

# Learning mathematics teaching when rehearsing instruction

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*This study explores rehearsals. Norwegian elementary in-service teachers participated in a practice-based approach to professional development. They collaborated in learning cycles of enactment and investigation, aiming at learning to enact ambitious mathematics teaching practices. The ways in which Teacher Time-Outs (TTOs) in the learning cycles' rehearsals provided the teachers with opportunities to learn multiple practices of ambitious mathematics teaching were explored. The findings revealed that the TTOs provided opportunities for collaborative and simultaneous learning of multiple core ambitious teaching practices, such as whether or not and when to use talk moves to facilitate student talk when eliciting their strategies, parallel to aiming for the goal for the lesson.*

*Keywords: Rehearsing mathematics teaching, learning cycles, professional development*

## Introduction

Based on their review of research on mathematics teachers' professional development, Goldsmith, Doerr and Lewis (2014) conclude that there is a need to explore in-service teachers' (hereinafter teachers) opportunities to learn in and from enactments of teaching. To meet this call, this study addresses teachers' opportunities to learn to enact mathematics teaching practices when rehearsing instruction. The rehearsals were included in *learning cycles of enactment and investigation* (learning cycles, McDonald, Kazemi, & Kavanagh, 2013) in the *Mastering Ambitious Mathematics teaching project* (MAM) research and professional development project.

Ambitious mathematics teaching aims at developing all students' conceptual understanding, procedural knowledge and adaptive reasoning (e.g. Lampert et al., 2013). Among the principles of ambitious teaching are: treating students as sense-makers and engaging deeply with their thinking (Ghousseini, Beasley, & Lord, 2015; Lampert et al., 2013). Examples of core practices of ambitious mathematics teaching are eliciting and responding to students' mathematical reasoning, using representations, aiming towards the goal for a lesson, facilitating student talk and organizing the board (Lampert et al., 2013). Building instruction on students' mathematical ideas (ambitious teaching) is a centrepiece professional development. This is informed by the extensive and growing research base on students' mathematical thinking and development (e.g. Lester, 2007), as well as findings suggesting that gains in student achievement are related to instruction having students' ideas at the core (e.g. Sowder, 2007). Following this, the aim of professional development is to support teachers in learning the demanding endeavour of ambitious teaching practices and rehearsals are found to be contexts for such learning (Kavanagh et al., 2019; Lampert et al., 2013; Wæge & Fauskanger, 2020).

## Previous research on rehearsals

In a rehearsal, a teacher leads an instructional activity with colleagues acting as students. The participants may pause instruction by initiating a *Teacher Time Out* (TTO) during which they discuss how the rehearsing teacher might respond to student contributions and determine the direction of the further instruction (e.g. Gibbons, Kazemi, Hintz, & Hartmann, 2017). Teachers are, thus, provided with opportunities to try out and discuss ambitious teaching practices.

Most research on rehearsals has focused on initial mathematics teacher education in the US context (e.g. Ghouseini et al., 2015; Lampert et al., 2013). From this research we learn that rehearsals are contexts where novices could learn “to do adaptive teaching while developing their knowledge, skill, and identities” (Lampert et al., 2013, p. 238). We also learn that as novice teachers rehearse instruction, they connect their own knowledge and relevant aspects of the context when enacting instruction. There is, however, a need for research exploring if findings from the US context translate into contexts outside the US. More recent research has explored rehearsals in professional development for teachers. Kavanagh et al. (2019) found that by reducing teachers’ choices in rehearsals “it was possible to focus more tightly on how best to give full attention to, understand, and respond to student ideas” (p. 11). Based on these findings, Kavanagh et al. (2019) also call for future studies exploring if findings from the US context translate into other contexts.

Building on the findings from Kavanagh et al. (2019), Wæge and Fauskanger (2020) conclude that the rehearsals provided the teachers with opportunities to learn ambitious practices. These researchers point out that their findings indicate that the participants could work simultaneously on multiple practices but that this needs to be explored more thoroughly. Building on this limited research on rehearsals in professional development in the Nordic context, the aim of this study is to answer the following research question: In what ways do TTOs in rehearsals open for teachers’ opportunities to learn multiple practices of ambitious mathematics teaching?

Learning is in this study understood as emerging in activities, such as rehearsals. Learning, thinking and knowing are “relations among people engaged in activity in, with, and arising from the socially and culturally structured world” (Lave, 1991, p. 67). From this perspective, teachers’ opportunities to learn refer to developing the ability to engage in particular practices. In the learning cycles, the teachers were positioned as responsible contributors. The rehearsals allowed the teachers to pause instruction by initiating a TTO to ask questions, discuss, explain and justify their mathematical and instructional ideas, and thus share in the decision-making (Wæge & Fauskanger, 2020).

## **Methodology**

In the MAM project, 30 teachers from ten Norwegian elementary schools worked together in repeated learning cycles. Each cycle included preparation, co-planning, rehearsing, co-enacting and making collective analyses of instruction with the aim of learning core practices and principles of ambitious teaching. In order to support the teachers to encourage students to engage in mathematical talk, use of talk moves (Kazemi & Hintz, 2014) was worked on. Two groups of teachers (n=14) participated in the research study reported on here.

A total of 175 TTOs across 18 rehearsals were identified. Building on Lampert et al. (2013), ambitious teaching practices (e.g. elicit and respond, use of representations, aiming towards goals, facilitating student talk) were used as codes for coding the TTOs. In many of the TTOs analysed, the participants worked on two or more ambitious practices in relation to each other. An in-depth analysis of each of the TTOs was conducted in order to pinpoint the ways in which the TTOs in rehearsals provided teachers with opportunities to learn multiple practices simultaneously. This was first done by coding for the a priori codes described above, followed by an analysis of how the participants in parallel engaged in multiple teaching practices. In this paper, one of these TTOs will be used as an illustrative example. This TTO lasted for three 3 minutes and 23 seconds and included a total of 74 utterances.

The entire rehearsal lasted 19 minutes and included seven TTOs. The instructional activity in this rehearsal was quick images (see Figure 1). This activity was chosen as one of the activities in the MAM project because it is designed to allow inquiry into the relationships between practices and principles of ambitious teaching and the mathematical content relevant for the teachers. In addition, given instructional activities are found to support participants in eliciting student thinking and in making judgments on how to respond in principled, instructive ways (Lampert et al., 2013).

## Findings

In the co-planning session prior to the rehearsal, the teachers decided that the learning goal for the lesson should be the distributive property of multiplication and a quick image was selected as instructional activity for this purpose. In the beginning of the rehearsal, the students (the teachers and the teacher educator (TE)) were shown a quick image for a few seconds, and the rehearsing teacher (RT) asked them how many dots they saw and if they could explain how they arrived at their answer. Just prior to this TTO (initiated by the TE), the RT represented two student strategies on the board (Figure 1).

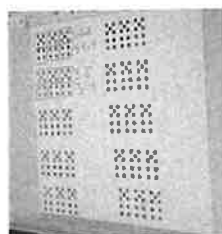


Figure 1: Student strategies represented on the board

- 1 TE: I want to take a very little time-out because I see we're getting a little crowded here [on the board]. Do you see that?
- 2 RT: Yes.
- 3 TE: In such a way that it/
- 4 RT: Should we make them bigger?
- 5 TE: Perhaps, or perhaps we should put them to the side [the second column]?
- 6 RT: These ones [points at the column of quick images on the right side]?
- 7 TE: Yes, these could go, I don't know, maybe.
- 8 RT: So, we could get more room for more along here [points to right side of the first column]?
- 9 TE: Yes [walks towards the Smartboard].
- 10 RT: Yes, there was more room before.
- 11 TE: Yes, because we started to make this row [column] on the side [presses the board to remove the quick images in the right column].
- 12 RT: I'll put this down [board pen] here now.
- 13 TE: I think we'll delete these here first [deletes the quick images in the right column], like this. Because then we can write along here, I think so...
- 14 RT: Mm.
- 15 TE: Mm.

The TE interjected to draw the participants' attention to the board, claiming that they did not have enough space (1). The RT asked if they should make the images larger (4) and the TE suggested that they could remove the quick images in the right column so they could write the whole number sentences (student strategies) next to the quick image (5, 7 and 13). As the RT agreed (8, 10 and 14), the TE deleted the upper two quick images from the right column (11 and 13). As this exchange illustrates, participation in this TTO episode opened for a learning situation for the participants in which they considered how to best organise the board in order to represent the students' strategies in a particular way. The participants were collaboratively making sense of the practices of organising the board and using representations.

The TTO continued as follows:

- 16 RT: Yes, is it smart to take even more to begin with, like this?  
17 TE: Yes.  
18 OT<sup>1</sup>2: But I thought perhaps that, before they offer their ideas, could it have been an idea to talk together and say something about "what you saw", or is there any point in doing this?  
19 RT: Turn and talk to begin with?  
20 TE: Yes, what do you think about that?  
21 RT: Before we start, yes.  
22 OT2: Yes.  
23 OT3: Then we make the process [of eliciting and representing student strategies] longer, I think.  
24 OT2: Yes, then everyone feels that they have been able to say what they want [their strategy].  
25 OT3: Yes, maybe both, but this makes it quite a long sequence for getting to where we want to be.

In lines 19–22 the participants clarified that OT2's suggestion in line 18 was to use the talk move "turn and talk" before the students presented their strategies. After this clarification, OT3 hesitated by indicating that using this talk move would take (too much) time (23 and 25). OT2 supported her own suggestion in line 16 by highlighting "turn and talk" as providing all students with an opportunity to present their strategies (24). The pros and cons of using the talk move "turn and talk" were part of this TTO discussion. This part of the TTO thus opened up a learning situation for the participants in which they considered if and why talk moves should be used when eliciting students' thinking. All participants were able to engage in the decision-making process, and they were collaboratively making sense of the practices of eliciting student ideas and facilitating student talk. The TTO continued by clarifying how much time they would have for enacting the lesson, and they agreed that they had enough time for "turn-and-talk" discussions (26–34). Due to this agreement, they continued their discussion as follows:

- 35 RT: Could they have discussed a little before beginning to tell me [their strategy]?  
36 OT2: The danger then is that perhaps they just copy what someone else has said.

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<sup>1</sup> OT is an abbreviation for "Observing Teacher".

- 37 Several: Yes.
- 38 OT2: And don't come with their own [strategy], maybe because they see that the other person's [strategy] is quicker and better.
- 39 Several: Yes.
- 40 OT2: And then maybe you don't get more of this "five plus five plus five".
- 41 RT: You might get less variation [in student strategies presented].
- 42 OT2: Yes.
- 43 Several: Yes.
- 44 OT3: Or maybe not.
- 45 OT2: You could rather...
- 46 OT3: Perhaps rather turn and talk when you have some examples up there and ask 'do you see any connections'?

When co-planning the lesson, the teachers anticipated that some students would suggest  $5 + 5 + 5 + 4 + 4 + 4$  as their strategy. They decided to use this strategy to lead the students towards the goal for the lesson: the distributive property of multiplication (i.e.  $3 \times 5 + 3 \times 4 = 3 \times (5 + 4)$ ). In this part of the TTO, OT2 suggested that some of the anticipated strategies might not be presented if students talk amongst themselves before presenting their own strategy (36, 38 and 40) and that the teachers risked that  $5 + 5 + 5$  would not be suggested (40) by the students after talking with their classmates and learning a strategy they might find "quicker and better" (38). Based on their discussion, they agreed that inviting the students to turn and talk might reduce the number of different strategies presented (41–43). Consideration of the pros and cons of using talk moves was also part of this TTO discussion, but whereas the first part of the discussion (23–34) was about time issues, this part was about the danger of having less variation in the student strategies presented if these were shared by the students when talking with each other. Bearing this in mind, OT3 suggested that they should rather use "turn and talk" "when you have some examples up there and ask 'do you see any connections'?" (line 46). As this exchange illustrates, participation in this TTO discussion opened up a learning situation for the participants in which they considered reasons for whether or not and when to use the talk move "turn and talk" when eliciting student strategies. They also discussed whether the use of turn and talk could support them in reaching the goal or not. The participants were collaboratively making sense of the practices of eliciting student responses, using talk moves and aiming for goals in relation to each other. Their goal for the lesson was implicitly visible in the discussion, but it was also discussed explicitly in the continuation of the TTO:

- 47 RT: Because we said we were going to use it [turn and talk] after, or when we begin to get them to focus on our goal [the distributive property of multiplication]?
- 48 Several: Yes.
- 49 RT: But we can agree on that, can't we?
- 50 Several: Yes.

Some of the TTOs addressed the practice of drawing attention to and leading the students towards the mathematical learning goal for the lesson. In this extract, the RT reminded the participants that they had planned to ask the students to turn and talk when aiming towards the learning goal for the lesson (47). The others remembered what they agreed upon (48 and 50). The analysis indicates that this part of the TTO engaged the participants in discussing the practice of facilitating student talk (i.e. whether

or not and when to use the talk move “turn and talk” when eliciting student strategies) while at the same time aiming for the goal for the lesson. Thus, the TTO opened up a learning situation in which the participants simultaneously worked on these practices. After this exchange, the participants agreed that the rehearsing teacher should ask the students to turn and talk if she felt that some students had “dropped out” (OT4, 52–58). The last part of this TTO proceeded as follows:

- 60 OT2: When it comes to writing them [the students’ strategies represented in the quick images] like this under each other, perhaps it would be better to write them [the student strategies written as number sentences] along this way?
- 61 OT4: And write it [the number sentence] out.
- 62 OT2: Then we come quicker to the [the distributive property of multiplication].
- 63 RT: That I write...
- 64 OT4: Three times five plus three times four.
- 65 RT: mm, at once.
- 66 OT2: Yes.
- 67 RT: [Removes  $3 \times 4$  written under  $3 \times 5$  and writes it next to  $3 \times 5$  on the board, see Figure 2] Yeah, because now we have room for it.
- 68 Several: Yes.
- 69 TE: And then I think that it’s kind of important for the four plus four plus four that it’s written out too.
- 70 RT: [Starts writing]. Should I use parentheses as well?
- 71 TE: I don’t think you need to.
- 72 RT: No [Writes  $4 + 4 + 4$  after  $5 + 5 + 5$  which is already written on the board].
- 73 Several: mm.
- 74 RT: Yes.

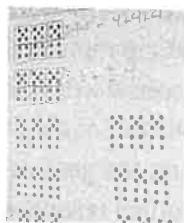


Figure 2: The board work towards the end of this TTO

This part of the TTO started out by focusing on where and how to write student strategies on the board (60–61), seeing this as important when aiming for the goal for the lesson (62). Several teachers (64, 66 and 68) supported the RT (63, 65 and 67) when deciding how and where to represent student strategies on the board. Whether or not to use parentheses when writing student strategies on the board was part of this discussion (71–74). At the same time, suggestions were also made as to which student strategies to focus on when aiming for the goal for the lesson (64 and 69), and the rehearsing teacher wrote the suggested strategies on the board (70). This analysis indicates that the activity enabled the participants to learn where, when and how to write student strategies on the board (organising the board and using representations) in order to reach the goal for the lesson.

This last part of the TTO was followed by the continuation of the rehearsal. The rehearsing teacher asked the other participants (acting as students) if they had other strategies for finding the number of dots in the quick image.

### **Concluding discussion**

Based on a need to study teachers' opportunities to learn in and from enactments of teaching (Goldsmith et al., 2014), the aim of this study was to explore how TTOs in rehearsals opened for teachers' opportunities to learn multiple practices of ambitious mathematics teaching simultaneously. TTOs in 18 rehearsals were analysed and the findings are presented by using one illustrative example of a TTO. In this TTO, the participants worked on several practices in relation to each other by asking questions, giving each other feedback and offering specific suggestions on what the rehearsing teacher could do in a particular situation, drawing on key principles of ambitious teaching (e.g. Lampert et al., 2013). Participating in TTO discussions when rehearsing instruction opened up learning situations (Lave, 1991) for the participants in which they were discussing and making sense together of multiple practices simultaneously, such as organising the board when representing student strategies so they could make connections between representations (lines 1–15). This supports findings from studies of novice teachers' rehearsals in the US context (e.g. Lampert et al., 2013), which indicates that rehearsals are learning situations for novice as well as experienced teachers. In the TTO, the participants also discussed how decisions concerning one practice could influence another practice. They discussed whether or not and when to use the talk move "turn and talk" to facilitate student talk when eliciting their strategies while simultaneously aiming for the goal of the lesson (lines 16–59). The finding that the participants are provided with opportunities to learn to facilitate student talk from rehearsing instruction supports findings from similar studies in a PD context in the US (Kavanagh et al., 2019). The focus on particular talk moves (Kazemi & Hintz, 2014) in MAM, seems to add to the existing literature on rehearsals as learning situations in PD (e.g. Kavanagh et al., 2019). The participants were provided with opportunities to learn whether or not and when to use talk moves to facilitate student talk. Furthermore, in their argumentation related to one practice, the participants sometimes included considerations about other practices. In lines 60–74, the participants discussed where, when and how to write which student strategies on the board when aiming for the goal of the lesson, while simultaneously considering what student strategies to focus on to reach the learning goal for the lesson. This supports findings from studies of rehearsals in the US context (Kavanagh et al., 2019; Lampert et al., 2013).

Similar to Kavanagh et al. (2019), we found that by reducing the teachers' choices in the rehearsals the TTOs gave the participants opportunities to try out and discuss, and thus learn (Lave, 1991), several teaching practices that are responsive to the students' contributions. In addition, and similar to findings from the US initial teacher education context (Lampert et al., 2013), we found that these practices were worked on simultaneously and in relation to each other. Finally, the findings indicate that learning cycles developed in a US teacher education context (McDonald et al., 2013), and in particular rehearsals, provide teachers in a Norwegian context with opportunities to learn ambitious teaching practices and thus to develop their capacity to enact responsive instruction. These findings have implications for design of professional development as well as for future professional development research in the Nordic countries.

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