DEVELOPING AND IMPLEMENTING TASK-FOCUSED GUIDANCE FOR LANGUAGE-RESPONSIVE MATHEMATICS TEACHING

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Mathematics teaching that is responsive to the linguistic demands of the mathematical content, as well as the linguistic resources that students bring, is widely recognised as supporting the learning of mathematics. In this paper we report on one aspect of the video analysis that occurred as part of a larger development project focused on language-responsive mathematics teaching. Videos of lessons where experienced teachers implemented tasks they had collaborated in designing guidance for were analysed using a standardised observation framework focused on classroom discourse and the quality of mathematical activity. The analysis shows the teachers explicitly including opportunities to elicit students' thinking and to enable students to engage in a range of rich discourse practices.

INTRODUCTION

This paper reports on part of the video analysis of mathematics teaching following a collaborative project in which experienced teachers and the project team co-developed task guidance and other professional development materials to support language-responsive teaching (Erath et al., 2021). The model of professional development draws on Mason's Discipline of Noticing (2002) by focusing on awareness of choices and possibilities so that teachers can make deliberate, conscious decisions in the moment of teaching, rather than acting out of habit. The analysis reported here focuses on the quality and quantity of discourse and the nature of the mathematical activity that was observed in the videos.

LANGUAGE-RESPONSIVE MATHEMATICS TEACHING

There has been considerable growth in research focused on language-responsive mathematics teaching in recent years. In a review of this research, Erath et al. (2021) identified six evidence-based design principles for language-responsive mathematics teaching. These principles include engaging students in rich discourse practices, establishing language routines, connecting representations and languages, including students' multilingual resources, scaffolding and planning the sequencing of learning opportunities that combine language and mathematics, and raising students' awareness of language.

Language has an important epistemic function as well as a communicative function in mathematics classrooms (Moschkovich, 2015; Pimm, 1987). Mathematics classroom content can be both mathematically complex and linguistically complex (Abedi &

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Herman, 2010; O'Halloran, 2005). One way in which language-responsive mathematics teaching addresses this is by focusing on meaning-related vocabulary and phrases. These are shared words and phrases that can be used to communicate and discuss mathematical meanings before introducing more formal mathematical ways of communicating (Pöhler & Prediger, 2015) and can be used alongside the more formal language.

Language-responsive mathematics teaching also relies on teachers using tasks that give students opportunities to engage in more mathematically demanding discourse practices such as explaining reasoning or justifying an argument. There has been considerable research identifying features of task design that support these opportunities (e.g., Geiger et al., 2022; Kieran et al., 2015; Kim, 2015; Koichu et al., 2016), but the implementation of these tasks also requires the use of teacher moves that support students' communication and reasoning of the mathematics involved (Erath et al., 2021). Again, there has been considerable research identifying those moves that are effective in encouraging students to participate in classroom discussions and to listen and engage with other students' ideas and reasons (e.g., Drageset, 2014; Michaels et al., 2008).

The project sought to identify which aspects of language-responsive mathematics teaching teachers could implement and embed in their teaching through participating in a professional development project that was based on a model of professional growth underpinning the Discipline of Noticing. Firstly, this was through working with teachers' awareness of the potential linguistic demands, meaning-related words, phrases and diagrams, and argumentation and reasoning structures that are specific to particular topics, and teachers' self-reflection on these aspects in their own classrooms. Secondly, this was through working on teacher moves such as those described by Erath et al. (2021), Drageset (2015) and Michaels et al. (2008) that cut across different mathematical topics but can support students in meeting the linguistic and cognitive demands of the mathematics they are learning.

DISCIPLINE OF NOTICING

The Discipline of Noticing (Mason, 2002) is a framework designed to support professionals in becoming more aware of their own practices and experiences in order to work on that practice. It involves intentional noticing, self-reflection, and a sensitivity to opportunities to act differently. It is widely used by mathematics teachers and mathematics teacher educators, including ourselves, for self-development and professional growth.

In the larger professional development project, the teachers worked collaboratively together and with the wider project team on a collection of widely used and familiar classroom tasks. This work involved intentionally noticing the linguistic demands of the tasks and the mathematics involved, reflecting on experiences of using these tasks and similar tasks with students and identifying opportunities to use or incorporate the principles of language-responsive mathematics teaching. These discussions were then used as the basis for writing new task guidance that draws attention to the linguistic demands of the task and the mathematics involved, possible student activities and responses to different aspects of the task with an emphasis on student reasoning and explanations, and identifying the mathematical aspects of this reasoning.

TASK GUIDANCE

Overarching principles of the project task guidance were to support teachers to develop awareness of the role of classroom language in student learning, rather than telling teachers what they should do, and to frame research findings on topic-specific challenges as situated within the mathematics, rather than as deficiencies of learners. The project task guidance specifically focused on engaging students in rich discourse practices, including explaining their reasoning and justifying approaches, even where the tasks focused on practising a particular skill or procedure, such as identifying corresponding or alternate angles in parallel lines. The task guidance also focused on different possible reasons why something was the way it was, and on anticipating and responding to students' thinking, such as the different ways that students might reason about variables in algebraic expressions. A further focus was on making explicit connections between representations and between mathematical ideas, concepts and processes. The task guides aimed to identify specific details of opportunities and challenges of the tasks and relate these to principles of language-responsive teaching. For example, one task guide provided different ways learners and teachers might say algebraic expressions such as $x+y$ and xy and draws attention to important distinctions between reading out statements and what they mean (incorporating meaning-related language).

METHODS

This paper reports on a small part of a larger project focused on the development of professional development materials to support language-responsive mathematics teaching. Specifically, it focuses on one stage of the coding of the video recordings of mathematics lessons from secondary schools in England. The project involved 11 experienced mathematics teachers from 6 state schools who volunteered to collaborate on the project as research participants. Ethical processes and procedures were followed (BERA, 2018), including teacher and parental informed consent and student assent.

As outlined above, the larger project involved the collaborative development of task guidance for well-known and familiar tasks widely used in England with a focus on language-responsive teaching. The project focused on three topics from the lower secondary mathematics curriculum in England: linear equations, angles in parallel lines, and introducing probability. For each topic the project teachers video recorded one of their lessons that included one of the tasks that guidance had been developed for. Videos were of the entire lesson, and not just the part of the lesson that included these project tasks, so that comparisons could be made between the different types of mathematical activities that occurred during the lessons.

These video recordings were analysed using a four-stage process, with each stage focusing more closely on the interactions than the previous stage. In this paper, we report on the results of stage 2 analysis. In stage 1, activity-focused episodes were identified. These episodes all involved some interactions around the mathematics in the lesson and included the introduction of a task, the work on that task and any summing up or conclusion to a task; boundaries between episodes were marked by a shift to a different activity. These episodes were then analysed in stage 2 using four of the domains from the Global Teaching Insights observation framework (Bell et al., 2020) that focused on the nature and quality of the mathematics or of the discourse, and the higher-inference components of those domains.

Each video was rated by two trained raters using the scale of 1 to 4 in the observation framework, where 4 refers to the highest quantity or quality of the target component and 1 was the lowest. Full details of the observation framework and the scales used are available from the Global Teaching Insights website: https://www.oecd.org/en/about/projects/global-teaching-insights.html. Overall, there was 89.4% exact agreement between the two raters and 98.5% exact or adjacent agreement between the two raters. Differences between ratings were jointly discussed until agreement was reached. A total of 49 episodes were coded, with between 3 and 10 episodes in a lesson. Twenty of these episodes included the tasks from the project, with the other 27 episodes including other mathematical tasks.

RESULTS

We begin this section by first discussing the coding domains focused on the nature and quantity of classroom discourse. We follow this with a discussion of the coding domains focused on the nature and quality of the mathematical activity during the episodes. Each of the aspects of these coding domains is analysed in relation to whether it measures aspects of teaching and learning targeted in the task guidance or not.

The nature and quantity of discourse

There were six components from the observation framework that addressed different aspects of the nature and quantity of the discourse during the lesson. These six components along with the average ratings for the two different types of episode are listed in Table 1.

In the episodes that included one of the tasks from the project, the average ratings for the nature of discourse component was significantly higher than for the other tasks in the lessons. This component focuses on how detailed students' contributions to the classroom discussions were. The mean for the episodes including the project tasks was 3.11, meaning that these episodes included detailed student turns, the interactions were characterised by students' ideas and reasoning, and the episodes included several student turns. The mean for the other tasks was 1.96, meaning that students' turns generally consisted of single-word answers. The project task guidance specifically focused on engaging students in rich discourse practices that are typical of detailed student turns, even where the tasks focused on practising a particular skill or procedure.

The task guidance also focused on responding to students' thinking. In the project task episodes more student thinking was elicited (Mean rating of 3.32 vs 2.27 for this component), and more questions that were cognitively demanding were asked (Mean rating of 3.26 vs 2.33 for the questioning component) than in the other task episodes. However, there was no significant difference in the extent to which teachers built on that student thinking (Mean rating of 3.67 vs 3.02). Ratings for this component were generally high, which was consistent with the findings of the Global Teaching Insights study of mathematics teaching in England.

Component	Project tasks (Mean, SD)	Other tasks (Mean, SD)
Nature of discourse	3.11 (0.89)	1.96 (0.51)
Questioning	3.26 (0.73)	2.33 (0.80)
Explanations	3.08 (0.79)	2.31 (0.79)
Eliciting student thinking	3.32 (0.80)	2.27 (0.68)
Teacher feedback	2.66 (1.17)	1.75 (0.72)
Aligning instruction to present student understanding	3.67 (0.69)	3.02 (0.91)

Table 1: Average ratings for the codes focused on language and discourse.

The nature and quality of the mathematics

There were also four components from the observation framework that addressed different aspects of the nature and quality of the mathematics in the lesson observations. These four components, along with the average ratings for the two different types of episodes, are listed in Table 2.

Making explicit connections between representations and between mathematical ideas, concepts and processes was targeted in the task guidance, as was a focus on reasoning why something was the way it was (rather than what or how). However, explicit connections were not often made in either the project task episodes or the other task episodes. While these average ratings of 2.32 and 2.15 are consistent with the findings of the Global Teaching Insights study, this is one aspect of practice where the task guidance appears to have had less impact on practice. This may be because discussions about the task guidance with the teachers had a far greater focus on the nature and quality of the discourse than on the mathematics, due in part to the teachers' familiarity with the tasks and the mathematical activities that often arose when they worked on the tasks with their students.

In contrast, the average rating for the focus on understanding the subject matter procedures and processes was higher in the project tasks episodes (3.03) compared to the other task episodes (1.81). This is likely to be a result of the focus on the different reasons and explanations students might give in response to the task in the guidance development sessions, where a specific focus was on how to respond to this reasoning in ways that highlighted the mathematical aspects and developed this reasoning in ways that explicitly addressed the mathematical aspects of reasoning and argumentation. Similarly, although the project did not focus on multiple approaches, it did focus on multiple perspectives of reasoning and argumentation. In this component the average rating for the project task episodes (2.66) was higher than in the other task episodes.

Component	Project tasks (Mean, SD)	Other tasks (Mean, SD)
Explicit connections	2.32 (0.87)	2.15 (0.88)
Engagement in cognitively demanding subject matter	3.45 (0.81)	2.00 (0.82)
Multiple approaches to and perspectives on reasoning	2.66 (1.19)	1.44 (0.92)
Understanding of subject matter procedures and processes	3.03 (1.09)	1.81 (0.87)

Table 2: Average ratings for the codes focused on mathematics.

Engagement in cognitively demanding subject matter was not directly targeted in the task guidance, but tasks were chosen because they involved engagement with a key concept within the topic (e.g. the role of letters as unknowns or variables, and the different meanings for '=') whereas the other task episodes also included tasks that were part of school established routines (e.g., Do Now Activities used as starters, silent independent practice work) which often focus on the more routine aspects of mathematics learning.

DISCUSSION AND CONCLUSIONS

The process of teachers analysing tasks in relation to the principles of language-responsive mathematics teaching resulted in teachers reporting that they were more aware of the linguistic and mathematical demands of the task and the student reasoning that could follow, and they reported using this awareness to develop their own practice in the spirit of the Discipline of Noticing. This was also reflected in the video observations as measured by the four domains of the Global Teaching InSights framework.

There are limitations to this analysis, given that the episodes varied in terms of length, focus, and structure. There was also variation between the different teachers involved. These variations are not reflected in average scores such as those reported on here. Furthermore, some of these components address aspects of mathematics teaching and learning that are relevant to a range of classroom tasks and activities. Other components address aspects of mathematics teaching and learning that are relevant to specific types of task and activities, such as multiple approaches to and perspectives on reasoning. For this second type of component, it would be reasonable to expect the average ratings to be lower as not including this aspect of practice could be entirely appropriate for the activity.

This analysis suggests that task guidance that focuses on awarenesses and intentions (Mason, 2006; Mason & Davis, 2013) in order for choices to become available when opportunities arise in the moment of teaching can improve the quality and quantity of classroom discourse focused on reasoning, understanding and argumentation, at least with experienced mathematics teachers with an interest in developing their practice to be more language-responsive. This is the case with tasks specifically focused on developing students' mathematical reasoning and argumentation, as well as tasks that focus more on developing fluency with a particular procedure or process.

Research focusing on the development of language-responsive mathematics teaching has demonstrated the value of language awareness and connections to mathematical meanings. Research focused on teacher moves that promote student reasoning has also demonstrated the positive impact of these moves on students' learning, both in general (O'Connor & Michaels, 2019), in combination with specific tasks (Rüede et al., 2023). Yet teachers often find language-responsive teaching challenging to implement and sustain in ways that reflect the underlying principles. This paper offers some evidence that an approach focused on developing awarenesses and self-reflection on practice, such as in the Discipline of Noticing, can result in the implementation of strategies in ways that are consistent with the underlying principles. Further research is needed to examine the longer-term effects and the extent to which these practices can be implemented with a wider range of mathematics teachers.

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