

Defining communication-responsive mathematics teaching and classrooms

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Research on supporting learners with the language demands of mathematics while drawing on the linguistic resources they bring to the classroom has grown considerably. This focus is often referred to as language-responsive mathematics teaching, yet despite the term being widely used, it is not consistently used. In this paper, we argue that much of this work focuses on communication rather than on language alone. We therefore propose a definition for communication-responsive mathematics teaching and communication-responsive mathematics classrooms that underpins our own research. This definition synthesises key aspects from recent research, including attention to the mathematics embedded within interactions, an inclusive stance that recognises and values learners' communicative resources, and recognition of the multiple modes and structures of communication through which mathematical meaning is co-constructed in teaching and learning.

Keywords: Language and communication, Responsive mathematics teaching, Inclusion.

Introduction

Recent research has an increased focus on examining and developing language-responsive mathematics teaching, particularly within the work presented at CERME and ETC conferences. Despite this, the phrase 'language-responsive mathematics teaching' (LRMT) is used in a range of ways, often reflecting the specific focus of the research, which has led to ambiguity in its meaning and use. This has been highlighted to us in our own search for a definition in this literature. In addition to the heterogeneous use of LRMT in the research literature, we also observed a varying use of 'language' from teachers in our work as teacher educators, leading to varying interpretations of language-responsive mathematics teaching from practitioners. While some identify 'language' with vocabulary, others use 'language' to talk about algebraic mathematical signs and symbols, and others use 'language' as comprising learners' communicative resources. Furthermore, a second observation led us to think about defining and re-thinking our understanding of a respective teaching framework. From our perspective, the mathematics in LRMT needs to be more foregrounded. While some studies explicitly conduct topic-specific research in the context of LRMT, a large body of literature does not explicitly consider the mathematics, but responsiveness cannot be fully understood without it.

In this theoretical paper, we move away from the term LRMT and propose a definition of communication-responsive mathematics teaching (CRMT). In the following, we start with our definition of CRMT. In the subsequent sections, we break down this definition and discuss several inherent aspects as they relate to existing research. Finally, we reflect on what CRMT means with respect to communication-responsive mathematics classrooms.

A definition

We define communication-responsive mathematics teaching as:

Communication-responsive mathematics teaching refers to teaching that intentionally draws on and develops the mathematical communication of all learners, across modes, registers and degrees of formality within a classroom community engaged in mathematical learning.

We do this to capture multiple turns in research on and practice of LRMT, compared with its introduction and initial use. This includes extending LRMT from multilingual contexts to all mathematics classrooms, and the shift in primary focus from multilingualism to communication. We follow the turn from deficit perspectives to resource perspectives and away from labelling learners. Finally, we observed a turn from a focus on words to a focus on culture. In this case, however, we do not follow this turn; rather, we argue that both aspects and everything in between are important for a teaching framework.

In this paper, we unpack this definition, outlining our choices and the distinctions we make that underpin it. The definition we propose here was developed through a synthesis of literature that has expanded beyond a primary concern with multilingual learners towards broader understandings of communication, meaning-making, and mathematical participation. This literature highlights aspects of classroom practices that are not fully captured by the term language-responsive mathematics teaching, such as multimodal communication. It also helps foreground the mathematics itself, which we argue must remain central to any account of responsiveness. We begin by focusing on those aspects of the definition that explicitly address the mathematics. We do this because we argue that the distinctiveness of mathematical communication, language, and argumentation needs to be central to any research on CRMT. This echoes the arguments made by Adler and Ronda (2014) and reflects the focus on topic-specific aspects of LRMT that much of the recent research adopts (e.g., Ingram et al., 2025; Prediger, Erath, et al., 2022).

Communicating, modes, registers and degrees of formality

In this section, we first distinguish between communicating mathematically and communicating about mathematics and then examine the distinction between language and communication that are central to our definition. These distinctions are necessary because mathematics education research often foregrounds one or the other without sufficiently differentiating between them, resulting in ambiguous findings that are then treated as synonymous despite these distinctions.

By communicating mathematically, we emphasise participation in discourse practices that are constitutive of mathematical thinking itself (Radford & Barwell, 2016). This distinction highlights the important role of language and communication in meaning-making and the rich discourse practices of explaining, generalising, justifying, and connecting (Moschkovich, 2015). In contrast, communicating about mathematics can be reduced to names or labels, descriptions, and reports, without necessarily engaging in the epistemic work of doing mathematics. This focus on language as central to meaning-making, i.e., communicating mathematically, is evident in current research.

This highlights the second distinction, articulated by Planas and Pimm (2023), who argue that there is a distinction between language and communication, and failing to make this distinction can have

unintended consequences. They describe language in terms of linguistic systems and resources that include words and vocabulary, named languages, registers and discourse practices. Communication, however, includes language, but also gestures, diagrams, spatial arrangements, pauses, and intonation. This focus of communication as meaning-making through the coordinated use of multiple semiotic resources resonates with the most recent use of language-responsive in the mathematics education literature. Importantly, Planas and Pimm argue that by describing research and teaching as focusing on language, we reproduce deficit framings by over-emphasising linguistic competence.

Emphasising communication rather than language alone is particularly important where meaning-making is inherently content- and topic-specific (Ingram et al., 2025; Planas, 2021; Prediger, 2022). Going beyond vocabulary to include argumentation structures, symbols, and other semiotic resources also underscores the importance of not losing sight of the mathematics. Here, mathematics is not just about content or knowledge, but also a way of being, a way of behaving and a state of mind (Cuoco et al., 1996). When Adler (2021) and Erath et al. (2021) emphasise responsiveness as involving identifying which language practices matter for the mathematics in focus, these include explaining, justifying, and connecting in mathematically fluent and flexible ways. Thus, our discussion of LRMT aligns more closely with communication than with language, emphasising the importance of mathematical communication.

A persistent challenge in discussing language is that the term is often reduced to vocabulary or to named languages by researchers, practitioners, and policymakers (Barwell, 2018; Moschkovich, 2015). This reduction results in the perpetuation of two perspectives: firstly, groups of learners as fitting into fixed categories, i.e., English language learners, or learners whose home language is different from the language of instruction. Secondly, language is some ‘thing’ to be taught and learnt, which is correct or not, technical or not, discipline-specific or not, etc. These perspectives, with their underlying assumptions about different cognitive values of language varieties, disguise the situated and intersectional nature of teaching, learning, languages and mathematics.

Research that foregrounds registers and repertoires challenges these perspectives by questioning the cognitive value of technical, mathematical or discipline-specific language over more informal, everyday language (Zahner & Aquino-Sterling, 2022). As Moschkovich (2015) argues, mathematical meanings are not inherent in the technical terms themselves, but emerge through participation in practices. Similar arguments, which challenge the assumption that formal terminology necessarily supports mathematical meanings, are made widely in mathematics education (Pimm, 1995; Zahner & Aquino-Sterling, 2022), supporting our turn to referring to communication instead of language.

Communication is discursive, multimodal and multisemiotic (Morgan et al., 2021; Moschkovich, 2015; Ní Ríordáin et al., 2024). The different modes and registers play key roles in mathematics teaching and learning. There are various studies that have focused on different modes individually, such as spoken language, mathematical symbols, diagrams, and gestures, but research considering multimodality is increasingly becoming central to much of the research in this area (Morgan et al., 2021). This shift highlights the importance of moving towards a focus on communication-

responsive mathematics teaching rather than language-responsive, in which meaning-making involves the coordinated use of multiple semiotic resources and modes of communication.

Inclusion of all learners

As highlighted earlier, research focused on language-responsiveness and communication-responsiveness is also concerned with deficit framings of learners in a wide range of contexts. Language-responsive teaching has its origins in work with second-language learners across diverse sociolinguistic contexts, often in contexts where there is a need to focus on the political and ideological role of language, which can stratify and legitimise “what counts as valid knowledge is regulated through how explanations and justifications are produced” (Adler, 2021, p. 85). Many of these studies highlight issues with deficit perspectives on learners, reflected in choices between labels such as English language learners vs multilingual learners.

Recent efforts challenge the traditional deficit-labelling of learners in research and practice. Barwell (2020) describes this in terms of different learners having different trajectories into mathematical discourse, but disputes that these trajectories are hierarchical. Others stress both the complexity of multilingualism (Morgan et al., 2021) and the ways in which different learners engage in high-level mathematical practices, irrespective of the linguistic resources they use (Moschkovich, 2015). Much of this work has both conceptually and empirically drawn attention to the role of language and communication as a resource for learning mathematics.

Since Planas (2018), there’s a more explicit focus on language and communication as resources for learning mathematics (e.g., Ryan et al., 2021). Language, gestures and diagrams are treated as meaning-making resources, not just tools, supports or barriers to overcome (Barwell, 2020). This explicitness is central to what Barwell (2020) calls language positive classrooms. Here, language is a resource for participation, for meaning-making, as well as needed for access to school mathematics.

Based on these ideas of language and communication as resources for learning mathematics and following the move away from deficit-based labelling of learners, research more recently expanded its focus to an inclusion of all learners in LRMT. For example, Prediger, Erath, et al. (2022) highlight the explicit focus on multilingual learners in the earlier research on language-responsive teaching and mathematics teaching, but emphasise that being multilingual is not synonymous with experiencing language difficulties, particularly when multilingual learners are comfortable engaging in the language of instruction. They also highlight the language difficulties that learners with a history of low attainment in mathematics who are fluent in the language of instruction encounter. This group is also highlighted in the work of Ingram et al. (2024), who also include learners from socioeconomically disadvantaged backgrounds who may use the language of instruction in their homes, but may not be less comfortable with the language of school.

All this work emphasises that it is the access to mathematically meaningful discourse practices that matters. The study by Prediger et al. (2022) provides evidence that this access to meaningful discourse practices can be beneficial for all learners’ mathematical learning, irrespective of their fluency in the language of instruction and their prior mathematical attainment, even though effects

differ in strength. For us, this is another argument for treating communication as a resource for learning mathematics and for shifting the focus to the opportunities for all learners' mathematical learning.

This thinking leads us to consider CRMT in a wide range of classrooms and to open our perspective to a shifting focus from teaching to classrooms. This involves seeing mathematics as practices and (socio)mathematical norms, habits of mind, as something that is done and developed together, not only as a completed set of symbols and rules. This will be revisited after the next section, which will address another key term: responsive.

Responsive

Responsive is another term that is widely used but seldom defined. The term is used to reflect the need to respond and adapt to the linguistic, modal and cultural complexity of interactions in mathematics classrooms. For some, this involves scaffolding the content and language demands in ways that do not reduce the cognitive demand of the mathematics (Ní Ríordáin et al., 2024).

Responsive teaching is not automatically synonymous with adaptive teaching, even though both share similar assumptions about teaching. Adaptive teaching is often associated with differentiation and planning learning pathways, while responsive teaching is often connected to communication and interaction. However, the distinction is rarely made, and in many contexts, the terms are synonymous. In the context of LRMT, responsiveness often also included lesson planning and the need for topic-specific research, with some research supporting an extension towards micro-adaptive practices that include a focus on communication and interaction (Prediger, Quabeck, et al., 2022). Our definition of CRMT underscores the intentionality of drawing on and developing all learners' mathematical communication, encompassing planning and lesson design.

We also want to particularly emphasise responsiveness in interaction, i.e., teaching in a way that builds on and is contingent upon learners' resources in mathematics classroom communication. However, this is not independent of planning lessons. Thus, we explicitly extend the general understanding of the term responsive, as this intentionality of responsiveness includes the planning and designing of lessons (Erath et al., 2021). This supports the shift from 'language sensitive' or 'language conscious' to communication-responsive. In this way, Prediger's (2019) five jobs involved in language-responsive mathematics teaching (noticing, demanding, supporting, developing, and identifying) are included in our understanding of communication-responsive teaching. These jobs are mathematical as well as pedagogic as they each involve focusing on conceptual and procedural distinctions, and mathematics-specific forms of explaining, justifying, etc.

Collective meaning-making and negotiating meaning through interaction

From the beginning of this paper, we argued for the important role of language and communication in meaning-making and the rich discourse practices of explaining, generalising, justifying, and connecting involved. Theoretically, this focus on collective reasoning and meaning-making can be based on social, interactionist perspectives that conceptualise mathematical learning inseparably from participation in classroom interaction and doing mathematics. Here, meaning-making is often

framed as a sort of socialisation into mathematical discourse. We recognise the important role of the social and cultural aspects that underpin all classroom interactions and meaning-making (such as those emphasised in culturally-responsive teaching). However, these aspects are backgrounded in our own work as we centre more on (socio)linguistic and epistemological aspects of classroom communication. The focus on collectively doing mathematics and communicating mathematically in interaction can be linked to much of the existing LRMT research by acknowledging that mathematical ideas are not separable from the language and discourse practices involved in their communication.

Many of our considerations in the proposed definition of CRMT provide opportunities not only to consider teaching but also to recognise that classrooms in their entirety are important for communication-responsiveness. With the special role of mathematics teachers in mind, we will therefore conclude by proposing a definition of communication-responsive mathematics classrooms.

Communication-responsive mathematics classrooms

A focus on teaching is important for research focusing on teachers and teaching, and for teacher educators and researchers working within teacher education (e.g., Prediger, 2019), but this foregrounds the role and intentionality of the teacher. In some contexts and some research, it is the interaction within the classroom, which includes learners, resources, tasks, etc., that is emphasised and here the notion of communication-responsive mathematics classrooms becomes important.

We define communication-responsive mathematics classrooms (CRMC) as:

Communication-responsive mathematics classrooms are defined as classrooms in which mathematical learning and development are embedded in mathematical communication in ways that engage everyone in and with mathematics and that embrace diversity.

The expansion from CRMT to CRMC provides the opportunity to integrate concepts from mathematics education research that are rooted in theories that step away from considering individuals to considering interactions, classrooms, communities, or systems and that look at norms, practices, authority, power, (school) rules, etc. Thus, this expansion allows deeper insights into the interplay of teachers' lesson planning and enactment and learners' participation and mathematical learning. Furthermore, it becomes possible to contextualise and understand better what we observe and experience in mathematics classrooms.

Conclusion

In this theoretical paper, we propose definitions of communication-responsive mathematics teaching (CRMT) and communication-responsive mathematics classrooms (CRMC) and argue why a shift from language to communication is theoretically justified and relevant to school practice. We argue that much of the recent research published under the term language-responsive fits under our definition of CRMT, as it already reflects turns from multilingual contexts to all mathematics classrooms, from multilingualism to communication, from deficit perspectives to resource perspectives and away from labelling learners. Thus, our aim was not to discard research on language-responsiveness but to provide an updated and clear definition of our current understanding

of this line of research. By proposing these definitions, we provide a clearer conceptual basis from which researchers can position their work. The distinction between communication-responsive and language-responsive approaches may also help teachers and teacher educators attend not only to linguistic forms but also to the wider communicative resources through which mathematical meaning is negotiated. Finally, out of our own theoretical rooting in social, interactionist perspectives, we arrived at a definition of CRMC more as an outlook on opportunities for research communication in mathematics classrooms, always bearing in mind that understanding and developing CRMC is always interwoven with understanding and developing CRMT and working in both perspectives is mutually beneficial.

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