NEGOTIATING MATHEMATICAL GOALS IN COACHING CONVERSATIONS

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Content-focused coaching aims to focus the coach-teacher conversations on the quality of mathematical goals and associated activities while co-planning a lesson. The coach's role is to support the teacher to articulate a mathematical goal that represents an important mathematical idea, to plan activities in support of that goal, and to anticipate how students will respond to the mathematical activities. We use a framework that emphasizes the dialogic and mediated nature of the coach-teacher conversations. We found that coaching conversations focused primarily on instrumental aspects of lesson planning and only less so on deeper articulations of content, and we found differences across coaches' practices. The findings provide nuance to empirical findings of coach-teacher conversations.

SUPPORTING TEACHERS TO ENGAGE IN AMBITIOUS INSTRUCTION

There are ongoing efforts in many countries to engage students in disciplinary practices, which entails greater support for teachers (cf. Andrews, 2013; Li & Ni, 2012). For teachers who are implementing challenging instructional practices, one type of professional support that is growing internationally is coaching (c.f, Kickbusch & Kelly, 2021). Coaching provides teachers feedback (Boston & Candela, 2018) and focuses them on core aspects of instruction (Coburn et al., 2012). Coaching typically involves someone with content and pedagogical expertise who works in a one-to-one setting with a teacher. Many coaching models have a three-part *coaching cycle*, in which the coach and teacher co-plan a lesson, the teacher and /or the coach teaches the lesson, and the coach and teacher then reflect on the lesson together (Campbell & Malkus, 2011; Gibbons & Cobb, 2016; Russel et al., 2020).

There needs to be a greater understanding of how coaching supports teachers' capacity to enact ambitious instructional practices (Gibbons & Cobb, 2016); mathematics educators need a more nuanced understanding of how coaches engage teachers in substantive mathematical and pedagogical discussions. A deeper understanding of the nature and impact of coaching conversations will inform how to engage teachers in the challenges necessary to transform their teaching.

THEORETICAL FRAMEWORK

Our framework emphasizes the dialogic nature of learning (Bakhtin, 1986; Vygotsky, 1986). Vygotsky emphasized the asymmetric nature of the dialogue between two parties in which one is well-versed in the principles of a discipline and the other is conversant in everyday formulations of the content. Vygotsky emphasized that for the learner there is a dynamic interplay between the disciplinary concepts introduced by

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the more expert member and the learner's informal and empirically-based formulations. Moreover, dialogue involves a process of interanimation (Bakhtin, 1986; Gee, 1999) in which multiple voices become intertwined in the thoughts and speech of the interlocutors. That is, dialogue involves learning by both members of the dyad and a shared way of conversing about the content in question. Importantly, the learner begins to incorporate characteristics of disciplinary discourses.

Considerations about the role of *communities of practice* in mathematics specifically has gained attention as a way to consider the situated aspects of learning, including coaching (Voskoglou, 2019). Within the context of coaching, the coach-teacher pair bridge multiple communities of practice as they negotiate principles of mathematics instruction, building from disciplinary and practical knowledge to develop a common language around and vision of instruction. Their work is mediated (e.g., Wertsch, 1995) by a range of contextual factors, such as individual characteristics, professional experiences, and curriculum materials.

Our framework focuses on four factors that mediate the coach-teacher interactions in a coaching cycle: coach characteristics, teacher characteristics, the coach-teacher relationship, and the content of the coaching cycle. A key coach characteristic is their *coaching stance* (Gillespie et al., 2019), of which we identify two basic stances: the reflective and the directive stances. The reflective stance involves inquiry into the teacher's thinking; the directive stance involves direct assistance to the teacher in the forms of evaluation, explanation, and suggestions. Teacher characteristics include their prior practices, beliefs, and knowledge. The coach-teacher relationship involves communication style and trust that evolves over multiple coaching cycles. The content of the coaching cycle pertains to the mathematical goals and tasks identified by the teacher and coach as the focal points of the lesson. See Figure 1 for a visual of our framework.

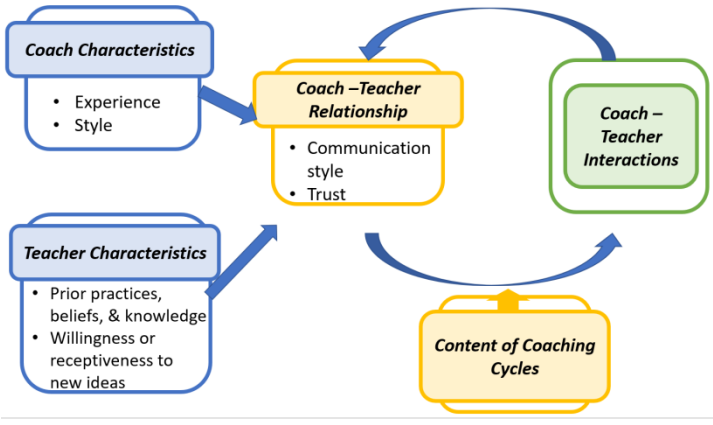

Figure 1: Diagram of Coaching Cycle

CONTENT-FOCUSED COACHING

Content-focused coaching has emerged in the USA as an effective model to help teachers develop productive instructional practices specific to their content area (West & Staub, 2003), and has been shown to have positive effects on teachers' instructional practices and student achievement in the area of literacy (Matsumura, Garnier, & Spybrook, 2012) and mathematics (Campbell & Malkus, 2011; McLaughlin, 2012; Neuberger, 2012). Stein et al. (2021) recently studied content-focused coaching specific to mathematics with 32 coaches and found that one-on-one content-focused coaching around the planning of a lesson led to positive outcomes. Results also indicated that the content-focused coaching model supported a shift from a focus on *what teachers* will do in a lesson to *how students* might think in a lesson, a trend we contend could support a focus on lesson goals.

RESEARCH METHODS

This study emerged from a larger study in which we designed and researched an online three-part professional development model for mathematics teachers in rural contexts (Choppin et al., 2020). We designed the three components as a set of coordinated experiences that took place across two academic years. Part of the model included video-based coaching in which the coach and teacher met via Zoom to plan the lessons, the teacher video-recorded the lesson using Swivl technology, the coach and teacher annotated the video in a Swivl library, and then met afterward to discuss the lesson via Zoom. In this paper, we focus only on the planning meeting conducted in advance of the lesson.

We focused on four cycles of coaching for five coach-teacher pairs involving four coaches and six teachers. We analyzed a total of 20 planning transcripts. Our analysis focused on the discussion around the mathematical goals, using the rubric in Table 1. We parsed the transcripts of the planning conversations into stanzas, which ran anywhere from four to 20 turns of coach-teacher conversation. Using a process that involved pairwise coding and a consensus discussion, we coded the stanzas as having or not having a mention or discussion around mathematical goals. Then all stanzas were coded line by line using the rubric in Table 1.

Rating	Description
1	Discussion focuses on mathematical goals without the connections mentioned in the level 3 rating, such as when the coach presses the teacher to clarify or revise the mathematical goal.
2	Discussion focuses on one or more of the following, without explicit connections made to the mathematical goal: the task, potential student strategies, or students' prior mathematical experiences.

3	Discussion entails one or more of the following connections central to core principles of content-focused coaching: the disciplinary connections between the goal and task; the ways in which the task supports student engagement with the goal; forms of student thinking that represent understanding of the goal; or how the goal represents part of a connected set of mathematical experiences or ideas.

Table 1: Rubric to analyze discussion around mathematical goals

Our research questions were:

1. To what extent did the coaching conversations highlight important connections related to the mathematical goals in the planned lessons?
2. What were the differences between the contributions of the coaches and teachers in the coaching conversations?
3. What were the important differences across the coaches' practices?

RESULTS

We discuss the results in order of the three research questions. In terms of the first question, nearly three-quarters of all turns were coded as focused exclusively on the goals (27%), task (32%), or potential student strategies (15%). By contrast, only 17% of all turns were coded at Level 3. These findings highlight the instrumental nature of the coaching conversations in negotiating the lesson plan elements versus engaging in deeper discussions around how those lesson elements represent connections to broader sets of mathematical experiences or topics. Below, we present samples from the data that represent these findings. In Episode 1, the coach (Reiss) pressed the teacher to clarify the goal.

Reiss: Students will evaluate a situation and determine—to determine and apply whether to use multiplication or division. Students will be able to interpret a remainder? Or—because we want them to be able to interpret what that remainder actually means in the situation—in a context.

Sandoval: Interpret situation in context, if or when, if remainders are part of the answer. Hmm, that's still not clear. No. Students will interpret what to do with remainders? [Laughter] Or how to—I know that over here it says that they have to interpret it. Including problems which remainders must be interpreted. Maybe it's just that simple.

In Episode 2, the coach (Bishop) and teacher worked out details of the task.

Bishop: What would be your next steps? How would you move them towards the symbolic expression, or would you want to wait to do that? What's your thinking around that?

Wise: I would draw a triangle and label the sides, a, b and c. Then have them draw the squares off of it, and see how—could they represent the area of the square. Hopefully they would say, squared and then how would they represent the other square on the leg. There'd be a picture of the right triangle with a squared, b squared and c squared in the square.

Bishop: Oh, I think it's great, yeah.

In Episode 3, the coach and teacher engaged in a substantive discussion (rated a 3) in which the coach and teacher connected the goal to bigger mathematical ideas.

Reiss: Because they might. Even though—I mean, I divided in number one to find the answer, I can see a kid actually working the opposite way and multiplying up to try to get to that answer of twenty-four. In that sense, if we think kids—if we really want them to understand multiplication and division and how to apply it to a situation, that would be different than taking a situation and deciding, "Do I have to use multiplication, or do I have to use division?" They might work in the opposite way.

Sandoval: I see what you're saying, because now that you're saying that, I'm, "Oh, yeah, we just spent a week talking about factors, so—" They might work in an opposite way saying— because today we did review, that they're—when I asked, "How are factors important to the multiplication process?" Then they were, "Oh!" Well, this is why." Yeah, so, [laughter] oh, boy.

In terms of the second question, coaches contributed more frequently (58% of total turns) than the teachers and had 2.6 times as many turns rated at Level 3 than the teachers. By contrast, the teachers had nearly as many turns rated at Level 2 (170 compared to 183) as the coaches, which constituted 64% of the teachers' turns and only 50% of the coaches' turns. This indicates the coaches focused more consistently on the disciplinary connections than the teachers and less on the instrumental aspects of lesson planning, even though just over half of the coach turns were rated at Level 2. Roughly half of the Level 3 codes for the coaches were *the goal and task are connected from a disciplinary perspective*. Episode 4 is an example of the coach providing most of the explanations and connections.

Lowrey: Yeah. In this one—because I know that when they're breaking up the brownies, it's like each brownie has its own area.

Fernandez: Right.

Lowrey: And if we step back, just back a step, I would think that they're really actually practicing fractions within a set. It's just using like, each brownie would have its own area and model, but it's really a set of brownies. So, it's a set of seven brownies that we're going to share among four people.

Fernandez: Right.

Lowrey: So, the idea of division, and what results out of this division is a fraction. Like, what each person's actually going to get, to be able to have that?

Fernandez: Right.

In terms of the third question, there were differences across coaches in the distribution of turns in the rubric categories. Alvarez's turns were evenly distributed across the three categories, while Bishop's turns were primarily concentrated at Level 2 (58%). The other two coaches were similar to Bishop but had more balanced distributions, as seen in Table 2.

Rating	Alvarez	Bishop	Lowrey	Reiss
1	32	31	18	28
2	35	58	46	45
3	33	12	36	27

Table 2: Percentages of coach turns in each category

These differences primarily point to distinctions in the characteristics of the coach; we hope to better understand the impact of teacher characteristics when we analyze the coaching cycles from the next two years of data in which the same coaches worked with different teachers.

DISCUSSION

Our results highlight the instrumental nature of much of the discussion between teachers and coaches (see Episode 2) despite an explicit focus in the coaching model on engaging students in substantive discussions around content. The high number of turns focused on goals (27%) suggests an emphasis on the part of the coaches to identify a goal that is clear and connected to a big mathematical idea, as illustrated in Episode 1. The results also illustrate the coach's role as the expert responsible for directing the discussion, as seen in Episode 4. The coaches had 58% of the overall turns and 72% of all of the turns rated at Level 3. The variation in the patterns of coach moves reveals, unsurprisingly, differences in the coach characteristics that contributed to the dynamics of the discussions. The study provides necessary nuance into coach-teacher discussions that will hopefully serve as a reference for future coaching studies in the US and elsewhere.

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