

TEACHERS LEARNING TOGETHER: PEDAGOGICAL REASONING IN MATHEMATICS TEACHERS' COLLABORATIVE CONVERSATIONS

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In the United States, teaching is an isolated profession. At the same time, ambitious forms of teaching have been shown to benefit from teachers' collaborations. What is it about collegial conversations that supports teachers' ongoing professional learning? In this paper, I synthesize findings from prior studies on mathematics teachers' collaborative conversations, focus my analysis on collective pedagogical reasoning. I examine four facets of collegial conversations that support refinements in this reasoning. These facets are: interactional organization, engagement of individual teachers in a group, epistemic stance on mathematics teaching, and locally negotiated standards of representational adequacy. Together, these aspects of teacher talk differently organize opportunities for professional learning.

professional learning, in-service teachers, discourse analysis

INTRODUCTION

In the United States, teaching is an isolated profession. Teachers tend to work alone in their classrooms, having little interaction with colleagues. Typically, other adults in the school only visit a teacher's classroom to evaluate performance — and even then, such visits are infrequent.

At the same time, mathematics teaching that engages learners in sense making requires challenging forms of pedagogy. For example, practices like building on student thinking or effectively using high-press questioning shift teachers' attention away from the clear presentation of ideas to building students' understanding. This shift increases the uncertainty of teaching, requiring adaptation and maneuvering even among the most sophisticated of practitioners (Cohen 2011).

My work takes these two observations as a starting point to make the claim that teachers' professional isolation works against the demanding teaching practices that are at the center of many reforms in mathematics education. By leaving teachers on their own to diagnose and respond to the inevitable puzzles of practice that arise, these desired forms of teaching may not take a firm root in many classrooms.

There are two primary reasons for this. First, many teachers will implement superficial changes that take the form of ambitious pedagogies without fulfilling their intended function. They may, for instance, have students work on a cognitively demanding task, but in

implementation, turn it into a procedural one. Alternatively, teachers will find the uncertainty inherent in this kind of teaching untenable and simply abandon it for more traditional forms of practice that are better aligned with the institution of schooling.

For these reasons, I have spent the last decade examining how teachers might learn together in support of ambitious mathematics pedagogy. Educational research has consistently shown a relationship between schools or departments in which teachers work collectively and higher-than-expected student achievement (Bryk et al., 2011, Lee & Smith, 1996, McLaughlin & Talbert 2003). This relationship is often coupled with more ambitious forms of teaching. The hunch in the field has been that these teacher collectives support and sustain professional learning, yet the ways in which this learning unfolds has been underspecified.

In this paper, I describe findings from several studies I have conducted with the aim of uncovering how teachers' collaborative conversations might support and sustain professional learning.

HOW MATHEMATICS TEACHERS LEARN TOGETHER

For over a decade, I have studied secondary mathematics teachers' conversations about their work. I have collected records of hundreds of hours of these discussions in the form of field notes, audio recordings, and videos. I analyze the learning opportunities within these interactions by looking at the *episodes of pedagogical reasoning* (EPRs), or the moments in teacher talk where are moments of teacher-to-teacher talk where issues or questions about teaching practice are brought out and accompanied by some elaboration of reasons, explanations, or justifications. EPRs can be single turn utterances, such as, "I'm not using this worksheet because it bores the kids." More relevant to group development are multiparty EPRs, in which descriptions of practice and pedagogical reasoning are co-constructed over many turns at talk.

EPRs provide a window on teachers' learning opportunities because they are moments in which pedagogical reasoning is made publicly available to colleagues. Depending on the interactional organization of a particular group, the nature of the learning opportunities may vary. On the one end of the spectrum, where norms of questioning others' thinking are not in place, teachers may simply have an opportunity to hear the way their colleagues think without taking it on. On the other end of the spectrum, teachers may have an opportunity to critically engage with one another's thinking, considering alternative explanations in ways that support deeper understandings or even conceptual change.

This paper is an opportunity for me to synthesize prior analysis of the resources for teacher learning in collegial conversations. The four components I describe below are features of any teacher workgroup. They can be differently marshalled to provide more or less opportunities for the kinds of learning that supports ambitious mathematical teaching. In the following sections, I describe critical features of these conversations: interactional organization, engagement in a group, epistemic stance, and representational adequacy. Together, these allow for an analysis of the resources for learning within a teacher group.

Interactional organization

To learn together, teachers must, at the very least, have opportunities to work together. In American secondary schools, this is a nontrivial condition. In 2002 survey conducted by Public Agenda, only 20% of U.S. high school teachers reported that they “regularly meet to share ideas about lesson plans and methods of instruction” (Public Agenda, 2002, p. 23), suggesting that norms of privacy still prevail. Given the paucity of idea sharing among teachers — which does not approach the complexity of collaborative pedagogical problem solving (Horn & Little, 2010) — typical school cultures are not ripe for productive teacher conversations.

Gatherings of teachers are rare in U.S. schools, yet even these are decidedly insufficient for the development of pedagogical reasoning. My research has supported findings in earlier work saying that, to succeed in improvement, teachers need a common focus on student learning and a commitment to improvement. When examined at the level of interaction, we find that this, too, is insufficient to support teachers’ professional learning. Teachers can have a stated commitment to student learning and professional improvement, yet still focus on logistical aspects of planning over a deeper focus on student thinking (Horn & Little 2010).

The kinds of conversations that provide teachers with professional learning opportunities take a distinct shape. In an analysis of a group of teachers who sustained ambitious forms of mathematics teaching for over a decade, I found that their conversations unfolded in ways that first gave emotional support and then encouraged elaboration, specification, and revision of interpretation of classroom teaching events. These conversations supported a collective interpretation of teaching, with colleagues providing multiple conjectures about the uncertain aspects of teaching and the introduction of teaching principles to interpret and eventually build a general understanding of the work (Horn 2010).

Consider the following problem statement by Tina, a new teacher, to her colleagues in the Algebra Group:

TINA: My students, I don’t know where they’re from, but they’re doing so well, I mean they know the difference between a linear graph versus exponential. But the thing about my students is that there’s kids that know a lot and then there’s kids that you know, feel like they’re slow learners.

CHRISTY: (*Nodding vigorously from “a lot” to “slow learners”*)

TINA: And I’m trying to find group-worthy activities

CARRIE: (*Nods*)

TINA: where the kids who are fast learners and the kids who are slow learners, that it can close the gap.

Another new teacher, Christy, nodded as Tina explained her problem, expressing at empathy for Tina’s portrait of her students’ knowledge. Carrie, a more experienced teacher, then nodded as Tina described her proposed solution to the problem,

finding group-worthy activities. Such gestures indicate emotional support and alignment among the teachers as they report on teaching problems.

As the conversation unfolded, Carrie posed questions that drew out a more elaborated account of Tina's problem. She then offered another interpretation:

CARRIE: I wonder if it's not just the activities you're doing but also just status.

TINA: Mhm.

CARRIE: You know? I mean even if you did give them a group-worthy task, those kids who feel like they have low status will just continue to play that *role*

TINA: (*Nodding.*)

CARRIE: (*Nodding*) because they think that that's what they're supposed to do.

Carrie's introduction of status reframed Tina's analysis of the fast and slow kids in her classroom by proposing that something besides the content of the activities may have been hindering students' participation. As the episode went on, the elaboration and re-interpretation of Tina's fast kids problem continued (Horn 2007), providing supports for her professional learning as well as other interlocutors like Christy.

What is it about this kind of interaction that supports professional learning? In a comparison of the mathematics teachers' conversations to those of statisticians and health scientists, Hall and Horn (in press) found similarities in the kinds of talk that supported new understandings about work-as-usual. Consulting interactions, such as the one above, provide an occasion for comparisons over accounts of practice that allow participants to borrow and extend methods. These kinds of consultations support teachers' ongoing learning about their work. The introduction of multiple viewpoints — is the problem the activity or student status? — and the work of reconciliation can reorganize teachers' understandings of teaching.

Engagement in a group

The question of interactional organization becomes meaningless if teachers are not engaged in the activities of a teacher group. At a minimum, teachers find collegial conversations for the emotional support they are able to garner. Simply telling the tale of classroom trouble — griping or venting — to other adults may be emotionally beneficial. Beyond this, individual teachers may or may not be aligned with the broader purposes of the story swapping, even in the most productively organized teacher group.

The most productive groups I have studied have a clearly stated goal that has meaning to the participants. For instance, one group met regularly to work on detracking, emphasizing finding activities that supported multiple forms of student mathematical competence (Horn 2005, 2006, 2007, 2012), while another aimed to increase success first year college preparatory algebra class (Horn 2012, Horn & Kane under review). Teachers not aligned with

the groups' purpose did not participate as successfully, whether because they wanted to hold onto traditional forms of teaching or because they found the work of examining students' thinking too demanding.

Engagement supports teachers in sustaining complex forms of practice. In more accomplished teacher groups, participants reported a sense of accountability through regular meetings with colleagues. In interviews, they often compared their workgroups to having an exercise partner: they held teachers accountable to what they set out to improve. Ambitious forms of mathematics teaching are difficult to sustain, particularly when students' expectations are for other kinds of teaching. Regular conversations with other teachers motivated participants to persist (Horn 2012).

Engagement is not always an easy accomplishment. In addition to alignment of individuals with the group's purpose, engagement requires a capacity for conflict (Achinstein 2002; Grossman, Wineburg & Woolworth 2001). For individuals to learn they must be able to air their thinking. To this end, alternative viewpoints need to have a means to be considered, as when Carrie proposed another interpretation of Tina's problem. If teachers cannot honestly speak their minds, their ideas about teaching will not be in play and not have traction for conceptual change.

Because teaching has moral dimensions, certain questions about the role and obligation of teachers are a matter of interpretation and commitment (Bartlett 2004). Misalignments can occur between a teacher's conception of their role and the group's conception. In these instances, the group is not a productive place for that teacher's learning. Likewise, such an individual can disrupt other's learning by persistently airing alternative framings of problems and redirecting the conversations (Horn & Little, 2010).

In groups where sufficient alignment exists among participants, the collaboration becomes a resource for teacher identity. On the less productive end, this collective identity can take the form of balkanization (Hargreaves, 19xx) in what McLaughlin and Talbert (200x) have called *traditional teacher communities*. More productively for the goals of improvement, these teachers groups support ambitious forms of practice. Participants become, for instance, "an Algebra Group teacher"; this identity marks them as taking a certain stance on teaching, embodying a set of moral and professional commitments. In these instances, teachers report in interviews the significance of their participation, and sometimes the visibility of their participation to other colleagues who may express either envy for their support or scepticism toward their ambitious goals. The group identity supports ongoing improvement efforts on the part of individuals, since reverting to traditional practice would be to deny this part of them selves.

Epistemic stance on mathematics teaching

The organization of interaction and resulting teaching identities described above indicate a certain epistemic stance on the work of teaching. By *epistemic stance*, I refer to an expressed perspective on what can be known, how to know it, and why it is of value (Hall & Horn in press). Being an Algebra Group teacher like Tina and Carrie, for instance, required some buy in to the project of detracking. Such a project entails a certain epistemic stance that presumes

ridding a department of ability leveling is a worthwhile and reasonable goal. Likewise, to participate successfully in the Algebra Group meant seeking collegial discussions to collectively interpret the work of teaching. Epistemically, this indicates a view of teaching expertise as partial and in ongoing development.

At a finer grain of analysis, we find other indicators of epistemic stance in teachers' conversations. Three interrelated features of conversations highlight any teacher group's epistemic stance on the work of teaching: *framings*, *principles*, and *category systems*.

Framings refer to the ways that problems are defined through activities and interactions (Goffman 1974). Problem definition, whether explicit through talk or implicit through the organization of activity, communicates an epistemic stance. By defining an activity as serving the goal of detracking, for instance, this communicates that this work is worthwhile and feasible. At the level of conversational routines, interactional organization that helps teachers coordinate schedules versus re-interpret classroom events (as described in the previous section) communicate very different epistemic stances on what can be known, how to know it, and what is of value.

Closer in the content of teachers' talk, we find all teacher groups use teaching principles, or propositions that serve as the foundation for pedagogical reasoning (Horn & Little, 2010; Horn & Kane, under review). Principles occur in teachers' talk and focus the analysis of a teaching problem on any combination of teaching, students, or content. These statements may be more or less explicit, ranging from statements like, "Being consistent with routines help students understand expectations," to smaller claims like, "Starting a new unit is a good time to start fresh." While both of these principles express a stance on teaching and students, neither engages issues of mathematics.

In a comparative analysis of teacher groups at different levels of teaching accomplishment, principles turned out to be the primary window into the content of the teachers' collective thinking about students, teaching, and mathematics (Horn & Kane, under review). In addition, teachers' use of principles revealed conversational processes that yielded important distinctions across the groups. The more sophisticated teacher group tended to use principles with greater frequency, grounding their pedagogical reasoning in well-articulated stances on teaching. In addition, they tended to use *multidimensional principles*, focusing simultaneously on teaching, students, and mathematics more often than either the beginning or emergent teacher groups. This reflected the sophisticated group's more complex view of teaching they expressed and exhibited in their own classrooms. In this way, principles reflected epistemic stance as expressions of how one knows something in the work of teaching.

Teachers' conversational category systems classify things in the world in everyday talk. For instance, a teacher might, as Tina did, refer to "slow" or "fast" students, a "hard" or "easy" class. A component of frames, these systems model problems of practice and communicate assumptions about students, subject, and teaching (Horn 2007). In the fuller paper that Tina's problem comes from, I analyzed how teachers' conversational categories for students played out in two different mathematics teacher groups who were faced with a Mismatch Problem.

That is, they felt that their students' achievement levels were not well matched to their intended school curricula. As they talked through the problem, one group of teachers maintained static categories of student ability and motivation: students *were* fast, slow, or lazy. The only viable solution to the Mismatch Problem was to lessen the demand of the curriculum to accommodate the problem as they understood it. In contrast, Tina's group saw student abilities as malleable: students were fast and slow at certain mathematical things, but these descriptors did not fix student characteristics. In this light, teachers could shift the nature of activities to allow different students' strengths to come into play, keeping the curriculum's rigor in tact.

Representational adequacy

For people to learn together, they require a common object to reflect upon and examine. When teachers work together to deepen their understanding of teaching, a persistent challenge is that their conversations are generally outside of moments of practice. This asynchronous alignment of conversation and action demands some form of representing their work to provide grounds for consultation.

Representational adequacy describes the locally determined standards for constructing portraits of practice (Hall & Horn in press). In some teacher groups, reports like, "The lesson went well," or plans like, "We'll teach Section 7.1" sufficed for participants to feel as if they had a grasp on the discussion. In other groups, these representations of teaching were not adequate, and teachers would provide or solicit a clearer window on classroom life (Little 2003). Three conversational means I have found for this representational work are *artifacts*, *replays*, and *rehearsals*.

Artifacts of practice include curricular materials, student work, calculators, or even slogans for reform. They serve as symbols for more complex activities, and, as such, their full meaning comes out through teachers' interactions. Nonetheless, they can anchor conversations by providing a common object for teachers' conversations.

Much of the complexity of ambitious teaching practice occurs in the course of interaction. Artifacts typically cannot fix classroom dialogue as a common object (unless they are observation notes or a video tape). Because these discussions about interaction are critical to the success of ambitious teaching, workgroups often find ways to represent this facet of practice. I have found this representational work done in two ways. Retrospectively, teachers *replay* classroom events, reporting classroom dialogue, often embedded in a story. Prospectively or generally, teachers *rehearse* classroom events (Horn 2010).

The issue of representational adequacy becomes interesting in the analysis of replays and rehearsals in teachers' conversations. Like principles and artifacts, the teachers more adept at sophisticated forms of practice represent their work with greater specification and complexity. "We'll teach 7.1" would be a wholly insufficient rehearsal for a sophisticated group. Consider this excerpt of a sophisticated teacher examining a possible lesson on standard deviation. The underlined text is rehearsal talk that could be directly imported into the classroom:

He says aloud, "So standard deviation helps decide what does 'in here' mean.
Whether they learn/ go through an algorithm or this messy thing that doesn't

make much sense, or whether they just get it from their calculators, either way the connection to something real... Is it in *this* area?” He points to the area underneath the normal curve that would be within two standard deviations of the mean. He pauses and then continues. “What’s the difference between the data point and the mean? What’s the square root all about? To get rid of the negative...” He looks up at his colleagues around the table and says: “Try out this algorithm.” He points to the algorithm for finding standard deviation. “Try explaining each step.”

As he examined a piece of curriculum, the teacher’s evaluation did not come from simply reading and evaluating it. Instead, he imagined it enacted in the classroom via rehearsal talk, trying to understand how it will help his students understand the key mathematical idea. In other words, the curricular artifact was not adequate for representing the classroom but required the enhancement of instructional language.

Sophisticated teacher workgroups consistently produce more complex representations. In particular, the teachers’ replays and rehearsals simultaneously portray student and teacher voices in interaction (Horn & Kane, under review). This multivocality indicated a stance on representational adequacy of classroom activity. Specifically, it was not enough to represent teaching through only utterances of teachers *or* students. Instead, interactions became a key point of inquiry in the workgroup conversations, requiring the reported speech of both parties. Such representations fix interactional aspects of teaching for collective interpretation.

DISCUSSION

Taking these different pieces of analyses together, I propose that teachers’ collaborative conversations stand to provide opportunities for practice-based understandings of ambitious instruction. Interactionally, teachers revisit important classroom events in consultation with their colleagues, interpreting them, considering alternative responses, and linking them to other instances of practice.

The four components of teachers’ conversations described in this paper work together to support these professional learning opportunities. In the most productive examples of teacher workgroups, teachers’ conversations accrue complex representations of practice linked to certain principles. The principles serve as the interpretive lens for these instances of teaching, embodying epistemic stances on what is knowable in teaching and how one should go about learning it. Routines of interaction allow for the description and elaboration of classroom practice, communicating local standards for representational adequacy. Teachers’ engagement in productive groups supports their work toward ambitious goals and their sustaining complex forms of teaching practice. This engagement is important to help them air their ideas and find meaning in their colleagues’ responses to their problems of practice.

Although teacher collaboration is not a regular part of teachers’ work in the United States, it seems to have a role in the support of ambitious forms of mathematics teaching. By highlighting the aspects of conversations that open up opportunities for professional learning, this framework provides an analytic tool for both researchers and practitioners seeking to support productive conversations. Instructional improvement efforts would be well served by providing opportunities for teachers to consult with colleagues in ways that support ongoing learning through practice.

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