THE COMPLEXITY OF THE IMPLEMENTATION OF MOTHER TONGUE-BASED BILINGUAL EDUCATION IN MATHEMATICS CLASSROOMS: AN ILLUSTRATIVE CASE IN SOUTH AFRICA

Jill Adler, Shemunyenge Hamukwaya, & Anthony A Essien

University of the Witwatersrand, South Africa

From 2025, South Africa introduced mother tongue-based bilingual education to replace the early exit language transition. The study reported in this paper uses a case of a teacher in a Grade 4 classroom to illustrate the complexity of implementing mother tongue-based bilingual education (MTBBE) as envisioned by the curriculum. Using a translanguaging framework, merged with language responsive mathematics teaching, this qualitative study provides empirical evidence of the complexity of simultaneously working across languages, representations and registers where MTBBE is mandated.

INTRODUCTION

The incorporation of indigenous languages into formal schooling across many African contexts predominantly follows a transitional exit model, in which learners receive instruction in the home language for a limited number of years prior to a shift to a globally dominant language (Trudell, 2023). South Africa adhered to this model until 2024, with the transition to English as the sole medium of instruction taking place in Grade 4. In 2025, however, the country moved away from a monolingual sequential ideology and adopted mother tongue-based bilingual education (MTBBE), a model characterised by the sustained use of learners' home languages in mathematics, science, and technology through Grade 7, alongside the gradual and systematic introduction of English between Grades 4 and 7. South Africa has also adopted translanguaging as the pedagogic practice that provides instructional lens, foregrounding the dynamic and agentive mobilisation of learners' full linguistic repertoires for mathematical sense-making, reasoning, and knowledge construction. Rather than treating languages as bounded or alternating codes, translanguaging enables fluid movement across languages to mediate conceptual access, support explanatory communication, and deepen engagement with mathematical registers. When integrated with MTBBE, translanguaging shifts bilingual mathematics teaching from a model of parallel language exposure to one of integrated epistemic resource use, where both the mother tongue and English are leveraged deliberately to develop procedural fluency, conceptual understanding, and academic discourse. Under MTBBE, versioning, rather than simple translation, has emerged as a central component of curriculum development and linguistic adaption. In mathematics education within MTBBE, versioning is associated with the transliteration of the mathematics register aimed at enabling linguistic accessibility and conceptual

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equivalence. This process aims to secure semantically valid and culturally appropriate representations of subject-specific terms so as to preserve mathematical meaning while making content linguistically accessible.

However, implementing MTBBE has significant language/linguistic entailments, much of which needs to be researched, particularly in the South African context with its complex linguistic infrastructure. Questions remain regarding how teachers simultaneously attend to content and language learning goals in large multilingual classrooms where neither the home language nor English alone can fully mediate mathematical meaning-making.

The study reported in this paper is part of a larger study where the Wits Maths Connect (WMC) project has a research and development initiative to support teachers in the implementation of MTBBE. We do this using a merged framework that brings together a translanguaging framework and the language responsive mathematics teaching framework (LRMT) (see below). The purpose of the present paper is to provide empirical evidence of the complexity of working across languages, representations and registers through a critically selected case of one teacher (who we will name MsT) in the WMC project in a multilingual (isiZulu and English) Grade 4 mathematics lesson where mother tongue-based bilingual education has recently been mandated. Our study is informed by the following questions:

1. What opportunities for mathematics learning/meaning making are opened/closed as MsT enacts MTBBE and LRMT in her Grade 4 class?
2. What do we learn from MsT's practice that can inform the development of MTBBE implementation?

Under MTBBE globally, few studies provide analyses of classroom practice that illuminate teachers' work across languages, representations, and registers while engaging the whole class in mathematical sense-making. This study responds to that gap by contributing empirical evidence from a Grade 4 classroom in a newly mandated MTBBE context. Drawing on detailed analysis of teaching, the paper illustrates the complexity of integrating language and content goals in practice, focusing on how a teacher supports learners' meaning making of perimeter using multiple languages, representations, and discursive moves. In doing so, the study extends LRMT and translanguaging research by grounding these frameworks in the realities of multilingual African classrooms at a critical point of curricular and linguistic transition.

TEACHING AND LEARNING MATHEMATICS IN MORE THAN ONE LANGUAGE

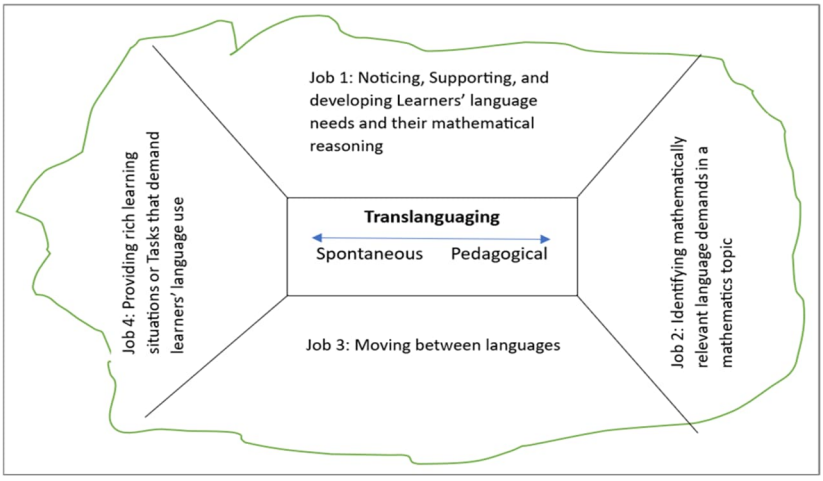
In sub-Saharan Africa, and particularly in South Africa, mathematics classrooms are shaped by sociolinguistic conditions resulting from colonial histories, persistent inequalities, and policy-driven language transitions. Research has consistently shown that learners are taught mathematics through a second or third language most commonly English which constrains their opportunities for participation, and

conceptual development (Probyn, 2009). In response, scholars have argued for pedagogies that position learners' home languages as epistemic resources for mathematical sense-making rather than as obstacles to learning (e.g. Adler, 2001; Essien et al., 2024). From this perspective, language is not merely a medium of instruction but a component of mathematical activity that shapes what learners can say, do, and understand. More recently, translanguaging theory has provided a powerful lens for understanding multilingual classroom practices, particularly in contexts where language separation is neither feasible nor pedagogically productive (García & Li, 2014; Li, 2018). Translanguaging foregrounds the use of learners' full linguistic repertoires for meaning-making, problem-solving, and identity construction. In mathematics education, translanguaging research has demonstrated how teachers and learners move flexibly across languages to explain concepts, justify solutions, and negotiate meaning, especially when engaging with abstract mathematical ideas (Planas & Setati-Phakeng, 2014). However, scholars have stressed that translanguaging alone does not guarantee access to mathematical discourse unless learners are explicitly supported to move between everyday meanings and more formalised mathematical registers, and across registers (Prediger, 2019). Without such support, learners may participate linguistically without developing access to the conceptual structures and practices valued in school mathematics. This concern is particularly salient in the context of South Africa's recent policy shift towards MTBBE.

THE TRANSLANGUAGING-LRMT FRAMEWORK

The larger study uses a framework that integrates translanguaging and LRMT, developed through iterative cycles of research and professional development within the Research and development project. Within education, García et al. (2017) emphasise that translanguaging fosters the integration of language and content, a principle echoed in Prediger's (2019) framework for LRMT in the Global North. Building on these insights, and informed by classroom research in South Africa, our project has identified four pedagogical "jobs" of mathematics teachers that are particularly suited to language-responsive practices.

Figure 1: Translanguaging-LRMT framework (Essien, 2025)



These jobs, presented in Figure 1, illustrate how teachers can deliberately mobilise students' linguistic repertoires to support both communicative interaction and conceptual development in multilingual mathematics classrooms. Working within the scope of a Research Report, we background discussion of tasks (job 4) and focus on the MsT's moves between languages (job 3) and her moves to support and develop learners' language needs and reasoning (job 1) and the use of specialised mathematics language (job 2).

METHODOLOGY

The case: A teacher and her lesson

As noted, we focus on a critical case to facilitate in-depth investigation of a teacher's language practices in relation to the content being taught. MsT is working in a large class of 52 learners who are seated in rows, three to a desk. IsiZulu is both her and her learners' mother tongue. She poses numerous questions that require learner responses that go beyond single words, and in both languages. Moreover, she draws in everyday settings, and visual and verbal written representations. She enacts a complex practice, not typical for her context, suggesting this is a critical and potentially illuminating case.

The lesson topic is "IPherimitha YeSheyiphu" (*Perimeter of shapes*) and the main teaching resource is a large chalkboard on the front wall of the class. The teacher has prepared two charts and cutouts of 2D shapes that are pasted on the board. Chart 1 is headed with the lesson topic, followed by questions that guide the lesson (described below) and Chart 2 has a contextualised word problem, all hand-written in isiZulu. The lesson has two main parts. In part 1 (eight minutes – 104 'turns'), following a greeting and recap of the previous lesson on 2D shapes, the teacher focuses on the meaning of perimeter. The remainder of the lesson (30 + mins) is on solving contextualised problems involving calculations with perimeters of shapes. Our focus here is only on part 1, where discussion is led by the teacher, most taking place in isiZulu, with descriptions/definitions of perimeter (and in relation to area) also in English.

The Unit of analysis and analytic frame

The story of the lesson part is presented through 7 episodes (see Table 1 below), where a next episode is indicated by a change in focus that matches the posing of a different question on perimeter by the teacher. Given our focus on discursive moves, the unit of analysis is a speaking turn, illustrated in Table 2 below. Each turn is coded to distinguish languages, registers, LRMT moves and representations used. Briefly here (space constraints preclude elaboration), we distinguish (1) use of isiZulu, English, a mixture, and transliteration i.e. expression of mathematical terms in English, prefixed with some isiZulu (e.g. i-perimeter); (2) informal and formal registers, as well as what we refer to as a bridging register to name turns where the language in use is somewhere between; (3) discursive moves in terms of the jobs discussed above - between supporting and developing learners' talk, and specialised mathematical language and

(4) verbal from visual representations including diagrams, and concrete objects. Most of these categories are exemplified in Table 2.

FINDINGS AND DISCUSSIONS

To illuminate how MsT enacted MTBBE and LRMT, part 1 of the lesson is described in Table 1, capturing turns per episode, the question guiding the episode, and so its focus, together with some descriptive commentary.

Table 1: Lesson Part 1 on the meaning of Perimeter (T = teacher. Ls = Learners)

Ep, turns	Question posed	Descriptive comment
1, 1 - 6	Are you happy?	|Typical, informal, lesson greeting
2, 7 - 20	What did we talk about yesterday?	Interactive recap, in isiZulu, of previous lesson on 2D shapes, with cut-outs – visual representations - made by the T and pasted on the board. Ls named each shape - triangle, rectangle, square, circle – in English. T then requested they repeat and rename each in isiZulu
3, 21 - 34	What is a Perimeter?	The topic on the chart (Perimeters of shapes) is pointed to followed by discussion of the question mainly in isiZulu. A learner responds "A perimeter is a distance around a shape" (i.e. formally, and in English), and MsT checks others heard and can repeat this statement.
4, 35 - 66	Do we need to know about perimeter in the future?	Discussion of question is in informal register and includes fencing, and measuring 'around' a house/site. Mathematical terms are transliterated (i-perimeter). T sketches outline of rectangular shape (the house) on the chalkboard, and pushes Ls to answer in fuller sentences.
5, 67 - 78	Is there a difference between area and perimeter?	Discussion, mainly in isiZulu, leading to description of perimeter as measuring 'outside' the shape, and area measuring 'inside' the shape (analysed in detail below in Table 2).
6, 79 - 90	Will our formulae to measure perimeter be the same for different shapes?	Discussion, mainly in isiZulu, of whether the formulae will be different for the shapes pasted on the board, particularly triangle, square and rectangle, and why. T marks the different equal sides on the triangle, square and rectangle.
7, 91 - 104	Recap on why we need perimeter and what it is?	Return to why perimeter, and how it differs from area, expressed by a L, revoiced by T (turn 104) as: "Ukuthi perimeter is around outside the shape, i-eriya is around inside a shape", i.e. mainly in English.
8, 105 ...	Remainder of lesson: solving word problems related to perimeter of shapes	

We point to some overview observations of this first part of the lesson, before moving to detailed analysis of Ep 5. Most of the talk across the episodes takes place in isiZulu, with transliteration of mathematical terms, and some articulations by learners and the teacher in English or a mix of languages. The initial definition of perimeter is provided by a learner in English in the formal mathematics register (Ep 3). This is followed by elaboration of the meaning of perimeter through a discussion of fencing a house/site in informal talk (Ep 4), where MsT's questioning pushes learners to go beyond single word responses, and a comparison with area (Ep 5). Together these lead to a description in a bridging register of perimeter being 'around outside' and area 'around inside' a shape. The questions that guide the discussion are all posed orally, and written on the chart, with 2D shapes represented visually, and a sketch of a rectangular shape drawn by the teacher is used to point to perimeter (Ep 4) and perimeter and area in Eps 5 and 7. We thus see across the episodes movement across languages, registers and representations, and MsT encouraging learners to express their thinking. To understand how this movement opens and/or closes opportunities for learning/meaning making of the concept of perimeter, we analyse Episode 5 in detail in Table 2 below.

Table 2: Extract 1, Episode 5, Comparing area and perimeter

Turn	T/L	What is said (translation in italics)	What is done
67	T	IPerimeter. Ukhona yini umehluko phakathi k we-Perimeter ne-Ariya? Ukhona yini umehluko? Yebo, Gumede? *(A Perimeter. Is there a difference between a Perimeter and an Area? Is there a difference? Yes Gumede?)*	T points to question written on the chart and reads it out, in isiZulu. She pauses while LS put up hands, then points to Gumede
68	L	I-ariya iyi distance … (*An area is a distance… inaudible*)	Gumede answers mixing isiZulu and English, some of this inaudible
69	T	Very good. Nimzwile ukuthi utheni? *(Very good. Did you hear what he said?)*	T turns to whole class checking whether he was heard
70	LS	Yes	Learners chorus yes
71	T	Utheni? (*What did he say?)*	T asks for elaboration
72	LS	Ukhona umehluko…(*There is a difference …*)	LS together (isiZulu), T interrupts
73	T	Ukhona ngoba i-arear injani? (*There is because what does area measure?)*	T focuses her question by asking what area measures, in isiZulu
74	LS	Ine distance outside i-shape. (*It has a distance outside a shape)*	LS answer, again mixing languages
75	T	Ay! akashongo kanjalo utheni? *(No! he did not say that, what did he say?)*	T moves to the board and her sketch of a rectangular shape
76	LS	I-distance inside a shape.	

77	T	Inside a shape, kanti iPerimeter yona? (*Inside a shape while the Perimeter?)*	As T says 'inside' she points inside the outline drawn
78	LS	Outside the shape	As T says 'outside', she points to the outline drawn

This episode illustrates key jobs of LRMT as MsT supports learners' understanding of perimeter through multilingual mediation. Job 3 (moving between languages) can be seen in the MsT's language mixing. MsT teaches mainly in isiZulu thus complying with the MTBBE imperative that mandates that 80% of the teaching be done in isiZulu, and only 20% in English at Grade 4 level. MsT also enacts Jobs 1 and 2 by repeatedly probing learners use of the terms "inside" and "outside" a shape, supported though somewhat late in the discussion) through gesture and a drawn shape. Learners' mixed isiZulu–English responses reveal emerging but imprecise meanings (e.g., "area is a distance," "distance outside the shape" - (Turns 68, 74)), which the teacher refines through revoicing and focused questioning, thereby enacting both Jobs 1 and 2. An increased learner opportunity to participate in the mathematics discussions using mixed language, enabled the teacher to access learners' mathematical reasoning. This represents an opportunity for mathematics learning in the context of MTBBE.

MsT builds connections across representations and registers by coordinating talk, gesture, and diagrammatic representation. MsT supports movement informal, everyday descriptions ("inside," "outside," "distance") toward more mathematically grounded interpretations of area and perimeter. Starting from Episode 3, there is evidence of a unidirectional progression from formal language to informal language and subsequently to bridging language. However, this movement remains largely unidirectional, moving from learner talk toward clarification without explicitly returning to formalised mathematical definitions. From an LRMT perspective, further opportunities exist illustrate perimeter earlier, and to consolidate learning by re-articulating the refined meanings in more formal mathematical language in both isiZulu and English.

CONCLUDING THOUGHTS

The episodes examined in this paper underscore the multifaceted demands placed on teachers, who must simultaneously attend to the curricular mandates of MTBBE and support learners' mathematical meaning-making. Teachers need to simultaneously pay attention to: 1) the split in percentages between the home language and English; 2) building connections across languages; 3) building connections across everyday meaning and mathematical meaning. Meaning-making across multiple languages, representations, registers, and discourses is inherently complex, and this complexity is further exacerbated in an MTBBE context where learners' explanations and justifications are elicited in more than one language. These demands warrant explicit consideration in teacher development initiatives as South Africa seeks to strengthen

the implementation of MTBBE. At the heart of these teacher development initiatives lies attention to how representational forms are used to develop meaning drawing on multiple languages. Anecdotal evidence exists that suggests that South African primary teachers frequently employ visual representations—such as drawing shapes as with MsT in our present study—to confirm mathematical concepts at the end of concept development rather than as tools for thinking and meaning-making from the outset. Teacher development initiatives would also need to focus on what we have called here bridging register or what has been referred to elsewhere as meaning-related register (Prediger, 2019). This register remains difficult to capture, and is part of our ongoing work.

References

Adler, J. (2001). *Teaching mathematics in multilingual classrooms.* Dordrecht: Kluwer Academic Publishers.

Essien, A. A. (2025). Harnessing the Epistemic Potential of Multiple Languages in Transitional Multilingual Mathematics Classrooms in South Africa. *Norrag Special Issue 11*, 80-84.

Essien, A. A., Sapire, I., & Moleko, M. M. (2024). The concept of language-as-resource/sources of meaning from an African perspective: Challenges and opportunities in mathematics education. In A. Essien (Ed.), *Multilingualism in mathematics education in Africa* (pp. 1–20). Bloomsbury Publisher. https://doi.org/10.5040/9781350369238.ch-001.

García, O., & Li, W. (2014). *Translanguaging: Language, bilingualism and education*. Palgrave Macmillan.

García, O., Johnson, S., & Seltzer, K. (2017). *The translanguaging classroom: Leveraging student bilingualism for learning.* Philadelphia, PA: Caslon.

Li, W. (2018). Translanguaging as a practical theory of language. *Applied Linguistics*, *39*(1), 9–30. https://doi.org/10.1093/applin/amx039

Planas, N., & Setati-Phakeng, M. (2014). On the process of gaining language as a resource in mathematics education. *ZDM–Mathematics Education*, *46*, 883–893.

Prediger, S. (2019). Investigating and promoting teachers' expertise for language responsive mathematics teaching. *Mathematics Education Research Journal*, *31*, 367–392.

Probyn, M. (2009). 'Smuggling the vernacular into the classroom': conflicts and tensions in classroom codeswitching in township/rural schools in South Africa. *International Journal of Bilingual Education and Bilingualism*, *12*(2), 123-136.

Trudell, B. (2023), *Early-exit language transitioning programming: The rationale, the benefits and the limitations.* Paper commissioned for International Mother Language Day 2023. © UNESCO 2023

Zacharos, K. (2006). Prevailing educational practices for area and perimeter. *Journal of Mathematical Behavior*, *25*(3), 224–239. https://doi.org/10.1016/j.jmathb.2006.09.003