Rehearsing Instruction in One-on-one Mathematics Coaching

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While there is evidence that rehearsing instruction with groups of teachers can support their learning, whether this is the case in one-on-one coaching settings remains largely unexplored. In this exploratory self-study, I examined my coaching work with a cadre of mathematics teachers to determine whether and how rehearsing instruction in one-on-one coaching provides individual teachers with opportunities to learn. I found that rehearsing instruction during one-on-one planning conversations can give rise to teacher learning opportunities. Three features of the rehearsal activity appeared central to the learning opportunities: (a) framing the instructional situation so that the teacher understands the context for the rehearsal, (b) acting out a range of student solution strategies during the rehearsal, and (c) analysing and discussing specific instructional decisions the teacher made while rehearsing instruction. This work contributes to research on coaching by clarifying that rehearsals can be potentially productive one-on-one coaching activities and by highlighting what is involved in incorporating rehearsals into one-on-one coaching with mathematics teachers.

Introduction

Mathematics coaching is becoming an increasingly common support for instructional improvement in schools. In practice, mathematics coaching often involves working with both groups of teachers and individual teachers (Campbell & Griffin, 2017; Gibbons & Cobb, 2017). The goal of mathematics coaches' work with teachers is to support them in developing the kinds of instructional practices that can support students in developing conceptual understanding, procedural fluency, disciplinary practices, and positive mathematical dispositions. These research-based instructional practices include, for example, selecting cognitively demanding mathematics tasks (Stein et al., 1996; Stein & Lane, 1996), introducing tasks without lowering their cognitive-demand (Jackson et al., 2012), and facilitating mathematics discussions in which teachers press students to make connections between mathematical ideas (Kazemi & Stipek, 2001; Stein et al., 2008).

Researchers of coaching have identified several types of potentially productive coaching activities that, if done well, can support individual and groups of mathematics teachers in developing the instructional practices (Gibbons & Cobb, 2017). Potentially productive coaching activities for working with groups of teachers include activities such as analysing classroom video (e.g., Borko et al., 2008) and engaging teachers in lesson study (e.g., Gibbons et al., 2017). Potentially productive one-on-one coaching activities include modeling, co-teaching, and engaging teachers in coaching cycles consisting of three phases: a lesson planning phase, a lesson enactment phase, and a lesson debrief phase (Gibbons & Cobb, 2017; Russell et al., 2020; Saclarides & Munson, 2021). This line of inquiry, however, is still relatively new and there may be coaching activities that can support teachers in improving their instructional practices beyond those currently identified in the literature.

This paper reports on a study that aimed to determine whether and how a type of coaching activity typically intended for work with groups of teachers, rehearsals of instruction, can provide individual teachers with opportunities to learn in one-on-one coaching contexts. In other words, the primary purpose of the study was to determine whether rehearsals are potentially productive one-on-one coaching activities, in addition to potentially productive group coaching activities. There is strong

evidence that rehearsing instruction with groups of teachers can support them in developing research-based mathematics instructional practices (Anthony et al., 2015; Campbell et al., 2020; Kazemi et al., 2016; Lampert et al., 2013). Yet, the use of this type of teacher learning activity in one-on-one coaching settings remains unexplored in the current coaching literature. The following research questions guided the study:

1. What teacher learning opportunities, if any, can arise when a coach and a teacher rehearse instruction in a one-on-one coaching context?
2. What features of the rehearsal activity appear to be central to the teacher learning opportunities, if they arise?

Potentially Productive One-on-one Coaching Activities

Prior research on coaching has resulted in the identification of several types of one-on-one coaching activities that, if enacted well, can support mathematics teachers in developing research-based instructional practices. In a large-scale study of a state-wide coaching initiative, Russell et al. (2020) found that engaging mathematics teachers in one-on-one coaching cycles, which consist of a lesson planning phase, lesson enactment phase, and lesson debrief phase, can support teachers in selecting and maintaining the cognitive demand of mathematics tasks. More specifically, Russell et al. found that engaging teachers in high-depth planning conversations in which coaches and teachers make connections between instruction, students' thinking, and content was central to supporting teachers' learning in coaching cycles. This indicates that one-on-one coaching cycles and planning conversations, are potentially productive one-on-one coaching activities.

In a conceptual review of literature examining mathematics and science teacher learning, Gibbons and Cobb (2017) found that modeling instruction with individual teachers and co-teaching with individual teachers can support their development of research-based instructional practices, indicating that both of these types of activities are also potentially productive one-on-one coaching activities. In line with Gibbons and Cobb's findings, Saclarides and Munson (2021) found that modeling instruction with individual teachers as part of a coaching cycle can provide coaches and teachers with opportunities to make their instructional reasoning public, and thus provide teachers with instructional learning opportunities. In a follow-up study, Saclarides (2022) found that co-teaching with teachers can provide similar opportunities for coaches and teachers to make their reasoning public.

Taken together, modeling, co-teaching, and engaging teachers in coaching cycles begin to delineate a "technical core" for one-on-one coaching because they describe what mathematics coaches should consider doing as they work to support individual teachers' professional learning (Gibbons & Cobb 2017). Yet, coaches often work in ways that go beyond just those activities (Mudzimiri et al., 2014). For example, Mudzimiri et al. found that mathematics coaches may work closely with students during a lesson, observe a lesson and provide teachers with feedback, or locate resources for teachers. Further, the boundaries between one-on-one coaching activities and group coaching activities may be less distinct than sometimes portrayed in the coaching literature. For example, *examining students' work* is an activity that has the potential to support the collective learning of teachers (Borko et al., 2008; Gibbons & Cobb, 2017), but coaches and teachers often examine students' work as part of one-on-one coaching (Knight, 2007). There is therefore more to learn about the types of coaching activities that can support individual teachers' learning and, specifically, whether activities typically aimed at supporting the collective learning of teachers can also prove beneficial in supporting individual teachers' learning.

Rehearsals of Instruction as Activities for Supporting Teachers' Learning

Rehearsals of instruction are a type of teacher learning activity intended to provide teachers with opportunities to try out new, challenging forms of instruction in an environment that is less complex than the classroom. Typically, rehearsals involve a teacher enacting a lesson, portion of a lesson, or a specific instructional activity, such as a number string, while colleagues act as students (Kazemi et al., 2016; Lampert et al., 2013). Rehearsals are also often facilitated by an accomplished educator, such as a

teacher educator or a coach, who can then provide rehearsing teachers with feedback on their enactment (Lampert et al., 2013). Additionally, rehearsals often involve opportunities for participating teachers to analyse and discuss instruction collectively. These opportunities can arise during the approximation, as rehearsing teachers or facilitators pause the enactment to ask questions, provide feedback, or highlight instructional decisions (e.g., Anthony et al., 2015; Wæge & Fauskanger, 2021). These pauses can provide opportunities for collective sense-making, which can also occur in debrief conversations following a teacher's enactment. In these debrief conversations, the rehearsing teacher, facilitator, and other participating colleagues analyse the teacher's enactment of the lesson or instructional activity (Lampert et al., 2013). Doing so can provide teachers with opportunities to collectively interpret and examine teaching practice.

Educational researchers have, to date, studied rehearsals primarily in the context of teacher educators' or coaches' work with groups of teachers. Most often, this has occurred as part of practice-based teacher education initiatives (e.g., Baldinger et al., 2021; Campbell et al., 2020; Kazemi et al., 2016; Lampert et al., 2013), though researchers have also begun to investigate efforts aimed at engaging currently practicing teachers in rehearsals (e.g., Wæge & Fauskanger, 2021). Findings from this line of research indicated that rehearsing instruction with groups of mathematics teachers can support them in developing effective mathematics teaching practices (e.g., Baldinger et al., 2021; Campbell et al., 2020; Kazemi et al., 2016; Lampert et al., 2013). For example, Campbell et al. (2020) found that engaging groups of pre-service teachers in rehearsals in which they were pressed to respond to and address student errors in whole class discussions supported the teachers in becoming more responsive to students' thinking. Similarly, Kavanagh and colleagues (2020) found that engaging groups of pre-service teachers in rehearsals can support them in developing skills for responding to students' ideas.

Taken together, these findings indicate that rehearsals can be potentially productive coaching activities for supporting the learning of groups of teachers. If, however, rehearsals can support teachers' collective learning, then it stands to reason that they could also support individual teachers' learning. Yet, few if any prior research studies have closely investigated whether and how this is the case. Consequently, little is known about whether rehearsals constitute potentially productive one-on-one coaching activities and, if they do, how engaging individual teachers in one-on-one rehearsals can contribute to their learning. The primary purpose of the research study undertaken was to address these gaps in the literature, and thus further delineate a technical core for one-on-one coaching.

Theoretical Framework: Teacher Learning Opportunities in Workplace Interactions

Determining whether rehearsals are potentially productive one-on-one coaching activities involves establishing a working definition for teachers' professional learning in one-on-one coaching interactions. To establish this working definition, I draw from prior work that investigates the *teacher learning opportunities* that can arise during teachers' workplace interactions (Horn & Kane, 2015; Horn et al., 2015; Horn et al., 2017). This is appropriate, as one-on-one coaching is a type of workplace interaction in which teachers often participate.

In their analysis of teacher workgroup meetings, Horn and colleagues (2017) found that teachers' workplace interactions can provide opportunities for teachers to "shift their pedagogical reasoning," and thus develop new concepts related to teaching. They also found that conversations in which teachers "reimagine possibilities for practice" can provide teachers with opportunities to consider changes in "their future participation as classroom teachers" (p. 42). According to the authors, rich teacher learning opportunities arise when teachers have opportunities to both develop new concepts about teaching and then act on those developing concepts by considering changes they might make to their teaching.

When applying this notion to one-on-one coaching, it follows that rich teacher learning opportunities arise when coaches support teachers to develop new concepts about teaching and to then act on those developing concepts by making changes to their instruction. This definition of *learning opportunity,* however, does not clarify *what* teachers have opportunities to learn about. It is entirely

possible that coaches and teachers can engage in work that aims toward shifts in practice that would have negative implications for students' learning opportunities. To address this issue, teachers' learning opportunities are defined as opportunities to develop new concepts about or propose changes in teaching that align with the kinds of instructional practices that support students' development of conceptual understanding and procedural fluency in mathematics (e.g., Kazemi et al., 2009; Lampert et al., 2010; Lampert & Graziani, 2009). These practices are outlined in the National Council of Teachers of Mathematics' *Principles to Actions* (2014) and include, for example, selecting cognitively demanding tasks, introducing tasks to students such that all students can engage meaningfully in them without lowering their cognitive demand, and facilitating whole-class discussions in which teachers support students to make connections between strategies.

Methodology

The primary purpose of the study was to determine whether and how rehearsals can support teachers' learning, and thus whether rehearsals can be potentially productive one-on-one coaching activities. Qualitative, self-study methods were utilised to accomplish addressing the research questions. Specifically, I collected qualitative data on my own work as a coach with a cadre of teachers, making me a participant-observer in the study. Self-study was an appropriate approach for this research because it meant that I could ensure I would encounter the kind of coaching interaction I intended to study—in this case, one-on-one rehearsals. In other words, because I was studying my own work as a coach, I could ensure that I would collect data on the use of rehearsals in one-on-one coaching. Given that research on coaching and teachers' learning typically frames rehearsing instruction as an activity for working with groups of teachers, I was unlikely to encounter the phenomena of interest by collecting data on typical coaching practices conducted by others.

Study Context and Participants

The self-study was conducted as part of a larger partnership between a private university in the South-eastern United States and a large, urban public school district. The district serves over 85,000 students and is highly diverse, with over 100 languages spoken by students. In this partnership, currently practicing teachers commit to teach in a local, difficult-to-staff school for a minimum of three years and in return have tuition and fees waived for their pursuit of a master's degree in education. As part of the program, teachers worked full-time in a school while taking classes in the evening. In addition to the support provided by their coursework, teachers received job-embedded support in the form of university-sponsored coaching.

While a doctoral student at the partner university, I worked as a university-sponsored instructional coach with three mathematics teachers who were participating in the partnership program. Early in my work as their university-sponsored coach, I approached each of the teachers about participating in a small study investigating my own coaching practice, emphasising that their responses would in no way impact our coaching relationship or their engagement in the master's degree program. I explained that this study would involve video or audio recording our co-planning conversations and debrief conversations, depending on whether the conversations took place in person at the school (video recorded) or over the phone (audio recorded), and that I would use pseudonyms when describing their work with me. Two of the three teachers agreed to participate in the study, with one teacher opting not to participate in the study due to taking on additional responsibilities at her school site. I did, however, continue to support that teacher as part of the partnership program.

The two teachers who agreed to participate in the study taught at different schools in the school district. One of the teachers, Heather (both names are pseudonyms), taught sixth-grade mathematics. Prior to starting the master's degree program, she had spent a year teaching fifth-grade mathematics at a different school in the district. The other teacher, Jennifer, was a seventh-grade mathematics teacher. Prior to our work together, Jennifer had spent two years teaching mathematics and science in the same school as the one in which she taught during our coaching work. As part of my one-on-one

coaching work, I incorporated rehearsals into my one-on-one co-planning conversations with the two teachers.

Data Sources

The primary data analysed in this study consisted of video recordings of the co-planning conversations in which I engaged the individual teachers in one-on-one rehearsals, each of which lasted more than 15 minutes and less than 40 minutes. In addition to analysing the video recording, I also consulted artefacts collected during and after the co-planning conversations to clarify my rationale for my coaching decisions, as well as the teachers' rationales for their decisions prior to and during the rehearsal. These artefacts included the teachers' lesson plan, the email exchanges that followed the coaching conversation, and the coaching memos I wrote before and after the focal conversation. The data associated with one teacher, Jennifer, are reported in this article.

Data Analysis

Due to the exploratory nature of the study, I focused my analysis on one of the three co-planning conversations in which I incorporated one-on-one rehearsals. This enabled me to conduct a microgenetic analysis (Luwel, 2012) of the learning opportunities that arose over the course of the focal rehearsal. I selected the focal rehearsal because it was representative of the two other rehearsals in both structure and content, in that it focused on facilitating productive whole-class discussions, which, as noted previously, is an instructional practice that research indicated is central to supporting students' mathematical learning.

Focal case

At the time of the study, the rehearsing teacher, Jennifer, taught seventh-grade mathematics. Early in our work together, Jennifer expressed interest in capitalising on what she was learning in her university-based mathematics education courses in her classroom. The coaching work therefore focused on Jennifer's development of the mathematics teaching practices outlined in the National Council of Teachers of Mathematics' *Principles to Actions* (2014), such as facilitating productive whole-class discussions and selecting rigorous, cognitively demanding mathematics tasks. We also worked together to move away from lessons in which the teacher introduces a strategy for solving a series of similar problems, which is typical of many US classrooms (e.g., Hiebert, 2013), and toward lessons characterised by opportunities for exploration, productive struggle, and student sensemaking during small group and whole class discussions (e.g., Smith & Sherin, 2019).

Jennifer's rehearsal focused on facilitating whole-class mathematics discussions. Specifically, Jennifer wanted to explore how she could select and sequence strategies, as well as how she could ask students questions that might support them in making connections among different strategies. In the rehearsal, Jennifer engaged in three distinct approximations of practice in which she enacted portions of her planned lesson. After each approximation, she and I debriefed together. This was important, as it enabled me to trace the evolution of her approximation of teaching and pedagogical rationale, as expressed through her talk, over the course of the entire rehearsal.

Teacher learning opportunities

Having identified the focal case, I then engaged in a four-step process to determine whether the rehearsal provided Jennifer with learning opportunities, and, if so, what the focus of those learning opportunities was, thereby answering my first research question. First, I viewed and transcribed the relevant video recording. Second, I segmented the rehearsal into "rounds" consisting of Jennifer's enactment of instruction and the subsequent coach-teacher debrief discussion. As noted above, the focal rehearsal featured three distinct rounds, each of which had an enactment followed by a debrief discussion.

In the third step of my analysis, I coded transcripts of each of the three rounds to characterise the learning opportunities therein. This involved both deductive and inductive coding (Elliot, 2018). To conduct the deductive coding, I drew on the definition of teacher learning opportunities outlined previously in the paper. In other words, I coded for two types of teachers learning opportunities in the coach-teacher debrief conversations: opportunities to develop pedagogical concepts, and opportunities to mobilise for future action. I defined opportunities to develop pedagogical concepts as episodes of talk in which the teacher connected or was supported to connect her rationale for instructional decisions with broader pedagogical principles relevant to the types of mathematics instructional practices for which there is evidence that they can support students' learning. This involved, for example, episodes in which the teacher explained why she featured one student's mathematical strategy over another strategy by linking that decision to the principle of selecting and sequencing students' strategies in mathematics discussions. Mobilising for future action involved instances in which the teacher noted what she was going to do differently in the future or asked questions about how she might adjust instruction, be it in the next round of enactment or when working with her students.

For the inductive coding, I coded for the topics of conversation that arose in the debriefing sessions, attending closely to the ideas about students' learning and instruction that came up as Jennifer and I discussed her teaching. Topic codes included anticipated students' responses to specific questions, selecting specific student strategies for whole-class discussions, and effective teacher questioning. In each of the three enactments, I also conducted inductive coding to characterise the teacher's actions as she approximated instruction. In line with grounded methods for qualitative analysis (Corbin & Strauss, 2015), I used the constant comparative method to systematically refine and improve the topic codes and teacher action codes based on my interpretations of the data.

In the fourth phase of the analysis, I recoded the transcripts of the three rounds using the refined coding scheme. I then looked across the three transcripts to identify themes in the types of learning opportunities that arose over the course of the rehearsal.

Activity features that supported teacher learning opportunities

To address my second research question, I explored the features of the rehearsal activity that appeared to contribute to the teacher learning opportunities that occurred. To do so, I first coded each round of the rehearsal for observable characteristics of the rehearsal activity, drawing upon prior research on rehearsals to do so. For example, drawing upon several past studies of rehearsals (Anthony et al., 2015; Wæge & Fauskanger, 2021), I used the code "interject with feedback" to describe rounds in which I, as the coach, interrupted the teacher's enactment to provide feedback to the teacher or ask a follow-up question. Table 1 (below) lists the codes used for this portion of the analysis.

Next, I conducted axial coding (Strauss, 1987) to identify associations between the results of my coding for teacher learning opportunities and my coding for the features of the rehearsal activity. This involved overlaying my codes for activity features with my codes for the learning opportunities. I then looked for patterns in the types of activity features that corresponded with or immediately preceded episodes coded as involving a learning opportunity, thereby answering my second research question.

Table 1
Codes for activity features

Code	Example
Frame the rehearsal	"Let's say at this point that the students have already plotted their points and you've ..."
Acts out student strategies	"Yeah, so I saw that the three there was the y-intercept, so I know that it had to go on the ..."
Model instruction	"What about if you do this, if you say ... [coach stands up] I saw you put your point right here ... I see something different on your page ..."
Interject with feedback	"Good, pause. So, what are you hoping to accomplish there by asking that question, as far as student responses go?"
Discuss specific teacher action when debriefing	"So, what was different about how you selected the strategies for that discussion versus how you did it the first time?"

Results

Evidence of Teacher Learning Opportunities in Rehearsal

There was evidence of teacher learning opportunities in Jennifer's focal rehearsal. Specifically, there was evidence that she had opportunities to link her pedagogical reasoning with broader instructional principles, thereby signaling opportunities to develop pedagogical concepts. There was also evidence that she had opportunities to discuss the changes she planned to make to her lesson or in subsequent approximations of the lesson, thereby indicating that Jennifer had opportunities to mobilise for future action. In what follows, I draw on several illustrative episodes from Jennifer's rehearsal to demonstrate how rehearsing instruction during the planning phase of a coaching cycle gave rise to teacher learning opportunities. Prior to doing so, an overview of the rehearsal is provided.

Overview of the Focal Rehearsal

As a reminder to readers, this rehearsal occurred as part of a planning conversation in which Jennifer and I discussed how she could facilitate a whole class discussion of students' solution strategies on a mathematics task. The task asked students to identify the x- and y-intercepts for the linear equation $y = x + 3$, and then use that information to graph the line for the equation. In the planning conversation, Jennifer indicated that many of her students were currently struggling to identify the x- and y-intercepts based on equations in the form $y = mx + b$. She intended to facilitate a discussion around students' approaches to this task in which she would ask students to share their current thinking about and rationales for the intercepts they identified. She hoped this would provide her with an opportunity to draw out students' processes for identifying the x- and y-intercept, and thus support all students in making progress toward a process that would result in correct answers.

Prior to rehearsing, Jennifer and I first anticipated the ways in which we expected students to think about identifying the x- and y-intercept. This enabled us to consider how her students were currently approaching this task. I then suggested that Jennifer facilitate a discussion of the task with me acting as multiple students, some of whom had identified the x- and y-intercepts correctly, and some of whom had identified the intercepts incorrectly using the strategies we had discussed while anticipating potential answers. Throughout the rehearsal, Jennifer acted as the teacher, whereas I acted as different "students" in the class, as well as interjected as a coach when appropriate. As mentioned previously, the rehearsal included three distinct rounds, each of which consisted of the teacher practicing the whole class discussion portion of the lesson followed by a debrief conversation.

Opportunities to Develop Pedagogical Concepts

In her one-on-one rehearsal, Jennifer had several opportunities to link specific instructional decisions with broader principles of instruction, and thus several opportunities to develop a pedagogical concept. For example, Jennifer had the opportunity to recognise that by making decisions as to which strategies to feature in whole class discussions, she could orient students to mathematical ideas that aligned with her lesson goals. In what follows, I describe two such opportunities that occurred in the first round of Jennifer's rehearsal.

Learning Opportunity 1

Recall that Jennifer intended to rehearse a whole class discussion of students' solutions to a mathematics task. The task asked students to graph and find the x- and y-intercepts for the equation y = x + 3. In her first round of deliberate practice, Jennifer facilitated the discussion by asking a series of questions that guided "students" to correct answers, in the process limiting students' opportunities to share their reasoning about the task. This was evident in the following exchange from the first round of practice:

Jennifer:	Let's look at this—I'm going to box in positive three. What term do we use for this number here? We know it's b. What does b represent?
Nick (as student):	Uhh, the y-intercept.
Jennifer:	y-intercept. Now, using the y-intercept, what axis do you think it should be on?
Nick (as student):	y-axis?
Jennifer:	y-axis, y-intercept. y-axis, y-intercept.

In asking this set of questions, Jennifer made the connection between the equation in the task and the form y = mx + b for students. She also asked known-answer questions with limited potential to elicit students' reasoning. Additionally, asking these questions implicitly oriented students to a specific process for identifying the y-intercept. The rest of her first round of practice proceeded in a similar fashion and featured similar questions and rhetorical moves.

In the subsequent debrief, I asked Jennifer to explain what she was hoping to accomplish by structuring her discussion the way she did. She explained that she wanted the students "to understand that y-intercept should be on the y-axis, so maybe ... y-intercept, y-axis, it's kind of been my whole thing." This indicates that Jennifer viewed the purpose of the discussion as reminding students of her strategy for identifying the y-intercept of a line.

I then asked Jennifer if she could come up with a way to have "students do more of the thinking" to draw out their reasoning in the discussion. Asking this question pressed Jennifer to reconsider the structure of her discussion. It also implicitly oriented Jennifer to a principle of inquiry-oriented mathematics teaching, namely, the importance of eliciting and building on students' thinking in discussions. In her response to my question, Jennifer suggested that she could ask two different students to share their answers, and then ask the whole class to determine whether they agreed with the students. Specifically, she noted, "Yeah, I could ask them, all right, using accountable talk, do you agree or disagree with, uh, Nick ..." Here, Jennifer linked the specifics of her teaching ("using accountable talk") with the idea of pressing students to do the thinking and reasoning in the discussion, indicating she had an opportunity to develop a pedagogical concept related to the facilitation of classroom discourse.

Learning Opportunity 2

Immediately following the exchange detailed above, Jennifer had another opportunity to develop a pedagogical concept. In this episode of talk, I suggested an alternate way of structuring the whole class discussion, one that built on Jennifer's reference to accountable talk strategies:

Nick:	Yes, so ... what about, what about if you do this, if you were to say, Jennifer, I saw you put your point right here. Is that right ...?

| Jennifer: | Yes |
| Nick: | Ok, so, I see something a little bit different on yours, you put your point … right there. So, there are different sort of options here, among what we've done, ok? Let's use accountable talk to talk about what these two different things mean … |

In making this suggestion, I posed an alternate approach to discussing students' strategies—namely, calling students' attention to the various solutions to the problem, and then asking them to consider the thinking underpinning those different solutions. Jennifer and I then compared this alternate discussion structure with the structure in her first enactment. Specifically, I asked Jennifer to consider the difference between her initial approach to facilitating the discussion and my suggested approach. In comparing the two structures, we agreed there was a "difference there," in that her initial approach focused on reminding students of a correct strategy, whereas the alternate approach focused on "explaining different strategies." This latter observation indicates that Jennifer had a second opportunity to link specific instructional decisions with broader principles about teaching—in this case, linking the second discussion structure with a new purpose for whole-class discussions, to explain different approaches for solving the problem. Taken together, these two episodes indicate that Jennifer's rehearsal provided her with opportunities to develop pedagogical concepts, and thus provided her with opportunities to learn.

Opportunities to Mobilise for Future Action

Jennifer had several opportunities to mobilise for future action. For example, following the two opportunities detailed above, Jennifer asked me how she might go about implementing a whole class discussion in which students compared and discussed several strategies. Specifically, Jennifer asked how she might handle instances in which students still got the answer incorrect, even after providing them with an opportunity to consider multiple solution strategies. Jennifer asked, "So what would happen … if I [asked] what axis should this be on? And they say x?" Analytically, this question indicates that Jennifer was beginning to consider how she might take up the alternate discussion structure posed previously, and thus is an indicator that she was mobilising for future action. Following this question, Jennifer and I discussed how she might approach incorrect answers while eliciting students' thinking in whole class discussions.

Importantly, there was also evidence that Jennifer acted on our conversation and revised her facilitation of the whole class discussion in the subsequent enactment. This indicates that Jennifer not only mobilised for future action but also acted on her proposed adjustments. For example, in the second round of the rehearsal, Jennifer decided to structure her whole class discussion around a comparison of students' strategies, rather than around a sequence of questions designed to lead students to a correct answer. This was evident in the following exchange:

Jennifer:	Ok! So, Nick, where did you end up plotting your positive three?
Nick (as student):	I put it on three to the right of centre.
Jennifer:	Ok, now [student] I saw that you did a little something different in that you decided to plot your point on the positive three here. [Teacher draws point three *up* from centre] Why would you do that? … Can you explain your thinking here?
Nick (as different student):	Yeah, so I saw that the three there was the y intercept, so I knew that it had to go on the y axis, and I saw the plus, so I counted one two three up, and put my dot right there.

Unlike in her first round of deliberate practice, Jennifer asked two students to share solutions in this second round of deliberate practice. After having done so, Jennifer then asked me, acting as a "student," to explain my thinking. This revision related directly to the suggestion I had made previously about how Jennifer might structure a whole class discussion, as well as our discussion of how to elicit students' thinking in discussions. Specifically, it marks a clear effort to highlight various solutions to the problem,

and then prompt students to share and consider the thinking underpinning those different solutions. Thus, Jennifer had opportunities to not only develop pedagogical concepts, but also mobilise for future action. Notably, Jennifer's opportunities to mobilise for future action emerged after and in relation to her opportunities to develop pedagogical concepts related to facilitating whole class discussions.

Features that Supported Teacher Learning Opportunities

Three features of the rehearsal activity emerged as central to Jennifer's learning opportunities. They were: (a) the framing of the rehearsal, (b) acting out a range of student solution strategies during the rehearsal, and (c) analysing and discussing specific instructional decisions the teacher made while enacting instruction.

Framing the rehearsal

The first feature of the rehearsal that appeared central to Jennifer's learning opportunities was the framing discussion Jennifer and I had prior to her first enactment. In this discussion, Jennifer and I agreed upon a classroom situation that would serve as the backdrop for her approximation of practice. In other words, we situated Jennifer's enactment in a specific classroom scenario. In this case, we agreed to imagine that Jennifer had just finished monitoring students' small group work time and was about to begin a whole class discussion. We focused on the discussion because Jennifer had highlighted her facilitation of whole class discussions as an area for improvement in our planning conversation immediately prior. As part of our framing conversation, I also asked Jennifer to imagine she had seen multiple students making an error we had anticipated her students might make earlier in our planning conversation. I did so because, prior to the rehearsal, Jennifer she had wondered about how she might support students in reconsidering unproductive strategies during whole class discussions.

Engaging in this framing conversation appeared to inform what Jennifer did when enacting instruction. It also oriented our debrief conversations after each approximation, as the topic of all three debrief conversations centred predominantly on her facilitation of whole class discussions. Clarifying this focus therefore informed what Jennifer had opportunities to learn about during the rehearsal activity.

Acting out a range of student solution strategies

It also appeared important that I acted as a range of students during Jennifer's approximation of practice, each of whom had varied strategies or ideas during the two teachers' approximations. Doing so enabled Jennifer to ask questions and engage with multiple "students" while rehearsing the whole class discussion. Whereas rehearsals with groups of teachers necessarily have a built in "class" of colleagues who can approximate the range of student strategies and voiced, this is not the case in a one-on-one coaching setting. As such, it falls to the coach to mimic the range of voices and strategies in a classroom. Therefore, it was essential that I approximated multiple student voices and strategies during the rehearsal, as doing so enabled Jennifer to approximate the facilitation of a whole class discussion. As an illustration of this, I played the role of two different students while Jennifer rehearsed the whole class discussion:

Jennifer:	Ok, all right … Ok, so [student B], I noticed that you plotted your point right here … [Student A], I noticed you plotted your point up here. Can you explain to the class why you decided to plot your point here?
Nick (as Student A):	Yeah, I saw there is a plus three, and I know that is the y intercept, so it's got to be through that up and down line, and I counted up three and put my point right there.
Jennifer:	Ok, nice, now [student B] let's go back to you—this is the y axis, we know this is the y intercept, so which line do you think it should go through?

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Nick (as Student B):   I think it should go straight across, because it is plus, so we should count to the right, and I am thinking plus.

Acting as two different students, each of whom had different mathematical strategies, provided Jennifer with an opportunity to facilitate a discussion in which she supported the "class" in comparing two students' ways of thinking about the focal task. As discussed earlier, this constituted a shift in how Jennifer was structuring whole class discussions. Jennifer would not have had the opportunity to test out this discussion structure if I had not taken on the role of two different students in her rehearsal, indicating this feature of the rehearsal was central to Jennifer's learning opportunities.

Analysing and discussing specific instructional decisions

Finally, it also appeared important that Jennifer and I analysed and reflected on specific instructional decisions she made while enacting instruction. Doing so provided Jennifer with an opportunity to link her specific instructional decisions to pedagogical principles. It also enabled us to discuss what Jennifer might do to adjust her instruction moving forwards. The importance of these debrief conversations is consistent with findings from several studies investigating the facilitation of rehearsals with groups of teachers (e.g., Anthony et al., 2015; Kazemi et al., 2016), which suggest that it is important for facilitators to take an active role in supporting teachers to analyse and discuss rehearsed instruction.

In addition to discussing specific instructional decisions after Jennifer approximated her teaching, in one instance, I also interrupted Jennifer's approximation to probe on a specific instructional decision. By pausing instruction and asking Jennifer about her questioning strategy, I drew her attention to a specific decision she had made in the rehearsal. This triggered a discussion of whether and how Jennifer's question moved her students toward the learning goal. The subsequent discussion provided Jennifer with an opportunity to discuss her rationale for her questioning practices, and thus provided Jennifer with an opportunity to link specific instructional decisions with broader principles of teaching.

Discussion

The primary goal of this exploratory analysis was to investigate whether and how engaging an individual mathematics teacher in a one-on-one rehearsal could support her learning. There was evidence that the focal teacher, Jennifer, had opportunities to develop pedagogical concepts and mobilise for future action in the case I analysed. Several features of the rehearsal activities appeared central to the learning opportunities: (a) framing the instructional situation so that the teacher understands the context for the rehearsal, (b) acting out a range of student solution strategies, and (c) analysing and discussing specific instructional decisions the teacher made during the approximation of instruction.

Interestingly, and in line with descriptions of rehearsals with groups of teachers (Lampert et al., 2013), Jennifer's rehearsal also appeared to serve as a bridge between her planning for the focal lesson and her enactment of the lesson with students. As Jennifer enacted instruction, she began to consider how *her* students would engage in the lesson. This gave rise to opportunities for Jennifer to consider how she might adjust her instruction to better support her students' learning in her own classroom. Specifically, she considered what would happen if she asked students a different set of questions during the whole-class discussion. This may indicate a particular affordance of one-on-one rehearsals, as both Jennifer and I (as her coach) had a deep understanding of her students and their current progress toward learning mathematical concepts, meaning we could engage in a rich and thorough discussion of what might happen if Jennifer reorganised the structure of her whole-class discussion. In other words, we could easily situate the rehearsal in Jennifer's actual work with students. This points to a potential affordance of one-on-one rehearsals: that they can be more easily personalised to teachers' current contexts.

This exploratory study has implications for research and practice. Regarding research implications, prior work on coaching has identified several types of potentially productive coaching activities, including modeling instruction, co-teaching, and engaging teachers in coaching cycles (Gibbons & Cobb, 2017; Saclarides, 2022; Saclarides & Munson, 2021;); however, whether rehearsals constitute

potentially productive *one-on-one* coaching activities, in addition to group coaching activities, has to this point remained unexplored. The results of this study suggest that rehearsals can be potentially productive one-on-one coaching activities and therefore contribute to research on potentially productive coaching activities. This is significant, as it adds to our understanding of the technical core for one-on-one coaching. However, as this was an exploratory study, additional studies are needed to determine the extent to which rehearsals are potentially productive activities in other contexts and situations, or whether the learning opportunities were unique to this case.

The results of this analysis also indicate that some coaching activities typically intended for working with groups of teachers may, in some cases, prove productive when working one-on-one with a teacher. This serves to blur the line between the work of one-on-one coaching and group coaching, and thus advances current theories about the work of effective coaching. Future research might build on this exploratory analysis to investigate whether this is the case for other types of group coaching activities, or whether this overlap is unique to rehearsals. Finally, by identifying activity features that appeared to be central to the focal teacher's learning opportunities in the rehearsal, I took steps to clarify how coaches can facilitate one-on-one rehearsals effectively. The features identified in this study can serve as a starting point for larger studies investigating the effective facilitation of this type of activity when coaches work one-on-one with teachers.

In addition to research contributions, the findings from this study also have practical implications. My findings suggest that coaches might choose to incorporate rehearsals into their work with individual teachers, especially when planning for lessons. Often, coaches plan lessons by discussing students' learning goals for the lesson, the teacher's goals for improving instruction, the tasks, and materials for the lesson, anticipating potential student responses and strategies for those tasks, and considering how the teacher intends to build on those anticipated strategies in the lesson (Russell et al., 2020). The results of this study indicate that coaches might choose to rehearse instruction when planning with a teacher, as doing so could serve as a bridge between a teacher's plans for a lesson and the teacher's implementation of the lesson with students. However, doing so requires a significant time commitment from a coach and teacher. It also likely requires expertise in facilitating rehearsals on the part of the coach and the establishment of a trusting coaching relationship. As such, it may not always be practical for coaches to incorporate rehearsals into their work with teachers. This suggests that coaches should use discretion when choosing to incorporate rehearsals into their one-on-one work. Prior research indicates that accomplished coaches select coaching activities based on their goals for teachers' learning (Gibbons & Cobb, 2016). As such, I suggest that coaches should determine whether to rehearse instruction with individual teachers based on similar logic.

References

Anthony, G., Hunter, J., & Hunter, R. (2015). Supporting prospective teachers to notice students' mathematical thinking through rehearsal activities. *Mathematics Teacher Education and Development*, *17*(2), 7–24. https://mted.merga.net.au/index.php/mted/article/view/271

Baldinger, E. E., Campbell, M. P., & Graif, F. (2021). Learning to respond to students in discussions: Examining the use of planted errors in an approximation of practice. *Journal of Teacher Education*, *72*(5), 523–537. https://doi.org/10.1177/0022487120977148

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

Campbell, M. P., Baldinger, E. E., & Graif, F. (2020). Representing student voice in an approximation of practice: Using planted errors in coached rehearsals to support teacher candidate learning. *Mathematics Teacher Educator*, *9*(1), 23–49. https://doi.org/10.5951/MTE.2020.0005

Campbell, P. F., & Griffin, M. J. (2017). Reflections on the promise and complexity of mathematics coaching. *The Journal of Mathematical Behavior*, *46*, 163–176. https://doi.org/10.1016/j.jmathb.2016.12.007

Corbin, J., & Strauss, A. (2015). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. SAGE Publications.

Elliot, V. (2018). Thinking about the coding process in qualitative data analysis. *The Qualitative Report, 23*(11), 2850–2861. https://doi.org/10.46743/2160-3715/2018.3560

Gibbons, L. K., & Cobb, P. (2016). Content-focused coaching: Five key practices. *The Elementary School Journal, 117*(2), 237–260. https://doi.org/10.1086/688906

Gibbons, L. K., & Cobb, P. (2017). Focusing on teacher learning opportunities to identify potentially productive coaching activities. *Journal of Teacher Education, 68*(4), 411–425. https://doi.org/ 10.1177/0022487117702579

Gibbons, L. K., Kazemi, E., & Lewis, R. M. (2017). Developing collective capacity to improve mathematics instruction: Coaching as a lever for school-wide improvement. *The Journal of Mathematical Behavior, 46*, 231–250. https://doi.org/10.1016/j.jmathb.2016.12.002

Hiebert, J. (2013). The constantly underestimated challenge of improving mathematics instruction. In K. R. Leatham (Ed.), *Vital directions for mathematics education research* (pp. 45–56). Springer.

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. https://doi.org/10.1177/0022487116676315

Horn, I. S., & Kane, B. D. (2015). Opportunities for professional learning in mathematics teacher workgroup conversations: Relationships to instructional expertise. *Journal of the Learning Sciences, 24*(3), 373–418. https://doi.org/10.1080/10508406.2015.1034865

Horn, I. S., Kane, B. D., & Wilson, J. (2015). Making sense of student performance data: Data use logics and mathematics teachers' learning opportunities. *American Educational Research Journal, 52*(2), 208–242. https://doi.org/10.3102/0002831215573773

Jackson, K. J., Shahan, E. C., Gibbons, L. K., & Cobb, P. A. (2012). Launching complex tasks. *Mathematics Teaching in the Middle School, 18*(1), 24–29. https://doi.org/10.5951/mathteacmiddscho.18.1.0024

Kavanagh, S. S., Metz, M., Hauser, M., Fogo, B., Taylor, M. W., & Carlson, J. (2020). Practicing responsiveness: Using approximations of teaching to develop teachers' responsiveness to students' ideas. *Journal of Teacher Education, 71*(1), 94–107. https://doi.org/10.1177/0022487119841884

Kazemi, E., Franke, M., & Lampert, M. (2009). Developing pedagogies in teacher education to support novice teachers' ability to enact ambitious instruction. In R. K. Hunter; B. A. Bicknell & T. A. Burgess (Eds.), *Crossing divides Proceedings of the 32nd annual conference of the Mathematics Education Research Group of Australasia, Wellington* (Vol. 1, pp. 12–30).

Kazemi, E., Ghousseini, H., Cunard, A., & Turrou, A. C. (2016). Getting inside rehearsals: Insights from teacher educators to support work on complex practice. *Journal of Teacher Education, 67*(1), 18–31. https://doi.org/10.1177/0022487115615191

Kazemi, E., & Stipek, D. (2001). Promoting conceptual thinking in four upper-elementary mathematics classrooms. *Elementary School Journal, 102*(1), 59–80.

Knight, J. (2007). *Instructional coaching: A partnership approach to improving instruction*. Corwin Press.

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

Lampert, M., Franke, M. L., Kazemi, E., Ghousseini, H., Turrou, A. C., Beasley, H., Cunard, A. & Crowe, K. (2013). Keeping it complex: Using rehearsals to support novice teacher learning of ambitious teaching. *Journal of Teacher Education, 64*(3), 226–243. https://doi.org/10.1177/0022487112473837

Lampert, M., & Graziani, F. (2009). Instructional activities as a tool for teachers' and teacher educators' learning. *The Elementary School Journal, 109*(5), 491–509. https://doi.org/ 10.1086/596998

Luwel, K. (2012). Microgenetic analysis. In N. M. Seel (Ed.), *Encyclopedia of the Sciences of Learning* (pp. 2265–2268). Springer. https://doi.org/10.1007/978-1-4419-1428-6_4951

Mudzimiri, R., Burroughs, E. A., Luebeck, J., Sutton, J., & Yopp, D. (2014). A look inside mathematics coaching: Roles, content, and dynamics. *Education Policy Analysis Archives, 22*(53). https://doi.org/10.14507/epaa.v22n53.2014

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematics success for all*. NCTM.

Russell, J. L., Correnti, R., Stein, M. K., Thomas, A., Bill, V., & Speranzo, L. (2020). Mathematics coaching for conceptual understanding: Promising evidence regarding the Tennessee math coaching model. *Educational Evaluation and Policy Analysis, 42*(3), 439–466. https://doi.org/10.3102/0162373720940699

Saclarides, E. S. (2022). Studying coach-teacher interactions during co-taught mathematics lessons. *Investigations in Mathematics Learning*. https://doi.org/10.1080/19477503.2022.2052664

Saclarides, E. S., & Munson, J. (2021). Exploring the foci and depth of coach-teacher interactions during modeled lessons. *Teaching and Teacher Education, 105*, Article 103418. https://doi.org/10.1016/j.tate.2021.103418

Smith, M., & Sherin, M. G. (2019). *The 5 practices in practice: Successfully orchestrating mathematical discussion in your middle school classroom*. National Council of Teachers of Mathematics.

Stein, M. K., Engle, R. A., Smith, M. S., & Hughes, E. K. (2008). Orchestrating productive mathematical discussions: Five practices for helping teachers move beyond show and tell. *Mathematical Thinking and Learning*, *10*(4), 313–340. https://doi.org/10.1080/10986060802229675

Stein, M. K., Grover, B. W., & Henningsen, M. (1996). Building student capacity for mathematical thinking and reasoning: An analysis of mathematical tasks used in reform classrooms. *American Educational Research Journal*, *33*(2), 455–488. https://doi.org/10.3102/00028312033002455

Stein, M. K., & Lane, S. (1996). Instructional tasks and the development of student capacity to think and reason: An analysis of the relationship between teaching and learning in a reform mathematics project. *Educational Research and Evaluation*, *2*(1), 50–80. https://doi.org/10.1080/1380361960020103

Strauss, A. L. (1987). *Qualitative analysis for social scientists.* Cambridge University Press.

Wæge, K., & Fauskanger, J. (2021). Teacher time outs in rehearsals: In-service teachers learning ambitious mathematics teaching practices. *Journal of Mathematics Teacher Education*, *24*, 563–586. https://link.springer.com/article/10.1007/s10857-020-09474-0

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