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Author(s): Jen Munson

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Conferring in the Elementary Mathematics Classroom: A Framework

Responsiveness is critical to math learning. When teachers use their understanding of student thinking to craft instruction, students construct strong conceptual foundations (Carpenter, Fennema, & Franke, 1996). Interactions between teachers and students are one crucial way teachers learn about and respond to student thinking. But what do responsive interactions look like in the elementary math classroom?

While much research has been done on faciltiating whole group discussions in ways that are responsive to emergent student thinking (e.g., Chapin, O'Connor, & Anderson, 2013; Stein & Smith, 2011), far fewer studies have explored how these talk moves can be orchestrated by teachers in discourse with small groups of students during mathematical work. Student work time can represent the bulk of the lesson. Understanding how to use interactions during this time to provide responsive instruction has the potential to increase the instructional reach of teachers.

Conferring in literacy is a well-established practice intended to provide responsive instruction to individual students as they read and write (e.g., Calkins, 1986, 2001; Graves, 1983). No parallel discourse structure has been articulated for mathematics. Extending conferring to mathematics would thus takes advantage of existing teacher practices to make responsiveness actionable, routine, and consistent.

In order to confer, teachers must attend to and interpret student thinking (Jacobs, Lamb, & Philipp, 2010). Using all they have noticed, teachers must choose the most powerful response. A growing body of work examines how teachers attend to, elicit, and interpret students' mathematical thinking, and the challenges of deciding how to respond (e.g., Ball & Forzani, 2009; Jacobs et al., 2013). But we don't know much about what follows the decision, namely how teachers enact and adapt decisions in the moment with students.

Further, conferring with collaborating students in mathematics inevitably demands something different. Shifting conferring from one-on-one, as it is in literacy, to one-on-many means that teachers need to consider not just what the group is working on but how the group works together (e.g., Boaler, 2008, 2010; Featherstone et al., 2011; Webb et al., 2009). To do this, teachers must notice more than the mathematical thinking; they must notice collaborative dynamics that support or inhibit access to the learning for all members of the group.

I offer a framework for the math conference, building upon prior work on noticing, eliciting, and productive discourse. The practice of conferring in mathematics (as mapped in Figure 1) consists of:

1. Attending to student thinking and collaborative behaviors,
2. Eliciting student thinking or status of collaboration,
3. Interpreting student actions, words, and representations,
4. Deciding on an instructional focus and how to shift student attention to this focus,
5. Nudging student thinking forward, and
6. Moving fluidly and iteratively through this process as dialogue unfolds.

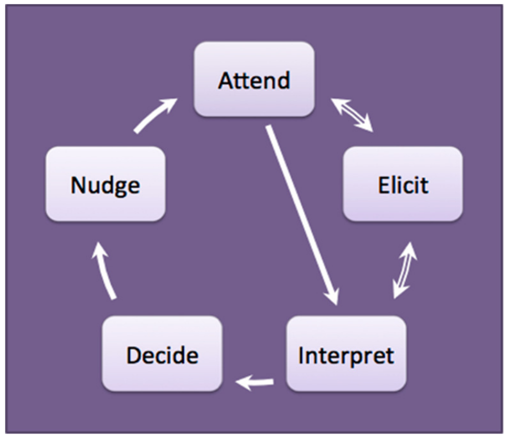

Figure 1. Conferring process, beginning with *attending*.

While we know that productive interactions between teachers and students "build on student thinking" (Franke, Carpenter, Levi, & Fennema, 2001), we don't yet know how teachers might use math conferences to do so. This study begins to address this gap by asking: What characterizes a math conferences? What do teachers focus on when they nudge student thinking?

Methods

Participants

This study examines the practices of two fourth grade math teachers who were learning to confer. The teachers each taught at the same large, diverse elementary school in the southern U.S., participated in ongoing professional development in mathematics instruction, and had more than 5 years' experience teaching fourth grade mathematics. During the fall of the year in which the data were collected the participants took part in professional development held at their school site for all math teachers on the practice of conferring in mathematics.

Data

During three consecutive days of instruction mid-year, I audio recorded all interactions between the participating teachers and students during collaborative work time. In total, nine lessons were captured, six lessons taught by one teacher and three by the other.

Analysis

Qualitative analysis encompassed three broad phases: (1) categorizing all teacher-student interactions to distinguish conferences; (2) analyzing the discourse within conferences to determine structure; and (3) categorizing types of nudges. All phases included *a prior* and emergent coding to create coding schemes that fully accounted for the data. All 330 interactions were categorized into one of five interaction types (see Table 1).

Table 1

Teacher-student interactions types during work time

Interaction Type	Description
Bid	Petitions for attention.
Monitoring	Checking on students to get an impression of the class and keep students on track.
Managing	Directing, repeating, redirecting, or clarifying so students can focus on the mathematical work.
Approximated Conference	Attending to, eliciting, and interpreting student thinking or work. May include probing, funneling (Wood, 1998), or attempted nudge. Does not include a complete nudge.
Complete Conference	Attending to, eliciting, interpreting, and nudging student thinking or work. May include additional moves such as probing.

In addition to the 32 complete conferences identified, analysis revealed 65 conferences in which the teacher focused attention on eliciting student thinking beyond simply monitoring for accuracy or progress, but did not successfully nudge student thinking forward. I termed these conferences *approximated conferences*, because they shared the intent of the conference while approximating its form.

I selected 57 conferences for transcription and qualitative analysis. These included all 32 complete conferences and a purposive sample of 25 of the approximated conferences, chosen to represent a range of forms and foci. Transcripts were segmented into episodes based on dialogic purpose. I analyzed the nudge episodes – which define complete conferences – with *a priori* codes drawn from prior scholarship (e.g., Chapin et al., 2013; Jacobs & Ambrose, 2008) and emerging themes to determine nudge types.

Findings

Complete Conference Structure

Of the complete conferences in the sample (n=32), 75% had a common structure, which included the following sequence: (1) initiation by teacher or student, which often serves to elicit, (2) eliciting and/or probing of thinking, and (3) a nudge. This progression reflects math conferences as conceptualized in this paper.

The complete conference in Figure 2 shows this structure, beginning with an initiation by student request (lines 1-3), the teacher eliciting further thinking (lines 4-11), a nudge focused on the difficulty the students named (lines 12-15), and a closing that confirms the students' plan (line 16).

S1: I don't know how I'm supposed to make it up to 50.
S2: 62.
S1: Not 62!
Teacher: Hmm? So what do you have so far?
S1: We were trying to make this...but, it's not working out.
Teacher: Oh, that's interesting. So what could you to do to, maybe... What's the problem with what you have so far?
S1: 12, 24 –
S3 *(From another group)*: - You didn't measure this...
S1: We're not doing that. 12's a foot, plus 24, and that plus that equals 14. 14 plus 24 only equals 38.
Teacher: Hmm... So what could we do to change that perimeter? Or to increase your perimeter?
S1: Hmm... *(Pause)* I don't know.
Teacher *(To S2)*: You have any ideas, (S2)? How could you increase your perimeter?
S1: We could always do 6. 6 and 6.
Teacher: Okay, you could try that. Why don't you try that?

Figure 2. Structure of a complete conference, with initiation, eliciting, and nudge.

Complete conferences are sustained interactions, (mean = 95 sec, compared to non-conference mean = 15 sec) and distinguished by the presence of a nudge. The nudge is co-constructed by the teacher and students, is contingent on the thinking elicited, and pushes student thinking forward. In Figure 3 the teacher made direct moves to prompt strategic thinking (lines 12 and 14), which only developed because the student took up the teacher's question (line 15). The teacher does not simply provide a direction (e.g., "Think about how you could increase the perimeter.") and then walk away. Rather, the teacher provides an avenue for consideration and participates with students in developing this into a nudge which advances student work.

The length of these episodes varied across the sample. For instance, in rare conferences the initiation yielded enough information for teachers to decide on a nudge that met student needs. However, in many conferences eliciting took over a full minute and sometimes teachers toggled between eliciting and probing. For interactions with an average duration of 1 min 35 seconds, this time commitment positions eliciting as the episode which anchors the conference. In contrast, nudges were often brief, as in Figure 2, but occasionally required lengthy co-construction by the students and teacher. Understanding the variation in nudges is important for understanding the conference as a whole. In the following section I zoom in on the typology of nudges the data yielded.

Typology of Nudges

The nudges (n=36) in this study were categorized into five types, distinguished by their purpose: conceptual understanding, developing a strategy, communication, representation, and collaboration (see Table 2). Each type of nudge leads to corresponding type of conference. Collectively, these five nudge types allow math conferences to span developing mathematical thinking, mathematical practices, and collaborative behaviors.

Table 2
Typology of nudges

Nudge Type	Description
Conceptual Understanding	• Focuses attention on the underlying meaning of the task and the concepts it represents • May include reasoning about an error
Developing a Strategy	• Coaches students to develop a strategy for the current problem • Students maintain ownership over the choice of strategy
Communication	• Prompts students to articulate thinking • Often a rehearsal for writing or sharing
Representation	• Prompts students to develop ways to represent the task, thinking, or strategy • May allow students to communicate more effectively, develop generalizable representations, identify a strategy, or uncover errors
Collaboration	• Orients students to each other's thinking (Chapin et al., 2013) and focuses efforts on joint work • May include deliberately structuring more equitable dialogue

Conceptual Understanding and Developing a Strategy Nudges. *Conceptual understanding* nudges focus on helping students to make sense of the mathematical ideas underlying the task at hand. Alternatively, *developing a strategy* nudges center on fostering student-driven strategies for tasking the task. Teachers do not suggest strategies but rather provide framing questions that allow students to develop a strategy that makes sense to them. These two types of nudges focused on the mathematical tasks students were grappling with and were inherently tied to the particular context and content of the math task. As such, the questions and prompts within these nudges were typically particular rather than generic.

In the following example of a conceptual understanding nudge, students were working to find the perimeter of rectangular objects in the classroom while using strategies developed the previous day for converting between feet and inches and inches only (i.e., 5 feet 2 inches = 62 inches). The teacher began the conference by eliciting student thinking and it surfaced that students were getting stuck thinking of 2 feet 4 inches as 12, 12, and 4 inches. This is a conceptually critical move, but the teacher nudges students to focus on the idea of "total inches" to solidify the conversion:

1 Teacher: Okay, so wh-, how many total inches is 2 feet and 4 inches?
2 S1: 12
3 S2: 12. Wait.
4 S3: Oh…24.
5 Teacher: 24? Just 24? Two feet is 24 inches. What about the oth-, you said 2 feet and what?
6 S3: 4 inches.
7 Teacher: 2 [feet and 4 inches], so, so, oh, 28 inches… Okay, so -
8 All Students: [28, 28]

At this point one student (S3) makes as assertion about the two opposite sides of the rectangle they are measuring, which shifts the conceptual focus of the nudge from conversion to perimeter:

S3: - And this is the same as this.
Teacher: Oh…how do you know that?
S3: Because [it's the same]
S2: [It's the same.] It's equal.
Teacher: Oh, because, oh, okay…
S2: Th-, it's equal parts –
S3: - And, and this is the same as this.
Teacher: Oh […okay.] So you only have to do half the work it sounds like, huh?
S2: [This one -]
S3: Uh-huh.

In this nudge the students move from a place of being somewhat conceptually stuck to thinking about how to find the perimeter of their rectangle in inches only using what they know about feet, inches, and rectangles. The nudge is co-constructed by the teacher and students. The teacher focuses attention on the idea of "total inches" and students do take up that focus, but they also choose to refocus attention as observations and connections bubble up. The teacher then takes up the student's suggestion that the two parallel sides are "the same" probing that thinking (line 10), which is then taken up by one of the partners as well (beginning on line 12). In line 16, the teacher draws student attention to how this observation might serve them in their work. Each of these moves is tied to the specific context of the task, the mathematical concepts involved, and the conceptual knot these students were trying to untangle.

A similar pattern of specificity can be seen in the following example of a developing a strategy nudge. In the example below students were asked to develop a strategy for converting between feet and inches and inches only. At the opening of the conference the student indicated that he has selected a ruler to help him but that he was confused about how to use it. The teacher nudges the child to develop a strategy utilizing the ruler he chose:

Teacher: Okay. Well, what do you understand about it though? *(Pause)* What are you going to do with this?
Student: I, uh, I…I have another ruler but I don't know where is it.
Teacher: Okay -
Student: - Maybe she do –

At the start of this nudge the student's attention focuses on the need for another ruler. The teacher refocuses him on *how* he will use the ruler:

Teacher: - Okay, so, so what are you going to do with that though?
Student: I want to circle the number and then I want see…by foot. Then I…then I…

At this point the student struggles to put words to his idea and falls silent. The teacher again refocuses his attention, but this time she expresses belief in his thinking. This move gives him enough time or confidence to find words for his strategy:

Teacher: You have an idea. What is it?
Student: My number is 64…my number is 64 inches, so I want to continue 'til to get to 64 –
Teacher: - Oh, okay –
Student: - And then we don't get to 64, we put inches.

In this example the teacher supports the student to develop a strategy for tackling the task at hand, while not dictating what that strategy should be. The teacher's prompting is, again, focused on the specifics of the student strategy, in this case how he might use the ruler to support finding the perimeter.

Communication and Representation Nudges. *Communication* nudges prompt students to articulate their thinking, typically to promote the construction of a complete, cohesive explanation. *Representation* nudges encourage students to develop way to represent their thinking with manipulatives, pictures, numbers, and/or symbols. These two types of nudges often came after the teacher elicited student thinking that represented sense-making of the mathematics. In the case of communication nudges, the teacher may have asked many eliciting or probing questions to draw out the students' strategy, understanding, or reasoning. Teachers tended to initiate a communication nudge using a standard question form which either generically asked students, "How could you explain your thinking to someone else?" or specifically prompted students to consider an audience, as in "How will you explain your thinking to the class when I call on you to share?"

Such a general prompt can be seen in the following example. One partner (S1) had dominated the explanation of the pair's strategy for converting inches to feet and inches, while the other (S2) remained silent during this initial part of the conference. The teacher starts to nudge the team as a whole about how they will communicate their thinking to the class, but then pivots to focusing on the previously silent partner (S2) to give her a chance to articulate the strategy:

Teacher: Very interesting. So whenever, if I asked you to come up there, can you guys explain it to the class? (S2), are you going to be able to explain it?
Student 2: Mmm…
Teacher: (S2), tell me what she just said.
S2: We, um… We subtract 67 and 12…and then we kept on going…
Teacher: Okay, so tell me why you subtracted 12 – what does that mean?
Student 1: Because 12 is, um, one foot.
Teacher: Okay, (S2), what does that mean? How come you subtracted 12 out of there? (Pause) Did you just pick a number? Did you have a reason?
S2: Because one foot is 12 [inches]

The teacher uses a repeating move (Chapin et al., 2013) in line 4 to prompt the student to put the ideas expressed first by her partner into her own words. It is important to note here that Student 1 had given voice to a strategy that they had used jointly. When the teacher prompts Student 2 to explain the strategy, it is presumed to be a strategy that she understands rather than one she is hearing for the first time. Student 2 begins to narrate their process (line 5), and the teacher follows up (line 6) probing the reasoning behind that process. Even when the more vocal partner (S1) inserts her own reasoning (line 7) the teacher reopens the opportunity for Student 2 to articulate her reasoning (lines 8-9). This sequence of moves, coupled with the original elicitation, created a deliberate space for both partners to rehearse presenting their strategy.

Representation nudges often followed a clear explanation of student thinking accompanied by a sparse or blank paper. Teachers initiated representation nudges in a similarly standard form, often "Could you draw a picture of what you just said?" or "How could you represent your thinking on your paper?" In the example below, the students provided a joint, complete explanation of the strategy they used to solve a problem and the reasoning that supported their thinking. The teacher, noticing that their oral explanation isn't captured in writing, nudges the team to represent:

Teacher: Oh, wow. Okay, can you, can you show the work on here, how you came up with that? 'Cause that way if I put it up in the hallway, people can see what you did.

Student: Okay, so 19 times 2 –

After the teacher makes the request that they show their thinking so that it can be seen by others, the students immediately begin talking to each other about their process, narrating out loud as they record.

Collaboration nudges. A *collaboration* nudge orients students to each other's' thinking (Chapin et al., 2013) and focuses efforts on joint work. Collaboration nudges typically occurred when partners appeared to be working independently or inequitably. In the example below, the teacher elicited student thinking about a task that involved finding the perimeter of a rectangle. One partner (S2) asserted that they could use multiplication to find perimeter, but he addresses this proposed strategy to the teacher only. At which point the teacher nudges the students to communicate with each other:

Teacher *(To Student 3):* So, did you hear that? Did you hear what he said?
Student 3: Mmhm.
Teacher *(To S3)*: What did he just say? *(Pause)*
S3: Well, I know what you said.
Teacher: Okay. Can you tell me what (S2) just said?
S3: No. I know what you said.

When the teacher asked Student 3 to repeat the strategy, he says that he cannot. Then the teacher pivots to Student 2 to ask him to address his partner directly, which simultaneously gives Student 3 another opportunity to hear the proposed strategy:

Teacher: Okay. (S2), can you explain what you just said again?
S2: Um, since there's 19 on each side and 18 on each side, just multiply 19 x 2 and 18 x 2, and then add up the answers…

10 S1: That’s what I was thinking.

At this point Student 1 has rejoined the conversation, and the teacher persists in following up on Student 3’s stated lack of clarity on the strategy:

11 Teacher *(To S3)*: Okay, does that make sense to you?

12 S3: Mmhm.

13 Teacher *(To S3)*: Why did he say 19 x 2 and 18 x 2? *(Pause)*

14 S1: I know.

15 S3: Um, because there’s two, like, 18 would up here and here.

A collaboration nudge such as this one can also serve to promote communication. However as in this case, there is a focus on orienting students to the thinking that their partners offer and to encouraging partners to address each other rather than just the teacher. In that way the communication focuses internally, within the group, rather than toward an external audience such as the class. It is this quality that distinguishes this nudge as focused on collaboration. In other collaboration nudges, the teacher may deliberately structure more equitable dialogue or physically orienting students toward joint work.

Significance

Responsive instruction is important for students’ mathematical learning, but defining how teachers can enact responsiveness has been slippery. Math conferences offer one structure making responsiveness routine and actionable. This study defined the math conference as a structure, catalogues conference foci, and identifies the critical feature of responsiveness in a conference, the nudge.

Nudges represent a new contribution to scholarship. Responsiveness hinges on turning an accurate interpretation of student thinking into action. The nudge is this action and embodies building on student thinking. Without the nudge a conference either remains an act of eliciting or degrades into funneling (Wood, 1998) students toward a particular way of thinking. Critically, while teachers select a focus, the nudge is a shared project. When teachers notice how students take up the nudge they create opportunities to revise and refine. This represents a further dimension of teacher noticing in the mathematics classroom.

NCTM’s “Principles to Actions” (2014) declares, “Support for access and equity requires…appropriate emphasis on differentiated processes that broaden students’ productive engagement with mathematics.” The math conference is one such process. This study provides a vision of how teachers and students can use conferences to co-construct differentiated, responsive learning experiences.

Future research is needed to examine how these practices are manifested in other classrooms and across grade levels. For instance, are other structures or types possible in primary grade classrooms? How might conferences be structured differently if the activity were not problem solving, but a mathematical game? Further, how teachers learn to confer is as yet unknown. Teacher learning and professional development around cross-disciplinary practices has become much studied. How could teachers who confer with their students in literacy learn to confer in mathematics? What pedagogies of professional development would best support such learning? Additional investigation of both responsiveness and learning to respond are needed to provide teachers access to the pedagogy of conferring.

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