

# Challenges in enacting classroom dialogue\*

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*In this article, we report on the challenges of enacting a dialogic approach to teaching mathematics. Using the five principles and three repertoires of dialogic teaching as theoretical framework, we draw on interviews and classroom observations of a secondary-school teacher who aspired to teach mathematics through dialogue. We analysed his accounts and videos of his lessons to identify his strategies for dialogic teaching and challenges in implementing these. We found that the usefulness of strategies for dialogue changed over time and that some challenges were manifestations of tensions between the five principles, and thus intrinsic to dialogic teaching. Specifically, concerns for broad participation needed to be balanced against concerns for mathematical content, while the pursuit of a specific mathematical goal – the purposeful principle – lead to missed opportunities for chaining ideas into coherent lines of thinking and understanding – the cumulative principle.*

*Keywords: Dialogic teaching, cumulative principle, systems of linear equations.*

## Introduction and background

Inclusion of all students is a cornerstone of Norwegian education, encapsulated in *adapted education*, a principle that endured through shifting political discourse (Jenssen & Lillejord, 2009). Interviews with teachers participating in the *Inclusive Mathematics Teaching* project (IMaT) revealed that many considered dialogue as key to both challenging and including every student in quality mathematics. In this study, we aim to understand one teacher's strategies for dialogue and the challenges he met, contributing to research efforts on the implementation of dialogic teaching (e.g. Alexander, Hardman, Hardman, Longmore, & Rajab, 2017; Sedova, Salamounova, & Svaricek, 2014).

## Literature review and theoretical framework

The idea of using language as a tool for learning has given rise to the development of different but interrelated pedagogical approaches involving classroom dialogue, and consequently conceptual confusion over what is meant by 'dialogic teaching' (Kim & Wilkinson, 2019, p.71). We draw here on the conceptualisation of Alexander (e.g. Alexander, 2018) who theorised *dialogic teaching* (DT) from empirical data in a large comparative international study. This emerging pedagogy aims to engage students in genuine dialogue, where participants attempt to take the others' perspective (Alexander, 2018) and it is defined by five principles: *collective* (the classroom is a site of joint learning and enquiry), *reciprocal* (participants listen to each other, share ideas, consider alternative viewpoints), *supportive* (participants do not fear embarrassment over wrong answers, help each other to reach common understanding), *cumulative* (participants build on their own and each other's ideas

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and chain them into coherent lines of thinking and understanding) and *purposeful* (classroom talk is structured with specific educational goals in view) (Alexander, 2018, p. 566).

The growing appeal of DT across disciplines creates a need for interrelated research directions, e.g. on operationalisations of the approach, on its impact on student learning, on pedagogical strategies that support or hinder its implementation (the focus of this article). Alexander argues that the realisation of DT depends on exploiting rich *repertoires* flexibly and appropriately. The most important are *organisation* (whole class, groups, one-to-one), *teaching talk* (discussion and dialogue in addition to direct instruction) and *learning talk* (narrate, explain, speculate, imagine, explore, analyse, evaluate, question, justify, discuss, argue) (Alexander, 2018, pp. 567-570). Discussion and dialogue are the most desirable forms of *teaching talk* as they activate a broad range of *learning talk*, while direct instruction only allows students “to tell/narrate and, at a pinch, to explain, but not to speculate, imagine, explore, analyze, argue or ask questions of their own” (Alexander, 2018, p. 569).

A more precise characterisation of these repertoires led to 61 indicators that operationalise DT (Alexander, Hardman, & Hardman, 2017). This extremely detailed decomposition is impractical in classroom observations and more holistic approaches are preferable (Alexander, 2018). Still, existing research (in other fields) found some of the indicators to be more noteworthy. *Higher order teacher feedback* and *open discussions* are considered key to DT, with open discussions identified as the most important variable affecting *student talk with reasoning* (e.g. Sedova, Sedlaeck, & Svaricek, 2016), while *authenticity* (*open-ended questions* aimed at including students’ thinking) and *uptake* (building on student responses) correlate most strongly to achievement (Nystrand, Gamoran, Kachur, & Prendergast, 1997). Nonetheless, regarding these indicators in isolation can mislead: Lefstein, Snell and Israeli (2015) found that *open-ended questions* do not guarantee elaborate or thoughtful student responses. As the indicators of the *teaching repertoire* do not necessarily reflect in the *learning repertoire*, we need to understand the factors that affect the impact of pedagogical strategies for DT.

While the idea of DT is seductive, implementation is challenging. We agree with Sedova et al. (2014) in that understanding the challenges of dialogic teaching can inform its implementation making it easier to incorporate in teachers’ practice. Some challenges in implementation are evident in Alexander’s randomised controlled trial (RCT) in primary schools. The intensive professional development programme transformed both student and teacher talk strikingly, with an improved closed- to open-ended questions rate across all subjects, higher order teacher feedback and a significant increase in discussions and dialogue (Alexander, 2018). In mathematics, student contributions in the intervention group were much more frequent than in the control group, and *the learning repertoire* differed, with students arguing, justifying, imagining, shifting position (Hardman, 2019). Still, the evaluation of this RCT also found that the first three principles of DT were easier to realise, while – even in a carefully designed intervention where the principles were explicit – making teaching *cumulative* and *purposeful* proved harder (Alexander, 2018).

Reviewing research on dialogic teaching – as defined by Alexander – in mathematics education, Bakker, Smit & Wegerif (2015) remark on its surprising scarcity, as well as its promise. Theoretically, quality mathematics teaching is compatible with this pedagogy where the goal is to teach both mathematical concepts and mathematical dialogue (i.e. dialogue is both a tool and an end) (Bakker et al., 2015, p. 1057). Empirical studies support this hypothesis, as investigations of teachers’ strategies provide evidence for the impact of dialogue on how students experience mathematics. For instance,

teacher questioning that scaffolds students' engagement in justifying and explaining can give rise to teacher-student dialogue that maintains the cognitive demand of tasks (Estrella, Zakaryan, Olfos, & Espinoza, 2020); responsive teaching strategies, including the provision of prompts that the students could then use in questioning their peers, foster teacher-student and student-student dialogue supporting broad student access to mathematics (Makar, Bakker, & Ben-Zvi, 2015). However, the impact of dialogue is not always positive: an ethnographic study revealed a relationship between the manner in which a mathematics teacher afforded differential access to the whole-class discussion over time and students' agency and identity in mathematics (Solomon & Black, 2008).

Understanding the mechanisms that support or hinder the realisation of DT informs the design of teacher education and professional development. In response to this need, we explore DT in mathematics drawing on interview data and classroom observations from a teacher, Rune, who saw dialogue as essential for quality mathematics teaching. We address the following research questions:

- RQ1 What strategies for dialogue did Rune promote and enact? How did they relate to DT?
- RQ2 What challenges in realising DT emerged?

## Methodology

The participants were Rune (all names are pseudonyms), a young mathematics teacher with a master's degree in mathematics education and the 24 students (age 15-16) in a mixed ability 10<sup>th</sup> grade class in a Norwegian urban lower secondary school. Rune was selected because of his aspiration to make dialogue a goal and a tool in mathematics, i.e. an aspiration towards DT (see Bakker et al., 2015). The data consists of two semi-structured interviews and video of three consecutive lessons. The pre-observation interview (I1) addressed Rune's view of quality mathematics teaching, his strategies and his challenges in realising his vision. The lessons (L1, L2, L3) were the formal introduction to systems of linear equations, including eight tasks (2-3 per lesson), six abstract to be solved by substitution and two problem stories. In the post-observation interview (I2), we used stimulated recall to obtain Rune's perspective on the implementation of the strategies, as captured on video.

To answer RQ1 and RQ2, we first identified in the interviews statements on the strategies Rune saw as supporting his goal of dialogue in mathematics and the challenges he reported meeting. We holistically analysed these in terms of their relation to the five principles of DT and the *organizational, teaching and learning repertoires*. Next, we identified in the video data the enacted strategies and, drawing on the stimulated recall in I2 when possible, we analysed these episodes in terms of the repertoires and principles of DT to identify other challenges. We proceed to the findings before discussing implications for the realisation of dialogic teaching.

## Findings

In this section, we first answer the research questions based on the interviews, where Rune gave his account of the strategies (S1, S2, S3) he used and the challenges (C1, C2) he met in realising a teaching approach centred on dialogue. Then, we turn to video data from the three lessons and to the stimulated recall during I2, and analyse the implementation of these specific strategies during the three lessons, identifying additional challenges (C3, C4) to the realisation of dialogic teaching.

## Strategies and challenges in the interview data

During interviews, Rune recounted his experience of teaching these students for the past 1.5 years. He described three strategies he used for dialogue in mathematics: (S1) asking open questions, (S2) employing group work, and (S3) using multiple solution tasks. The main types of challenges he reported experiencing over time are (C1) establishing a culture for dialogue in mathematics and (C2) recasting errors as productive. We discuss the findings in terms of the principles of DT.

Rune's goal "to facilitate dialogue among students and between students and me" (I1), has a *collective* quality. For him, "dialogue is central [to quality teaching], how to talk about mathematics":

[Create] an open forum ... What do we think about this [problem]? Everyone can answer in some way, can come with something (...) So maybe, make the questions as open as possible. (I1)

This strategy (S1) had been unsuccessful in the beginning, as students were "very individual [with a] right-answer mentality" (I2) and preferred to work silently on individual tasks (C1):

They only raised their hand if they had the right answer. If I asked 'What are your thoughts on this problem? About this solution?' it seemed this wasn't mathematics in their eyes. This had to change no matter what since (...) mathematics was for them right answers and 'recipes', algorithms. (I2)

Thus, his *purpose* for dialogue was for students to see mathematics as sense-making rather than right/wrong answers. Even in oral exams he hoped students would tell themselves "I can do it and talk about it, not only set it up and show the answer is right, but also reflect on it, own it." (I2). Initially, asking *open-ended, authentic question* (S1, *teaching repertoire*) had not increased student participation in dialogue and Rune had struggled to engage them in a broader *learning repertoire* in mathematics (C1). To ease their discomfort at speaking in class (C1), Rune varied the *organisational repertoire*, away from individual work and over to pairs ("you force the student to think, it isn't fun to have nothing to say while the other has something", I1) and groups (S2):

Asking a question to the crowd wouldn't feel as safe [to them]. 'Here I sit alone and think. These are my thoughts. If I come out with them – maybe I misunderstood or I didn't think right.' In pairs, you get either confirmation or refutation, (...) students feel safe. I get much more response (I2).

Thus, Rune reported seeing results in establishing a culture for dialogue (C1): working in pairs allowed students to practice talking about mathematics in low-risk settings, towards a *collective* quality and *reciprocity*, as both partners talked and listened. In addition, he noticed a shift in the content of the exchanges, away from seeing mathematics as just getting the right answers (C2):

They've gotten better at working [in groups]. They are better at seeing 'OK, that works better here! Your setup works better.' There is more natural equity, because they see what works better. So they take some bits from here, some from there and in the end the group [coalesces]. (I1)

The group's adoption of bits of ideas from everyone speaks to the *collective, reciprocal* and *supportive* interaction. Rune argued that this development was the result of working on multiple solution tasks, as students get a chance to see that all contributions are valued – also those with errors (C2). Looking for (five) solutions, students may speculate, imagine, analyse (*learning repertoire*).

We [then] look at what the groups did, get [on the board] the different solutions. Nothing is too silly. Mistakes are great because we can use them (...) see why the student thought as he did. (I2)



Rune's account of his strategies and of the challenges encompasses 1.5 years. He reported some progress, but stated that the process was ongoing (I2). We turn to the lessons for the current situation.

### **Strategies and challenges in the observed lessons**

The findings from the interview guided the analysis of the videos. We identified episodes representing the two challenges (C1 and C2) and the implementation of three strategies (S1-S3). Analyses in terms of the principles of DT revealed two tensions between conflicting priorities: (C3) broad participation vs. probing student reasoning (C4) building on student contributions vs. avoiding errors.

From the analysis of the strategies S2 (using group work) and S1 (asking open questions) in the lessons, an additional challenge for dialogic teaching emerged: the tension between concerns for broad participation and probing student reasoning (C3). Rune alternated purposefully the *organisational repertoire* between whole-class and groups (S2): pairs discussed specific issues as whole-class discussion paused, while small groups worked on more complex tasks. Twice we observed Rune meet the challenge of establishing a culture for dialogue (C1), and he made sure that students engaged in group-work in a *collective* and *reciprocal* manner, once insisting on four people sitting at a group table so that they see each other (L1) and once reminding a group to interact ("Talk to each other, people!" L1). Otherwise, while the groups (especially the pairs) were working, Rune paced back and forth and mainly waited to be called upon (except for seeking out students for whom he had special concerns). We asked in stimulated recall (I2) if he deliberately stayed away.

I guess [not engaging] lingers from 8<sup>th</sup> and 9<sup>th</sup> grade [when] they turned quiet. And [working in pairs] should be their chat, where they get to use their own words without me disturbing them. (I2)

In other words, his concern was for the *collective* and *reciprocal* exchange between the students, rather than for opportunities to probe student reasoning (C3). When Rune talked to groups, his *feedback* was always positive, but usually not of higher order. He encouraged grit ("You're really on to something there!" L1), praised, confirmed, but he rarely pressed for justifications (C3). Although *supportive*, this practice does not focus on mathematics.

Rune's *teaching repertoire* included some closed questions (driven by a clear *purpose*, e.g. "Can I choose which variable to isolate?" L2), but mostly *open-ended* ones (S2) (e.g. in L3: "What did you talk about?", "Do you have any thoughts about it?", "What do we see?", "What do we feel?", "What do you want to do?"). In these lessons, the *open-ended questions* prompted many students to participate and activated a broad *learning repertoire* (e.g. questioning, imagining, speculating etc.), but seldom *purposeful* in terms of the mathematics and there was limited *uptake*, resulting in many short exchanges lacking in *cumulative* qualities and few opportunities to justify, argue, discuss (C3).

The strategy of using multiple solution tasks (S3) was present in L1, as Rune encouraged multiple informal solutions to the doughnut and soda task (Two doughnuts and three sodas are 85 kroner. Two doughnuts and one soda are 55 kroner. How much for each?) drawn on the board (Figure 1, left). These included guess-and-check and comparing the two situations additively, corresponding to the addition method ("the one to the left is 30 kroner more than the other, so a soda is 15 kroner" L1).

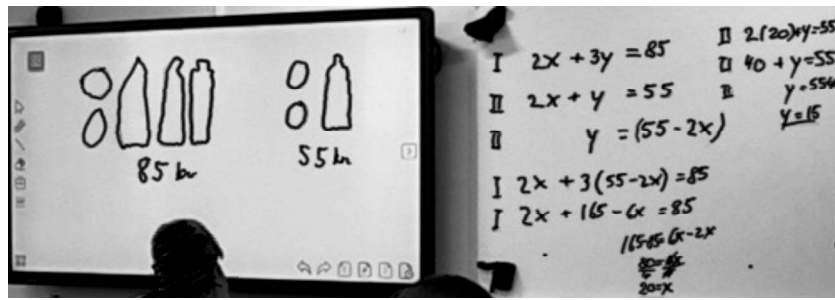


Figure 1: The doughnuts and soda task and its solution by substitution

Once the first equation was set up symbolically (Figure 1, right), and the class was working on setting up the second, Rune ignored twice Nora’s suggestion (“ $2x + y$  and then minus”, L1) that included not only the second equation but also continued with the addition method. He waited until someone suggested  $2x + y = 55$ , then solved the system by substitution. He then hinted to the addition method (“Do you see any relationship with the drawing? And perhaps how we could reason based only on the two equations? It’s a really hard question.”, L1). Nora’s renewed input (“ $2x + 3y$  minus  $2x + y$  and then divide by two”) was acknowledged (“Hold on to that, Nora”) but not built on. A numerical suggestion (“take 85 minus 55”) from another student was used to show arrive at 15 (the value for  $y$ ). Rune then dismissed the addition method as easy “in one particular case” and stated that the substitution method would be used further. During stimulated recall, we asked about the mismatch between Rune’s appreciation of multiple solution tasks (S3) and his reluctance to accept here the addition method. He explained choosing the substitution method deliberately, as “it always works” and reduce the risk of weaker students “messing up the signs” (I2). Naturally, Rune’s understanding of the addition method shapes his prioritising of the substitution method. Accepting his understanding as a premise, we identify the challenge he experiences between building on relevant student contributions and avoiding methods that can lead to errors (C4). This challenge is an instantiation of a tension between the *cumulative* (connecting the informal solutions and the formal system through Nora’s input on the addition method) and *purposeful* (avoiding avenues that can lead to errors).

## Discussion and conclusion

The realisation of DT holds great promise, but is difficult to achieve even for teachers participating in targeted professional development (Alexander et al., 2017; Hardman, 2019; Sedova et al., 2016). In this paper, we explore the pedagogical practices and challenges of a mathematics teacher who, although not aware of the theorisation of dialogic teaching, had aspirations compatible with this approach. Our analysis in terms of the principles of DT (Alexander, 2018) is not an evaluation of this particular teacher, but a means to understanding the challenges in implementing DT. We aim to contribute to the call by Sedova and colleagues to gain such insights with the goal of using them to make the DT more accessible for teachers (Sedova et al., 2014).

We identified four challenges, two from Rune’s accounts of working with this class over time, and two from the lessons observed. Rune describes the first – creating a culture for dialogue in mathematics (C1) – as multifaceted: changing established ways of participation (in this case silent, individual work), overcoming the vulnerability of sharing – potentially wrong – ideas with the others and, not least, re-imagining what it means to talk about mathematics. This challenge relates most strongly to the first three principles of dialogic teaching (*collective, reciprocal, supportive*) but touches on the remaining two (*purposeful* and *cumulative*) as well, as part of the classroom culture is

the meaning attached to talking about mathematics. While primary teachers in Alexander's PD established relatively quickly a practice aligned with the first three principles (Alexander, 2018, p. 581), Rune still had concerns for participation after a year and a half. This challenge was not prominent in the lessons we observed, but his concerns guided his actions, revealing the tension between fostering broad participation versus probing student reasoning (C3). In the lessons, in order to ensure the *collective* and *supportive* quality of the exchanges, Rune asked open (S1) but unfocused questions and avoided higher order feedback. *Open-ended* are key indicators of DT (Alexander, 2018; Nystrand et al., 1997), but our findings add to the evidence that such questions do not necessarily lead to student reasoning (e.g. Lefstein et al., 2015) and bring a new insight about a developing practice; as Rune initially failed to get any response to authentic questions, getting many response signals progress. His concerns for regressing appear to make him wary of systematically pressing for reasoning. This speaks to the contextual factors for the impact of teaching strategies and the need for teachers to continue adjusting them as a class progresses.

Rune's concern with participation at the expense of probing student reasoning (C3) reflect as a tension between the dynamics and the content of dialogue: the three first principles for dialogic teaching have to do with the dynamics of talk, while the last two have to do with its content (Alexander et al., 2017, p. 566). The tension between the dynamics and the content of exchanges mirrors that reported by Sedova and colleagues, who found that insufficient emphasis on rational argumentation was a basic deficit in embryonic forms of dialogic teaching (in Czech language, History or civics) and attributed it in part to the teachers' concern for being *supportive* (Sedova et al., 2014).

The content-related principles (*cumulative* and the *purposeful*) were harder to realise than the others for teachers in Alexander's PD. Alexander attributes the difficulty of the *cumulative* quality to the fact that it depends on the teacher's knowledge of the subject and of the students' pre-existing understanding, as well as on the teacher's interactive skills (Alexander, 2018, p. 566). In our study, we identified a tension between the *purposeful* and the *cumulative*. For Rune, the issue of errors in mathematics resulted in two challenges: his (self-reported) efforts to help students see errors as productive (C2) and his (observed) struggle to choose between building on student contributions or avoiding error-prone methods (C4). Rune prioritised the *purposeful* over the *cumulative*, even though the purpose (consolidating the method he saw as less prone to errors) is in itself in conflict with Rune's goal of projecting errors as productive (C2) and his appreciation of multiple solutions (S3).

Our findings highlight internal conflicts between the five principles of dialogic teaching, conflicts that teachers need to negotiate in the moment. In addition, we identified a shift in the challenges of the classroom (as reported in the past versus as observed) that raises the issue of pedagogical strategies keeping up with this moving target. We will pursue this line of investigation with others IMaT participants invested in dialogic approaches to mathematics to understand how teacher resolve such tensions between the principles of DT. However, we believe that other methodological approaches are needed, including longitudinal studies (to understand potential patterns of action to resolve tensions and the sources informing these) and shifting to a student perspective (to understand the impact). For example, Rune's prioritising of broad participation resulted in some lost opportunities to think deeper about the mathematics, but it may still be beneficial for the class: a quantitative study of dialogic teaching (in languages) showed that 'talkative' classes performed better and there was no connection between utterances with reasoning and class performance (Sedova et al., 2019).

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