

HIGH-QUALITY INSTRUCTION \neq HIGH-LEVEL NOTICING: EXAMINING FACTORS THAT INFLUENCE TEACHERS' NOTICING

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In this study, we investigate the relationship between teachers' noticing and the quality of their mathematics instruction. We analyzed the conversation of seven elementary teachers around five coaching cycles and scored their level of noticing and the mathematical quality of the instruction of the lesson. We compared teachers' noticing levels with their MQI scores for each coaching cycle. One case showed discrepancy between the level of noticing and the MQI scores. In this proposal, we discuss the cognitive and psychological constructs that seemed to influence teacher's noticing including mathematical knowledge for teaching (MKT), beliefs, teaching efficacy, and emotions. Results show that each of the constructs influenced the teacher's noticing to varying degrees. Implications for professional development are discussed.

Keywords: Coaching; Mathematical Knowledge for Teaching; Teacher Efficacy, Teacher Emotion; Noticing

Effective mathematics teaching requires foregrounding students' thinking (Ball & Cohen, 1999). This requires teachers to attend to and identify how students think and use their observations to make informed decisions about how to effectively respond. Recently, a significant amount of research (e.g. Sherin & van Es, 2009) has focused on investigating teacher noticing in order to understand what and how teachers observe, how they interpret the gathered information to respond to what they observe, and how this process can be influenced. These efforts have been focused on gaining a deeper understanding of how teacher noticing supports teacher learning in efforts to improve their instructional practices (Sherin, Jacobs & Philipp, 2010).

Professional noticing of children's mathematical thinking comprises a set of interrelated skills including (a) attending to students' strategies, (b) interpreting students' understandings, and (c) determining how to respond based on these understandings (Jacobs et al., 2010). Some of the work on teacher noticing has focused on the differences in what and how teachers' notice concluding that expert teachers tend to interpret and recall classroom events with greater detail and insight than novice teachers (Sherin, Jacobs & Philipp, 2010). We also acknowledge that teachers' abilities to notice may be impacted by the nature and quality of the instruction they are observing. For example, if a teacher is lecturing with minimal input from students, which is considered to be one indicator of low quality instruction, opportunities for noticing students' thinking will be limited. In this regard, we contend that evaluations of teachers' abilities to notice should be qualified based on the opportunities the teaching event affords for high-level noticing. Thus, we were interested in examining the alignment between teachers' levels of noticing and their quality of instruction, and the factors that influence this alignment. We considered

mathematical knowledge for teaching (MKT), emotions, beliefs and teaching efficacy (TE) as possible factors. We targeted the following research questions:

- Do teachers' mathematical quality of instruction align with their level of noticing?
 - If there is alignment, what factors seem to support alignment?
 - If there is misalignment, what factors seem to influence this misalignment?

Theoretical Framework

Teachers' mental lives have a significant impact on their teaching experiences (Schutz, Hong, Cross & Osbon, 2006). Surprisingly, the ways in which specific cognitive and psychological constructs, such as MKT, emotions, beliefs and TE collectively influence teachers' instructional activity including noticing, has not been investigated broadly. In what follows, we provide a brief overview of each of these constructs with a specific focus on how each may inform teachers' instructional practices.

Mathematical knowledge for teaching (MKT) encompasses deep knowledge of math concepts and the knowledge and skills to attend to students' thinking during the act of teaching, and make in-the-moment decisions about the best ways to respond to what they observe (Ball, Thame & Phelps, 2008; Hill et al., 2008.). There is also a high correlation between mathematics knowledge for teaching and the mathematics quality of instruction (Hill et al., 2008). Teaching is emotional work (Schutz, Hong, Cross & Osbon, 2006). Emotions play a significant role in teachers' relationships, instructional decision-making and overall professional well-being. According to Trigwell (2012), "there are systematic relations between the ways teachers emotionally experience the context of teaching and the ways they approach their teaching." (p. 617). In this regard, we consider that the emotions teachers experience as they engage in instructional activity, including noticing, may influence what and how they notice. Beliefs are defined as "embodied conscious and unconscious ideas and thoughts about oneself, the world, and one's position in it developed through membership in various social groups, which are considered by the individual to be true".(Cross, 2009, p. 4) They are considered precursors to actions (Pajares, 1992). Research has shown that teachers' beliefs about mathematics, learning and teaching greatly influence their practices (e.g. Cross Francis, 2015; Ernest, 1989). We also know that beliefs can serve as filters, orienting an individual's thoughts and ideas through a particular lens. For example, a teacher who believes that students are able to build knowledge through meaningful cognitive engagement in activity would perhaps organize her classroom activities to support inquiry and problem solving. Lastly, teacher efficacy (TE) is defined as teachers' beliefs about their capacity to affect how students learn and their perception of overall performance (Tsachannen-Moran, Woolfolk-Hoy & Hoy, 1998). It influences teachers' willingness to learn, adopt and enact particular instructional practices. TE has two components--- knowledge and personal efficacy. Knowledge efficacy refers to a person's confidence in her understanding of mathematics content (Roberts & Henson, 2000), while personal efficacy describes a person's confidence in her ability to support students' learning through teaching. Teachers with strong TE tend to be flexible in their approach to teaching and are more focused in planning and organizing instructional activity.

Methods

Seven elementary teachers participated in this study. The teachers were each involved in a PD program involving five coaching cycles. Coaching involved (i) preparing teachers' for their upcoming coaching session (pre-coaching), (ii) supporting teachers during instruction (coaching)

and, (iii) debriefing instruction after the coaching session (post-coaching). All conversations were audio-recorded and the coaching sessions were video-recorded. Data sources included (i) audio and videorecordings from the coaching cycle, (ii) scores on mathematical quality of instruction instrument (MQI) (see Hill et. al, 2008), (iii) interviews prior to the start of the coaching that provided data about the core constructs described, and (iv) quantitative results of their teaching efficacy and emotions. Pre-coaching conversations were analyzed to determine teachers' knowledge (about the topic to be taught in the coaching session), efficacy and emotions related to the upcoming coaching session. Coaching session videos were analyzed using the MQI instrument to determine the quality of instruction along four core dimensions. A second round of analysis of the coaching video was done to determine the MKT (specifically common content knowledge (CCK), knowledge of content and students (KCS), specialized content knowledge (SCK) and knowledge of content and teaching (KCT) – (see Ball, Thames and Phelps (2008) for full descriptions) specifically focusing on their knowledge of mathematics being taught in the lesson, instructional strategies and students' thinking and the ways they enacted this knowledge during instruction.

In preparation for the coaching conversations, teachers were asked to identify three instances during the lesson that they found interesting or significant. Post coaching conversations were used to identify the clips the teachers selected which were analyzed for their noticing levels using Van Es' (2011) framework. Then we examined both the MQI scores and noticing levels per coaching cycle (Table 1) to determine the degree of alignment. Analyses of pre- and post coaching interviews determined the emotions, knowledge and beliefs related to the coaching session. Teachers also completed the adapted SETAKIST (Self-Efficacy Teaching and Knowledge Instrument for Teachers of Mathematics) (see Roberts & Henson (2000) for description of the instrument) to determine their knowledge and personal efficacy.

Findings & Discussion

The corpus of data were examined for the seven teachers and presented in Tables 1 and 2. In Table 1, we show the data from the coaching video where they have the highest MQI score and the accompanying noticing level for that instructional video.

Table 1: Alignment between teachers' instructional quality and their noticing level

Teacher	Noticing Level	MQI (for items that align with noticing framework)	Alignment/Misalignment
Bill	3.7	2.5	H/H - alignment
Laura	3	3	H/H - alignment
Anthony	1.5	1	L/L - alignment
Wilma	1.6	3	L/H - misalignment
Katie	1.3	3	L/H - misalignment
Jessica	1.8	3	L/H - misalignment
Sarah	1.7	2.5	L/H - misalignment

L - low; H - high

In the cases of Bill, Laura and Anthony, there was alignment between the quality of their instruction and the level of noticing. We have discussed these findings elsewhere (Cross Francis, Eker, Lloyd, Lui & Alhaayan, 2017). In this proposal, we will focus on the cases where there was misalignment between the teachers' quality of instruction and their level of noticing. For the

purposes of this proposal, we present the analyses of the case of Katie. We considered this misalignment particularly noteworthy as we expected that a teacher who was able to produce relatively high quality instruction would foreground students' thinking which would be visible in how and what she noticed. To better understand the factors that may have influenced this misalignment, we examined her MKT, efficacy, beliefs and emotions.

Table 2. Results of analyses of Katie's noticing, MKT, TE and emotions

	Noticing		MQI	Emotions			Efficacy	
	What	How	Students' Productions	Before (Coaching)	During	After	KE	PE
Katie	Level 1	Level 1	3	Indifferent/Excited	Calm	Calm	High	High

MKT

The focus of the lesson was addition and subtraction of single-digit numbers. As with all of Katie's classes she began with the daily math review which consisted of questions aligned with the instructional goal of the lesson in addition to other questions related to concepts they had previously covered (e.g., number sequences). We determined her localized MKT by rating her knowledge as low, medium or high on four of the MKT dimensions – CCK, SCK, KCS and KCT. We considered both her CCK and her SCK to be strong with respect to single-digit addition and subtraction as she made no errors in solving the problems, supporting students in solving the problems or in discussing students' solutions about the problems. Katie was cognizant of the different types of subtraction problems (total unknown, initial unknown and change unknown) and their levels of complexity. Specifically, that total unknown problems are the least complex of the three and that addition can be used to verify the solution. Subtraction was a new concept for the students so Katie began with total unknown problems. She also discussed with the students the different ways of solving addition and subtraction problems – counting one by one, counting on and making items (drawing circles) to count. We considered her KCS and KCT to be low based on specific interactions with students during the instructional video and her responses to our questions referring to her thinking during those instances. In the first instance, the students were asked to solve the following problem:

Kenneth had 6 balloons. His sister popped 2. How many does he have left?

A student solved the problem and wrote:

$$6 - 2 = 4 \text{ (student put this on the board first)}$$

$$6 - 2 \neq 4 \text{ (Student changes to this but Katie doesn't correct the student)}$$

When asked about the student's thinking in the post-coaching conversation, Katie says he put the slash to show that he was saying that the left side is not equal to the right side. Although Katie knew the difference between both signs, she didn't think she needed to correct it. She was then shown a clip of what was written on the board for an earlier problem.

$$7 + 8 = 12 + 7$$

$$15 \neq 17$$

After seeing these two contrasting uses of the not equal sign, Katie was better able to understand how this could lead to misunderstandings for her students.

We also observed Katie's difficulties in supporting students to solve the following:

Macy had 6 cookies and she gave 2 away. How much does she have now?

Students were supplied with manipulatives to represent the problem. However, instead of being given a set of individual manipulatives (e.g., cubes) from which to select and manipulate to solve the problem, they were given a connected stack of 6 cubes to start. One student, Macy, kept adding two cubes instead of taking two away from the stack. There were several strategies that could have been employed to identify the struggle Macy was having and then to help move her thinking forward, some of which Katie employed. For example, asking a student to show how he would add some more cookies and if that is the same as taking away some cookies. However, although Macy continued to struggle, Katie essentially kept repeating the same strategy. Katie struggled to utilize other teaching approaches that would support Macy. After several minutes the coach asked Macy to show her six cookies, then suggested that she go ahead and eat two of the cookies. Macy took two of the cookies and put them in her lap. She was then able to tell the coach that she would have four cookies left. Katie commented that she didn't think of having Macy model the story. She also didn't consider having Macy separate the stack of cubes so she could represent each cookie with a cube. It's possible that Macy was not able to conceptualize the connected stack of cubes as six cubes (indication that she is not a numeric thinker/counter (Van de Walle, Karp, & Bay-Williams, 2016) but saw the stack as one unit. If Macy was not numeric, she would need individual cubes to count and solve the problem. Based on these observations in the lesson and Katie's interpretations of the events, we considered her KCS and KCT as low.

We considered this low KCS and KCT as a possible influential factor in her noticing. If Katie was not able to recognizing the range of possible reasons why Macy may have struggled to answer the question, she may not have considered this instance of students' thinking significant. Therefore, she would not have thought of it as a particularly interesting or pertinent event to discuss in the post-coaching conversation. Considering she stated that several students were struggling with subtraction, she perhaps categorized it as a part of the normal struggle students have with subtraction problems. As such, she wouldn't have *noticed* this incident as one to unpack independent of the struggles of the class more generally. Additionally, not being aware that allowing students to use the equal sign and not equal sign interchangeably may lead to a misconception would not have been significant, and therefore unlikely she would have identified it as meaningful for discussion.

Beliefs. Katie described math as problem solving and stated that math involved quantity and exploration. She believes there is always a "right" answer, but there are multiple ways to think about and solve problems. Regarding the learning of content, Katie believes that concepts need to be understood first through concrete work and manipulatives and that real contexts are important to use when teaching. She thought math can be applied to everything and that it allowed students to be creative, referencing the approaches of her first grade students. Katie stated that students are learning when they are engaged, when they ask for more, and when they can explain a concept. Katie believes students have varied abilities and learn concepts differently and as such should be allowed to talk about their thinking and make choices about tasks and activities, and the kinds of manipulatives that would support their thinking best. She considers productive struggle to be good and that students should be able to ask questions that lead to deep thinking and good conversation. Regarding her role as a teacher, she believes that when a student doesn't understand a concept, it is her responsibility and not the child's "problem." She also believes that teaching should be thought of as a learning process and teachers should be open to learning along with his/her students. Katie thinks that "teachers don't need to know every single thing" - they should start with what they know and build on their knowledge through a range of

teaching experiences; similar to the way we should engage students in learning. Mistakes are okay so teachers should model how one can reason through and struggle with a problem, as reasoning is an important part of the process to developing understanding. Although Katie thinks flexibility is important, she also thinks that consistency in routines and procedures is crucial to creating a classroom that supports learning.

We observed that in providing students with manipulatives to model the problem of giving away six cookies, Katie was adhering to her beliefs that students should use manipulatives (concrete objects) to build their understanding of new concepts. As well, starting with a total unknown problem in a context that she believed reflected their own experience allowed for students to build knowledge and develop reasoning of new concepts (in this case, subtraction). These practices aligned with what she indicates are some of her beliefs about teaching and how children learn. One belief that we considered particularly salient in this instance is Katie's belief that teachers don't need to know every single thing. Similar to the way we approach students' learning, she believes that teachers can start with what they know and continue to build on that. Katie believes that mathematics embodies a way of thinking and learning for both students and teachers. She believes that learning can be spontaneous and unplanned and that lessons should be designed to reflect this. However, while this belief aligns with what the mathematics education community would regard as healthy beliefs (NCTM, 2014) they can be problematic if the teacher does not have the MKT needed to attend to this spontaneity as learning unfolds. When working on the cookies task, Katie struggled to find a teaching approach that would benefit Macy. When the coach suggested an alternate strategy to develop understanding, Katie appreciated this step and acknowledged she didn't think of that possibility. There were a range of challenges that Macy was faced with that Katie didn't appear to know how to address. Katie saw this as a teachable moment for her – one where she learned a strategy for supporting students struggling to solve single-digit subtraction problems. However, she didn't go further into investigating why this approach worked – what was it about Macy's existing mental constructions of number, addition and subtraction that caused her to struggle when Katie posed the task? Katie also didn't see it as a shortcoming that she wasn't able to support Macy in the moment; rather, for Katie this was an opportunity to learn.

Teaching Efficacy. Katie's confidence in her mathematical knowledge, accessed shortly before the coaching experience, is relatively high with a 3.875 (5 is the highest). In the follow-up interview she stated that although she was fairly confident in her mathematical knowledge she still felt that she had "room for growth and improvement." The use of the words "growth" and "improvement" can be interpreted as indicators that Katie may be more open for learning new mathematics and expanding her knowledge of mathematics, however she was not specific about what aspects of mathematics she still needed to improve but spoke more generally. This may suggest that Katie did not have a clear idea of what she did not know or should know as a math teacher and where exactly she needed to improve her knowledge.

With respect to her personal teaching efficacy, Katie was less confident in her ability to support her students' math learning through her teaching. Her score on the survey was 2.25, which is lower than mid-range based on the scale. During the interview, she explained that: "I guess I feel like since I didn't have very strong math instruction [as a student], that I'm still trying to learn structure as a teacher. And I just question it [my teaching ability] because I know that my [own] math instruction wasn't very strong." Katie was not as confident about her teaching ability as she felt she didn't have very good teacher role models when she was a student. As such, she is still trying to develop structure as a teacher, which for her refers to classroom

management, grouping strategies and lesson implementation format. It's notable that she did not include analyzing and effectively utilizing students' thinking as a core concern of teaching. In this regard, if classroom features are of primary concern, this may explain her noticing score as she would be more focused on classroom-related issues and how the students are functioning as a group.

Emotions. During the pre-coaching conversation, Kim mentioned that the score of 4 on the anger scale was because the time allotted for math was limited and she was generally displeased with the misbehavior of the students. Her concern with students' misbehavior was also raised in a subsequent pre-coaching conversation where she stated that "Oh, I'm always a bit anxious about the students' behavior." As a result, she finds that she often spends a significant amount of time dealing with disciplinary issues which leaves less time to focus on the students' mathematical ability. A third factor that contributes to this score is that fact that the expectation of the administration, according to Katie, is unreasonable. She stated that the administration expects all the schools in the school district to teach a specific number of mathematics topics within a specific time period, although the students at the respective schools are at different levels of mathematical ability.

With respect to pride (which is 2.5), Katie noted that the reason this score is mid-way is because she tends to set a high standard for students in terms of their mathematics proficiency. Therefore, if after teaching a particular lesson, there is still a gap in their understanding, then she takes full responsibility for such outcome. So, she gave that score because at this point her students tend to have more gaps than she is satisfied with. When describing her emotions with respect to the teaching of the lesson, Katie notes that she feels indifferent. She states that "teaching is what I do for a living", so there is nothing special about teaching this upcoming lesson to her students. However, she mentions that she is excited that someone is going to observe her teaching. This is because even though she has been teaching a long while, she believes that there is always room for improvement and she thinks the feedback would be useful. Moreover, she is willing to learn new ways of teaching different mathematical concepts.

During the post coaching conversation, Katie noted that she felt good about the lesson as students were more engaged and they were able to work more independently in exploring mathematical ideas. She mentioned that she was expecting this type of outcome and so she was not overly excited by the successes or challenges the students demonstrated during the lesson. It didn't appear that she had any curiosity, excitement or disappointed related to Macy's struggle. She seemed not to consider it significant so for her it seemed not to warrant any increased pleasant or unpleasant emotion. We considered her emotional response noteworthy for two reasons, (i) if she had anticipated the outcome, why was she not better prepared to support Macy, and (ii) she did appear to have some excitement and interest in the approach that worked with Macy however, the heightened emotional response did not later deem the event significant for discussion.

Implications

Our analyses showed that although a teacher is able to orchestrate instruction that is of fairly high quality, that doesn't guarantee that he/she will readily identify meaningful instances of students' thinking as significant. This may indicate that teachers may enact high-quality teacher moves drawing on knowledge that is more tacit than explicit. We also observed that there were several factors that seemed to influence Katie's ability to notice students' mathematical thinking to some degree. They seemed to serve as filters focusing attention on more general aspects of classroom activity and not on students' mathematical thinking. As such, they are important

factors that need to be considered in teacher development work on noticing specifically, and on instruction broadly. This also underscores the notion that teaching is complex and multi-layered, and that there are a range of factors that influence what a teacher identifies as meaningful or worthwhile instructional events to varying degrees. Although our study focused on the factors that influenced Katie's ability to notice, we believe that the research literature supports that these factors would be influential on other core aspects of teachers' work. We suspect that across teachers the degree of influence varies which would suggest that professional development work be more individualized, first building knowledge of how these constructs influence a teacher's instructional activity, then drawing on this knowledge to inform the approach to be used to support the teacher. Coaching is one professional development model that can support this kind of work.

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