Journal for research in mathematics education*, 41-62. doi:10.2307/749717

Boaler, J., & Greeno, J. G. (2000). Identity, agency, and knowing in mathematics worlds. In J. Boaler (Ed.), *Multiple perspectives on mathematics teaching and learning* (pp. 171-200). Westport, CT: Greenwood Publishing Group.

Boaler, J., & Selling, S. K. (2017). Psychological imprisonment or intellectual freedom? A longitudinal study of contrasting school mathematics approaches and their impact on adults' lives. *Journal for Research in Mathematics Education, 48*(1), 78-105. doi:10.5951/jresematheduc.48.1.0078

Borko, H., Jacobs, J., Eiteljorg, E., & Pittman, M. E. (2008). Video as a tool for fostering productive discussions in mathematics professional development. *Teaching and Teacher Education, 24*(2), 417-436. https://doi.org/10.1016/j.tate.2006.11.012

Borko, H., Koellner, K., Jacobs, J., & Seago, N. (2011). Using video representations of teaching in practice-based professional development programs. *ZDM, 43*(1), 175-187. doi: 10.1007/s11858-010-0302-5

Cribbs, J. D., & Linder, S. M. (2013). Teacher practices and hybrid space in a fifth-grade mathematics classroom. *Mathematics Educator, 22*(2), 55-81. Retrieved from https://eric.ed.gov/?id=EJ1013929

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*(3), 363.

Davies, B., & Harré, R. (1990). Positioning: The discursive production of selves. *Journal for the Theory of Social Behaviour*, 20(1), 43-63. doi: 10.1111/j.14685914.1990.tb00174.x

Franke, M. L., Kazemi, E., & Battey, D. (2007). Mathematics teaching and classroom practice. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 225-256). Charlotte, NC: Information Age.

Goleman, D. (1985). *Simple lies, vital truths: the psychology of self-deception.* New York: Simon & Schuster.

Goodwin, C. (1994). Professional vision. *American Anthropologist, 96*(3), 606-633. doi:10.1525/aa.1994.96.3.02a00100

Greeno, J. G. (1998). The situativity of knowing, learning, and research. *American Psychologist, 53*(1), 5-26. doi: 10.1037//0003-066X.53.1.5

Greeno, J. G. (2006). Learning in activity. In K. I. Sawyer (Ed.), *The Cambridge handbook of the learning sciences.* (pp. 79-96). New York: Cambridge University Press. doi:10.1017/CBO9781139519526.009

Grossman, P., Compton, C., Igra, D., Ronfeldt, M., Shahan, E., & Williamson, P. (2009). Teaching practice: A cross-professional perspective. *Teachers College Record, 111*(9), 2055-2100.

Grossman, P., & McDonald, M. (2008). Back to the future: Directions for research in teaching and teacher education. *American Educational Research Journal,* 45(1), 184-205. doi:10.3102/0002831207312906

Harré, R., Moghaddam, F. M., Cairnie, T. P., Rothbart, D., & Sabat, S. R. (2009). Recent advances in positioning theory. *Theory & Psychology*, 19(1), 5-31. doi:10.1177/0959354308101417

Herbel-Eisenmann, B. A., Wagner, D., Johnson, K. R., Suh, H., & Figueras, H. (2015). Positioning in mathematics education: Revelations on an imported theory. *Educational Studies in Mathematics, 89*(2), 185-204. doi:10.1007/s10649-014-9588-5

Horn, I. S., Garner, B., Kane, B. D., & Brasel, J. (2017). A taxonomy of instructional learning opportunities in teachers' workgroup conversations. *Journal of Teacher Education, 68*(1), 41-54. doi:10.1177/0022487116676315

Kazemi, E., & Hintz, A. (2014). *Intentional talk: How to structure and lead productive mathematical discussions*. Portland, ME: Stenhouse Publishers.

Kersting, N. B., Givvin, K. B., Sotelo, F. L., & Stigler, J. W. (2010). Teachers' analyses of classroom video predict student learning of mathematics: Further explorations of a novel measure of teacher knowledge. *Journal of Teacher Education, 61*(1-2), 172-181. doi:10.1177/0022487109347875

Lampert, M. (2003). *Teaching problems and the problems of teaching.* New Haven, CT: Yale University Press.

Lampert, M., & Ball, D. L. (1990). Using hypermedia technology to support a new pedagogy of teacher education. *The National Center for Research on Teacher Education*, *90*(5), 1-17. doi:10.1177/016264349401200307

Lampert, M., Beasley, H., Ghousseini, H., Kazemi, E., & Franke, M. (2010). Using designed instructional activities to enable novices to manage ambitious mathematics. In M. K. Stein & L. Kucan (Eds.), *Instructional explanations in the disciplines* (pp. 129–141). New York, NY: Springer.

McDuffie, A. R., Foote, M. Q., Bolson, C., Turner, E. E., Aguirre, J. M., Bartell, T. G., . . . 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*(3), 245-270. doi:10.1007/s10857-013-9257-0

National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics (2014). *Principles to actions: Ensuring mathematical success for all*. Reston, VA: Author.

O'Connor, M. C., & Michaels, S. (1993). Aligning academic task and participation status through revoicing: Analysis of a classroom discourse strategy. *Anthropology & Education Quarterly, 24*(4), 318-335. doi:10.1525/aeq.1993.24.4.04x0063k

O'Connor, M. C., & Michaels, S. (1996). Shifting participant frameworks: Orchestrating thinking practices in group discussion. In D. Hicks (Ed.), (Tran.), *Discourse, Learning, and Schooling* (pp. 63-103). New York: Cambridge University Press.

Peressini, D., Borko, H., Romagnano, L., Knuth, E., & Willis, C. (2004). A conceptual framework for learning to teach secondary mathematics: A situative perspective. *Educational Studies in Mathematics, 56*(1), 67-96. doi:10.1023/B:EDUC.0000028398.80108.87

Putnam, R. T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29*(1), 4-15. doi:10.3102/0013189X029001004

Québec Ministère de L'Éducation (2001). Québec education program. Québec: Gouvernement du Québec.

Rosaen, C. L., Lundeberg, M., Cooper, M., Fritzen, A., & Terpstra, M. (2008). Noticing noticing: How does investigation of video records change how teachers reflect on their experiences? *Journal of Teacher Education, 59*(4), 347-360. doi:10.1177/0022487108322128

Santagata, R. (2011). From teacher noticing to a framework for analyzing and improving classroom lessons. In M. G. Sherin, V. R. Jacobs, & R. A. Philipp (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (152-168), New York, NY: Routledge.

Santagata, R., & Angelici, G. (2010). Studying the impact of the lesson analysis framework on preservice teachers' abilities to reflect on videos of classroom teaching. *Journal of Teacher Education, 61*(4), 339-349. doi:10.1177/0022487110369555

Santagata, R., & Guarino, J. (2011). Using video to teach future teachers to learn from teaching. *ZDM, 43*(1), 133-145. doi:10.1007/s11858-010-0292-3

Santagata, R., & Yeh, C. (2014). Learning to teach mathematics and to analyze teaching effectiveness: Evidence from a video-and practice-based approach. *Journal of Mathematics Teacher Education, 17*(6), 491-514. doi:10.1007/s10857-013-9263-2

Santagata, R., Zannoni, C., & Stigler, J. W. (2007). The role of lesson analysis in pre-service teacher education: An empirical investigation of teacher learning from a virtual video-based field experience. *Journal of Mathematics Teacher Education, 10*(2), 123-140. doi:10.1007/s10857-007-9029-9

Seago, N. (2003). Using video as an object of inquiry for mathematics teaching and learning. In E. J. Brophy (Ed.), *Using video in teacher education* (pp. 259-286). Oxford, UK: Elsevier.

Seidel, T., Blomberg, G., & Renkl, A. (2013). Instructional strategies for using video in teacher education. *Teaching and Teacher Education, 34*, 56-65. doi:10.1016/j.tate.2013.03.004

Sherin, M., Jacobs, V., & Philipp, R. (2011). *Mathematics teacher noticing: Seeing through teachers' eyes.* New York, NY: Routledge.

Star, J., Lynch, K., & Perova, N. (2011). Using video to improve mathematics' teachers' abilities to attend to classroom features: A replication study. In M. G. Sherin, V. R. Jacobs, & R. A. Philipp (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 117-136). New York, NY: Routledge.

Star, J. R., & Strickland, S. K. (2008). Learning to observe: Using video to improve preservice mathematics teachers' ability to notice. *Journal of Mathematics Teacher Education, 11*(2), 107-125. doi:10.1007/s10857-007-9063-7

Stokke, A. (2015). What to do about Canada's declining math scores? *CD Howe Institute Commentary, 427*. Retrieved from https://www.cdhowe.org/public-policy-research/what-do-about-canada%E2%80%99s-declining-math-scores

van Es, E. A., Cashen, M., Barnhart, T., & Auger, A. (2017). Learning to notice mathematics Instruction: Using video to develop preservice teachers' vision of ambitious pedagogy. *Cognition and Instruction*, 35(3), 1-23. doi:10.1080/07370008.2017.1317125

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), 571-595.

van Es, E. A., & Sherin, M. G. (2006). How different video club designs support teachers in "learning to notice". *Journal of Computing in Teacher Education, 22*(4), 125-135. doi: 10.1080/10402454.2006.10784548

van Es, E. A., Tunney, J., Goldsmith, L. T., & Seago, N. (2014). A framework for the facilitation of teachers' analysis of video. *Journal of Teacher Education, 65*(4), 340-356. doi:10.1177/0022487114534266