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What and how mathematics teachers notice while co-planning instruction

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The study explores what and how teachers notice while co-planning to teach given instructional activities. The analyzed data material has been chosen from video recordings of nine co-planning sessions from one group of primary school in-service teachers in collaboration with a teacher educator. Out of the 76 episodes identified in the nine co-planning sessions, only five were coded as high levels of noticing. However, we found that episodes of lower levels of noticing were important starting points, closely connected to episodes of high levels of noticing. This finding is illustrated by analyzing one co-planning session in depth. Our analysis indicates that the choice of instructional activity and by giving teachers the opportunity to try out the activity in their own class before the session might be of importance for co-planning discussions to attain higher levels of noticing.

Keywords: Co-planning, professional development, learning cycles, noticing.

Introduction

What and how teachers notice, matters for student learning (van Es & Sherin, 2021). As a reason, mathematics teachers' noticing has become widely accepted as key to both teaching (Dindyal et al., 2021) and to teachers' learning (e.g., Choy & Dindyal, 2019). The present study is a part of The *Mastering Ambitious Mathematics teaching* research and professional development project (MAM). MAM takes a view of noticing including attending to noteworthy aspects such as students' mathematical thinking (SMT), making sense of this information, and making informed teaching decisions according to an analysis of observations. Following Dietiker et al.'s (2018) suggestion that it is possible to prepare for noticing SMT and cues by Choy and colleagues (Choy, 2016; Choy et al., 2017; Choy & Dindyal, 2019, 2021; Lee & Choy, 2017), in MAM the notion of teacher noticing includes lesson planning. What and how teachers notice in co-planning sessions in *learning cycles* of enactment and investigation (Figure 1) is the focus of attention in this paper. Similar to Choy and colleagues, we extend extant research on teacher noticing to explore co-planning, but whereas these researchers focus on teachers' noticing in co-planning with the goal of designing high-level cognitive demand tasks, in MAM, instructional activities are given, and the focus is on teachers' noticing when co-planning to teach these activities.

As experienced teachers are found to be unprepared to notice SMT (Empson & Jakobs, 2008), equipping them with noticing practices is important for professional development (PD, e.g., Kavanagh et al., 2020). Building on previous research indicating that developing the ability to notice can be learned through collaboration and scaffolded support (e.g., Star et al., 2011), in MAM we aim at shedding light on the ways in which learning cycles might invite teachers to collectively work on noticing SMT and to enact on what they noticed. As asked for by Dindyal et al. (2021), our research augments the literature by situating teachers in the authentic work of teaching. We started out by investigating what teachers plan to notice focusing on one co-planning session (Fauskanger &

Bjuland, 2021b). The findings suggest that this discussion invited teachers to learn higher levels of noticing as described by van Es (2011), not only attending to teacher pedagogy and student behavior, but to particular and predicted SMT and to teaching strategies building on SMT. In a previous study, we critically examined teachers' opportunities to learn to notice while co-enacting instruction (Fauskanger & Bjuland, 2021a). Findings revealed that developing the ability to notice – both what to notice and how to notice (van Es, 2011) – can be learned while co-enacting instruction. When exploring a whole learning cycle (Fauskanger & Bjuland, 2022), we learned that all parts of the cycles are contexts where teachers can learn to notice and respond to SMT. Building on implications from these studies and drawing on analysis of teachers' noticing while participating in video-based programs (for a review, see Santagata et al., 2021), the present study explores co-planning sessions (see next section). This study meets the lack of focus on preparation to notice in previous research (Choy et al., 2017). Lesson planning has a direct influence on instruction (e.g., Kelly, 2009). Following this, it is critical for PD to support teachers in the process of co-planning (Li et al., 2009) and to examine teachers' noticing during the co-planning sessions. In our examination, we build on the notion of productive mathematical noticing, highlighting that teachers notice productively when they “sift out, relate and combine relevant information to generate alternatives for responding to instructional events” (Choy, 2013, p. 188). The following research question is addressed: What and how do mathematics teachers notice during co-planning sessions?

Methods

In MAM, learning cycles (Figure 1) were designed to engage teachers in learning to notice SMT.



Figure 1: Cycle of enactment and investigation for PD (Wæge & Fauskanger, 2021)

In the cycles and with teacher educators as supervisors, the teachers were provided with repeated opportunities to co-plan, rehearse, co-enact, and reflect upon instructional activities. The activities were intentionally selected to support the teachers in noticing SMT and in making judgments on how to respond in principled, instructive ways. Each learning cycle focused on one of the following instructional activities: choral counting, quick images, strings, problem solving and games (for descriptions of the activities, see Kazemi & Wæge, 2015).

In MAM, 30 mathematics teachers from 10 primary schools were selected for participation by the heads at each primary school in a city in Norway. Fourteen of these teachers (divided into two groups) were randomly chosen to be part of the study reported on here. They met for 12 sessions (nine full learning cycles) over the course of two years. This produced 18 videotaped cycles. In this paper, the analyzed data material has been taken from video recordings of nine co-planning sessions (one of the groups randomly chosen, Table 1).

Table 1: Length of co-planning sessions analyzed

	S2*	S3	S4	S5	S6	S8	S9	S10	S11
Group 2	58:24	55:42	59:21	49:25	57:27	54:59	54:52	59:15	56:21

*Cycles 1, 7 and 12 were not full learning cycles and are not analyzed here.

Throughout the cycles, questions and disagreements were viewed as a productive part of the enterprise and the teachers were encouraged to ask questions, explain, and justify their mathematical and instructional ideas, to find multiple strategies and to try to understand what other participants said and did. In our analysis, sociocultural perspectives were drawn on (Stockero, 2021).

We approached the data in the following steps. First, all recordings (Table 1) of co-planning sessions were reviewed and divided into episodes according to different thematic foci in the teachers' co-planning discussions. We identified 76 episodes across the sessions analyzed. A new episode begins when there is a clear thematic shift in the focus of the discussion as indicated by an utterance (e.g., a question or a statement). The episodes in all the co-planning sessions were identified by the two researchers watching the videos together discussing and agreeing along the way. This was followed by the process characterizing teachers' noticing in the episodes in terms of *what* and *how* they notice. By building on Choy and Dindyal's (2019) adaptation of van Es' (2011) framework for noticing SMT (Table 2), we evaluated the levels of what and how teachers planned to notice. This adaptation was chosen due to these researchers' focus on lesson planning.

Table 2: Framework for noticing SMT (Choy & Dindyal, 2019, p. 474)

	What teachers notice	How teachers notice
Level 1 Baseline	Attend to generic aspects of teaching and learning, e.g., seating arrangement and student behaviour	Provide general descriptive comments with little or no evidence from observations
Level 2 Mixed	Begin to attend to particular instances of SMT and behaviours	Provide mostly evaluative comments with few references to specific instances as evidence
Level 3 Focused	Attend to particular SMT	Provide elaborate and interpretive comments by drawing upon specific instances and interactions from observations as evidence
Level 4 Extended	Attend to relationships between particular SMT, mathematical concepts, and teaching approaches	Provide elaborate and interpretive comments by drawing upon specific instances and interactions from observations as evidence, make connections to principles of teaching and learning and promote alternative pedagogical solutions

As can be seen from Table 2, attending to SMT, making sense of SMT, and deciding how to respond to SMT are aspects at the core of this analytical framework. In addition, relevant parts of Choy's (2016) FOCUS framework – developed to include co-planning – was used in our analysis. According to this framework, teachers at higher levels of noticing should start by identifying key mathematical concepts or ideas of the lesson (key point) when planning a lesson aiming at revealing SMT.

Findings and discussion

In most of the co-planning sessions, we found no signs of noticing in the introductory episodes since the participants then discussed practical issues related to the instructional activity. The final episodes of the sessions were also coded “no noticing” since they were then concerned about who should teach in the enactment phase of the learning cycle. Out of the 76 episodes identified in the nine co-planning sessions, 24 episodes focused solely on logistical aspects of teaching and learning. The remaining episodes were difficult to code within only one of the categories in the framework for noticing SMT since both researchers identified two levels of noticing. 35 episodes focused on lower levels of noticing (Level 1 and 2, Table 2). The remaining 17 episodes were coded as 12 low-high levels of noticing (Level 2 and 3, Table 2) and 5 high levels of noticing (Level 3 and 4, Table 2). These results differ from our previous analysis of one co-planning session (Fauskanger & Bjuland, 2021b), where teachers to a large extent were invited to learn higher levels of noticing.

From our analyses of the 76 episodes from the co-planning sessions, we found that episodes of lower levels of noticing were important starting points, closely connected to episodes of high levels of noticing. It seems as if the teachers prepare for noticing SMT (Dietiker et al., 2018), elaborating their discussion into higher levels of noticing throughout a co-planning session. We will illustrate this interesting finding by presenting an example from the fifth co-planning session. The ten identified episodes in this session have been coded in the following noticing levels based on Choy and Dindyal’s (2019) adaptation of van Es’ (2011) framework for noticing SMT: 2 (No), 5 (Low), 2 (Low-High) and 1 (High).

In this session, the instructional activity is a string. In general, such a string consists of four to six tasks, designed in a given sequence, to engage students in discussions of given strategies or features related to mathematical operations. This string consists of five tasks: 400 – 379, 420 – 379, 423 – 379, 444 – 395, 335 – 187. The mathematical focus for the participants is here to highlight the strategy “adding up” from the lowest number, and to use different representations to reason about this strategy. The focus is on teachers’ noticing when co-planning to teach this sequence of related tasks in the given instructional activity. This is quite another starting point than Choy et al. (2017) who focus on teachers’ noticing in co-planning with the goal of designing cognitively demanding tasks.

In episodes before our high-level episode, the participants start making sense of the given instructional activity by attending to possible student strategies. In these predictions, they focus on possible strategies both connected to subtraction and addition by counting backwards and adding up on a number line. One of the teachers has tried out the activity in his fourth-grade class, and based on this experience, the participants focus on the following three strategies when dealing with the first task, 400 – 379:

- 1) $400 - 300 = 100$, $100 - 80 = 20$ $20 + 1 = 21$
- 2) $379 + 10 = 389$, $389 + 10 = 399$ $399 + 1 = 400$
- 3) $400 - 300 = 100$ $100 - 70 = 30$ $30 - 9 = 21$

They discuss these strategies in connection with the operations of adding and subtracting, considering them as opposite operations. This seems to be the mathematical key point (Choy et al., 2017) of the discussion. The focus is to make students aware of using addition when solving subtraction tasks.

These concrete examples from the fourth-grade students are visualized on the blackboard, and the teachers and their supervisor discuss how these examples can be represented on a number line.

From this brief summary of the co-planning discussion, we can argue that there are elements of mixed teacher noticing since the participants begin to attend to instances of SMT. But there are also elements of focused teacher noticing when they attend to particular SMT (what) by providing elaborations and interpretative comments by drawing on the specific strategies from the fourth-grade classroom (how).

The discussion from the co-planning session summarized above has so far illustrated that the teachers and their supervisor have been concerned with attending to and making sense of the given task and particular SMT. In the following high-level episode, they are more specifically interested in challenging SMT, inviting them to see the connection between tasks in the sequence by focusing on the “adding up” strategy from the lowest number. The participants are attending to teaching approaches of posing questions, deciding to use the strategy of questioning as one pedagogical solution. Some utterances from this episode exemplify this finding. The supervisor’s question is the ninth utterance into this episode:

- 9 Supervisor: Or is it possible to ask the students in such a way that we invite them to think further in a way... What questions could we ask to invite them to use what we did in the task before?
- 10 Teacher 5: Yes... could some of you use that strategy we used in the previous task... could some of you try.
- ...
- 21 Teacher1: I think if new differences or strategies emerge (in the co-enactment), we must highlight “adding up”... We must try to put particular emphasis on that (strategy).

The participants continue to focus on different talk moves which could be used to highlight these connections, emphasizing the importance of giving students the opportunities to express and explain their mathematical thinking to each other.

- 39 Teacher 4: I think if one (student) presents the correct strategy.
- 40 Supervisor: Yes.
- 41 Teacher 4: Then one could of course... “Did anyone understand what he/she meant?”... then he/she can retell... or one of the other (students) can maybe repeat after this (retelling).
- 42 Teacher 2: It could be fine when we have highlighted that strategy, adding up... then they (the students) can discuss that strategy, then the students can tell each other how they understood each other’s thinking.
- 43 Several: Yes.
- 44 Teacher 2: So that we are conscious about that it is that strategy we want them to discuss.
- 45 Several: Yes.
- 46 Teacher 2: Not their own strategy if they have another one.
- 47 Supervisor: Yes, you think of turn and talk (talk move) and in which context would turn and talk be an effective talk move for instance?

48 Teacher 5: I think that maybe when we are pretty sure that most of them have seen that method (strategy) and understood that way to think... then they can retell to each other to strengthen it.

We learn from this extract that the teachers' discussion focuses on the "correct strategy" (39), the "adding up" (42) strategy which they have highlighted. To challenge SMT, the teachers emphasize the importance of giving students the opportunity to repeat and retell their understanding of this strategy to each other (41, 42, 43). The participants build on each other's utterances, illustrating the collaboration and scaffolded support among the teachers. From predictions of possible student strategies discussed in previous episodes in the co-planning session, they are now more conscious about guiding the students from "own strategy" (46) towards the "adding up" strategy when solving subtraction tasks. The participants attend to SMT with a focus on considering addition and subtraction as inverse operations. In this co-planning session, we see elements of high levels of teacher noticing. This is revealed when the teachers are concerned with challenging SMT with a particular focus on the mathematical operations of addition and subtraction, connected with their pedagogical approaches of posing questions and using talk moves like turn and talk.

In a previous study, we started out by investigating what teachers plan to notice focusing on one co-planning session when a quick image was the instructional activity (Fauskanger & Bjuland, 2021b). The findings suggest that the teachers focused both on SMT and the relationship between SMT and teachers' pedagogy. The present study has also identified higher levels of noticing (low-high, high). However, by analyzing all 76 episodes in the nine co-planning sessions, we learned that a considerable part of the teachers' discussions consists of no-level or low-level noticing. Only five episodes were coded at a high level (high). Four out of these episodes were identified when a quick image was the instructional activity, indicating that the activity might be of importance for what and how mathematics teachers notice during the co-planning sessions and the level of their noticing (van Es, 2011). In this paper, we have illustrated the only high level of noticing episode emerging when a string was the instructional activity, indicating that various instructional activities might invite teachers to experience higher levels of noticing.

In MAM, however, various instructional activities were included, and leaving out the design of high-level cognitive demand tasks (e.g., Choy et al., 2017) might be the reason for lower levels of noticing in the MAM co-planning sessions. However, whereas the literature puts forward the importance of higher levels of noticing (e.g., Choy & Dindyal, 2019; van Es, 2011), our explorations of co-planning sessions suggest that lower levels of noticing are important starting points for co-planning discussions to include higher levels of noticing. More specifically, we have identified how the teachers have attended and made sense of a given task and particular SMT and gradually moved towards a more focused discussion on challenging SMT, inviting them to see the connection between tasks in the sequence and the particular "adding up" strategy. In our chosen co-planning session, one of the teachers has also tried out the activity in his class, and the teachers use this experience to discuss and make predictions of possible student strategies. This seems to be an example of how lower levels of noticing are important for the participants' discussions into higher levels of noticing. The focus on preparation to notice has been highlighted as an important research area (Choy et al., 2017) which still needs to be explored.

Conclusion and implications

Meeting the call from Choy et al. (2017) – to study teachers’ noticing while co-planning instruction – this study explores what and how teachers’ notice during the co-planning phase of learning cycles (Figure 1). Our analysis indicates that the choice of instructional activity might be of importance for co-planning discussions to include higher levels of noticing, but more research is needed for clear conclusions to be drawn in this respect. Our analysis also indicates that trying out the activity in one’s own class before a co-planning session seems to stimulate higher levels of noticing, but more research is also needed to explore this indication. An implication for future learning cycles, might be to include the design of high-level cognitive demand tasks in co-planning sessions (cf. Choy et al., 2017) or frameworks for noticing (e.g., van Es, 2011) for more episodes to include higher levels of noticing. Even though higher levels of noticing matter for student learning (e.g., van Es & Sherin, 2021) and noticing SMT can be planned for (e.g., Dietiker et al., 2018), we conclude that lower levels of noticing are important starting points for higher levels of noticing, highlighting the importance for future research to explore the relation between different levels of noticing.

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