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Operationalising Language-Responsive Mathematics Teaching for use in the context of mother tongue-based bilingual education

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Abstract

This study operationalises the language responsive mathematics teaching (LRMT) framework for use in the context of mother tongue-based bilingual education (MTBBE) – a language imperative that has recently been introduced in South Africa from Grades 4–7. The analytic framework is rooted in previous work where LRMT was merged with the translanguaging framework to produce a LRMT-Translanguaging (LRMT-T) framework. What the current article does is to provide a methodological approach for analysing classroom data based on the LRMT-T framework. This methodological approach (also called analytic framework) is the culmination of research work that uses data drawn from two three-year studies in two different research sites; one located in Grades 1–3 and the other in Grades 4–6. Using illustrative episodes, we show how, in the context of MTBBE, this framework identifies factors that enable or constrain both content- and language-learning goals, and how analysis of classroom practice using the LRMT-T framework can help in reframing MTBBE to support meaning-making in South Africa and similar contexts.

Introduction

Integrating content learning goals and language learning goals in teaching and learning has been a concern in education over the last few decades. This has been seen through approaches like culturally responsive teaching, culturally responsive pedagogy, language supportive pedagogies, and content and language integrated learning (CLiL) to mention but a few. In mathematics education, these pedagogical approaches aimed at integrating students' cultural backgrounds, languages, and experiences into the learning process to enhance learning (and for enabling more inclusive learning) have translated into research on culturally responsive mathematics teaching (CRMT), and in recent years, into language-responsive mathematics teaching (LRMT). Prediger et al. (2022, p. 255) define LRMT as "instructional approaches to enhance the language needed for mathematics learning", emphasising teaching approaches that offer rich content and language integration.

Much of the work on LRMT has been done in the global north with language immersion as the key context. The focus on LRMT in multilingual mathematics classrooms where the language of teaching and learning is not a majority language has emerged only recently. Our focus on operationalising LRMT for mother tongue-based bilingual education contexts is motivated by the implementation of a new language imperative in South Africa. In 2025, the country replaced the early language exit model (where students transitioned from the use of their home language to the use of English in Grade 4 (10 years of age)) with mother tongue-based bilingual education (MTBBE). Under this new language imperative, rather than abruptly transitioning to English as the sole medium of instruction in Grade 4, students continue to learn mathematics, science and technology in their home language from Grades 4 to 7, with English introduced incrementally alongside the home language. Under the MTBBE programme, the current Grade 4 language imperative for Mathematics, Science and Technology calls for 80% of classroom practice (including teaching, learning and assessment) to continue in the indigenous language, with the remaining 20% in English. For Grade 5, the ratio is 70%:30%; for Grade 6, 60%:40%, and

for Grade 7, 50%:50%. As Essien et al. (2026) argues elsewhere, regardless of these prescribed language proportions, teachers must be competent in drawing on and using multiple languages when teaching mathematics such that students can benefit cognitively from their multilingualism.

While a previous study (Essien et al., 2026) proposed the integration of LRMT and translanguaging into the LRMT-Translanguaging (LRMT-T) framework, no study to our knowledge has yet developed an analytic framework for examining how LRMT is enacted in multilingual classrooms operating within a mother tongue-based bilingual or multilingual education context. Consequently, although the LRMT-T framework provides a valuable conceptual foundation for supporting MTBBE implementation, there is still need for an analytic approach capable of examining how language-responsive mathematics teaching is operationalised in practice, particularly how teachers simultaneously attend to mathematical meaning-making, language development, and the strategic mobilisation of learners' multilingual repertoires.

The purpose of this article, therefore, is to propose a methodological approach for rethinking LRMT in the South African context of MTBBE that accounts for both the communicative and the epistemic functions of language. This approach may also be applicable to other multilingual contexts where the indigenous language and a more global language co-exist in the teaching and learning context. Our argument in attempting to operationalise LRMT for use in the context of MTBBE goes beyond the national imperative for Grade 4–7 outlined above, to include the earlier years of schooling. We contend that teachers need to develop competence to harness the epistemic potential of multiple languages when teaching mathematics for meaning making, and that developing this competence needs to start in the foundational grades, especially in a context like South Africa where 81% of students begin schooling in their home language (Sapire & Roberts, 2023) and transition to English as the medium of instruction in later years.

Language-Responsive Mathematics Teaching

Research in the LRMT domain emphasises the role of language in the teaching and learning of mathematics. Given the critical role that language plays in the learning of mathematics, it is important to foster an interplay between mathematical (content) learning goals and language learning goals in classroom settings rather than view the two as separate (Prediger, 2019; Adler & Essien, 2024). It is this interplay that the LRMT framework aims to address. Prediger's work has made significant contributions to this body of knowledge. In her 2019 study, Prediger argues that language gaps influence the conceptual understanding of mathematical concepts, thus suggesting that there is a strong link between mathematical understanding and language proficiency. The language proficiency in question is the language through which mathematics is taught and learned. In addition to integrating mathematical content and language goals, there is a need to connect these goals to the multiple representations within the mathematics register, which link to students' learning experiences and enhance their conceptual understanding (Adler & Essien, 2024). LRMT aims to challenge the traditional views that treat language as merely a learning goal and a medium of instruction. Language performs at least two roles (Pimm,

1987): its use for communication purposes or transmitting and relaying ‘a message’; as well as its role in relation to epistemic access, since language is necessary for thinking and for knowledge acquisition (Prediger, 2019). Through the LRMT framework, Prediger (2019) delineates five critical ‘jobs’ of teachers, defined as the complex situational demands inherent in subject-matter teaching, that necessitate integrating students’ language learning needs with their content learning needs.

As noted previously (Essien et al, 2026), although LRMT has been developed and applied as a valuable framework, its application in South African classrooms requires contextual adaptation to account for the country's distinctive multilingual realities. This is particularly important given that the South African context differs from the European contexts in which much of the existing work on LRMT has been developed. In South Africa, mathematics education increasingly takes place within a MTBBE context characterised by two important features: first, the majority or indigenous languages used for instruction are not necessarily the languages associated with social, economic, and political power; and second, these languages coexist with English, which continues to function as the dominant language of power and wider socioeconomic mobility.

In the next section, we explore how translanguaging can support the adaptation of the four jobs to the South African educational context.

The LRMT-Translanguaging Framework

Drawing on insights from the LRMT framework, as well as the pedagogical possibilities offered by translanguaging in African multilingual classrooms, Essien et al. (2026) propose a merged Language-Responsive Mathematics Teaching–Translanguaging (LRMT-T) framework. The framework brings together complementary elements of LRMT and translanguaging to provide a contextually responsive conceptual lens for understanding and supporting mathematics teaching and learning in multilingual classrooms. In particular, the LRMT-T framework seeks to harness the epistemic potential of learners' multiple linguistic resources, while attending to the specific linguistic, pedagogical, and sociopolitical conditions within which mathematics is taught and learned. We stress that the integration of these two perspectives is especially pertinent to the implementation of MTBBE in South Africa. Rather than treating languages as discrete and bounded systems with fixed instructional functions, the LRMT-T framework conceptualises learners' multilingual repertoires as resources that can be strategically mobilised to support mathematical meaning-making, reasoning, and communication (Essien et al. 2026; Sapire & Essien, 2021). In this way, the framework provides a basis for moving beyond the simple allocation of instructional time across languages towards a more dynamic understanding of how multiple languages can be strategically and productively deployed to support equitable and meaningful mathematics learning within the South African MTBBE context. Hence, at the core of this framework is the recognition that language is not merely a medium of communication, but also a tool/resource for reasoning, and for expressing mathematical ideas (Adler & Essien, 2024).

Drawing on work on translanguaging (Li, 2014, 2018); García & Li, 2014; Sánchez et al., 2022), LRMT-T uses the distinction between spontaneous and pedagogical translanguaging and brings this distinction to bear on the jobs of a teacher in enacting LRMT. For our methodological approach, spontaneous translanguaging refers to fluid movement between languages that is not planned, whereas pedagogical translanguaging refers to the planned movement between languages in the course of teaching and learning. Using data from their professional development programme, classroom observations, and drawing on the South African context, Essien (2025) and Essien et al. (2026) narrowed Prediger's five jobs of a teacher into four jobs for enacting LRMT as shown in Fig. 1. In this paper, we operationalise these four jobs by providing descriptors for their enactment of LRMT in multilingual classrooms, particularly within the context of MTBBE. Our contention is that given that MTBBE is a new imperative in South Africa, and this operationalisation has not yet been done, it is necessary for the implementation of MTBBE that attention to language learning goals as well as content learning goals be accounted for. Moreover, this four-part framework serves both as a theoretical and an analytical tool in this study. It allows for a structured investigation into how teachers operationalise LRMT in practice.

To operationalise the LRMT-Translanguaging framework in multilingual settings, this study draws on the theoretical insights outlined above, and adopts the conceptual/translanguaging framework initially developed by Prediger (2019) and subsequently re-interpretated and adapted by Essien (2025) and Essien et al. (2026). These four jobs, adapted for analytical use in this study, provide a lens through which teachers' practices can be observed, interpreted, and supported. Specifically, the framework focuses on four interrelated dimensions as shown in Fig. 1:

Each of these pedagogical jobs can be realised through spontaneous or pedagogical form of translanguaging. As illustrated in Fig. 1, this study theorises the relationship between translanguaging and LRMT, where translanguaging practices serve as both the medium and the mode through which the four jobs are enacted. Importantly the framework treats these jobs as intertwined pedagogical practices.

Methodological approach

The development of the methodological approach based on the LRMT-Translanguaging framework was done through both a priori and a posteriori processes. To capture the four jobs, the analysis involved two levels of iterative coding, moving back-and-forth between inductive and deductive processes. First, the 'jobs' were deductively derived from theoretical elaboration of LRMT in previously work, more specifically by Prediger (2019). We then met several times as a team to map the different jobs and sub-jobs to data from 15 selected Grades 2 and 4 classrooms; collected at two research sites in South Africa (Limpopo and KwaZulu-Natal) with different linguistic contexts. Through an iterative process, we further expanded and refined the descriptors in response to the classroom data. The integration of these dual inductive and deductive processes coalesced into an analytic framework as presented in Table 1.

Table 1
Indicators for the four jobs in enacting LRMT-T

	1	2	3
JOB 1 - Noticing learners' language needs; supporting and developing their mathematical language and reasoning. [NSD]			
[NSD-N] Teacher **notices** learners' **language use** and **mathematical reasoning** during discussions	[NSD-N1] No Instance [If there are no instances of "NSD-N1, then the second criterion (Supporting and Developing) falls away.]	[NSD-N2] Teacher notices **either** language use **or** mathematical reasoning – that is, teacher does only one and not the other	[NSD-N3] - Teacher notices **both** language use, **and** mathematical reasoning of learners -Teacher pays attention to how learners answer or do not answer questions
[NSD-SD] **Supporting**, and **developing** learners' mathematical language and reasoning	[NSD-SD1] -Teacher **notices** but offers **no support**	[NSD-SD2] -Teacher **notices and supports** learners' language needs **or** mathematical reasoning [the teacher does only one and not the other]	[NSD-SD3] -Teacher **notices, supports and develops** learners' language, and there is a **sustained effort** to do these over a lesson or during concept development -Teacher (consistently) invites learners to reason mathematically
	1	2	3
JOB 2 - Identifying mathematically relevant language demands in a mathematics concept. [IMRL]			
[IMRL-E] **Expanding learners' language repertoire** across different mathematical concepts [IMRL-E]	[IMRL-E1] **Teacher-talk only** and teacher not inviting learners to participate in talk [IMRL-E1]	[IMRL-E2] **Nature – procedural** -Teacher engages learners in content-specific mathematical **discussions that are procedural** in nature - enabling the ability to **pronounce/repeat** the appropriate maths terms	[IMRL-E3] **Nature – conceptual** -Teacher creates opportunities for learners to engage in **extended** content-specific **mathematical dialogue**
[IMRL-L] Linking informal/everyday language to	[IMRL-L1] Teacher uses **either** informal language only **or** formal	[IMRL-L2] Teacher makes **unidirectional** moves either from	[IMRL-L3] Teacher makes **bidirectional** moves linking informal to formal

	1	2	3
JOB 1 - Noticing learners' language needs; supporting and developing their mathematical language and reasoning. [NSD]			
formal/mathematical language **in one language**	language only but does **not explicitly link** the two	informal that links to formal OR from formal that **links** to informal	AND **linking** formal to informal
[IMRL-U] Using language to **mediate meaning** linked to different representations	[IMRL-U1] -Language used to mediate meaning linked to representation(s) is **not appropriate**	[IMRL-U2] Language used to mediate meaning linked to representation(s) is **appropriate**, but representations are **used in isolation**	[IMRL-U3] Language used to mediate meaning linked to representation(s) is **appropriate** and **connections are explicitly** made between representations
	1	2	3
JOB 3 - Using more than one language to teach/learn mathematics. [UML]			
Spontaneous [UML-S]	[UML-S1] -Use of **only everyday** language in one natural language -Use of **only mathematical** language in one natural language	[UML-S2] **Monoglossic -** "Pure language use" -**Movement** between everyday language and mathematical language using **one natural language**	[UML-S3] **Heteroglossic** - "Mixed language use" - **Movement** between everyday language and mathematical language using more than one natural language
Pedagogical [UML-P]	[UML-P1] -Use of **only everyday** language in one natural language -Use of **only mathematical** language in one natural language	[UML-P2] **Monoglossic -** "Pure language use" -**Movement** between everyday language and mathematical language using **one natural language**	[UML-P3] **Heteroglossic** - "Mixed language use" - **Movement** between everyday language and mathematical language using more than one natural language
	1	2	3
Job 4 – Providing rich learning situations[1] or tasks that demand learners' extended language use and mathematical reasoning. [PRLS]			
[PRLS-C] **Choosing** mathematical tasks with a strong focus on explaining, justifying, conjecturing,	[PRLS-C1 Chosen tasks **lend themselves to procedures** (that is, do not lend	[PRLS-C2] Rich task with potential for **inviting extended language use** (with no explicit	[PRLS-C3] Rich task with potential for inviting extended language use **through**

	1	2	3
JOB 1 - Noticing learners' language needs; supporting and developing their mathematical language and reasoning. [NSD]			
critiquing all of which can be done verbally and/or in writing.	themselves to explaining, justifying, conjecturing, critiquing).	call for explaining, justifying, conjecturing, critiquing, etc).	**explaining, justifying, conjecturing, critiquing**
[PRLS-U] **Using** mathematical situations/tasks with a strong focus on explaining, justifying, conjecturing, critiquing all of which can be done verbally and/or in writing	[PRLS-U1] -Language used by the teacher **leads to procedural responses** -**Rich task converted** to a lower level which reduces the richness	[PRLS-U2] Language used by the teacher in relation to task **leads to conceptual responses only** (without extended responses)	[PRLS-U3] Language used by the teacher in relation to task **leads to conceptual** and extended responses
[PRLS-E] The ability to **extend**/develop tasks that demand learners' extended language use	[PRLS-E1] **No evidence of task extension** seen in teaching	[PRLS-E2] N/A	[PRLS-E3] **Teacher extends task(s)** (e.g., in textbooks/workbook) to incorporate learners' extended use of language in writing and/or verbally through explaining, justifying, conjecturing, critiquing.

As mentioned previously, the framework treats the four jobs as intertwined pedagogical practices. For instance, a single classroom event may involve multiple jobs simultaneously; such as when a teacher acknowledges a language need (Job 1), creates opportunities for learners to engage in extended content-specific mathematical dialogue (Job 2), prompts learners to respond in their preferred or home language (and by so doing, creating opportunity for a fluid movement between informal and formal registers across more than one natural language) (Job 3), and provides rich mathematical tasks that encourage learners to explain their reasoning (Job 4).

While deliberating on the data in relation to mathematical talk, we concluded that not all word problems necessarily require learners to engage in extended language use. However, tasks that are seemingly algorithmic can be repurposed as extended language tasks that promote richer mathematical discourse. For example, learners may be asked to compare the number bonds 2 + 5 and 2 + 6 and describe what they notice. Such a prompt provides opportunities for learners to articulate the differences between the two expressions, recognising that the second addend has increased from 5 to 6, whereas the corresponding sum increases from 7 to 8. Through discussion, learners can generalise that increasing

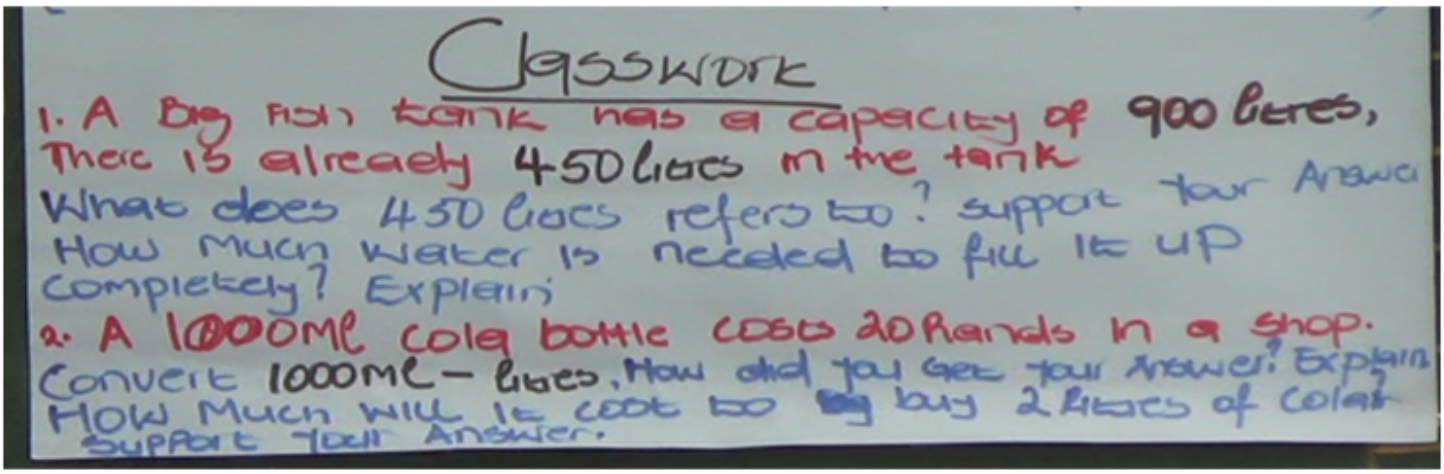
one addend by one, results in an increase of one in the sum. Learners who can express these relationships using appropriate mathematical language are reasoning about the underlying additive structure, rather than merely performing calculations. In this way, seemingly procedural tasks can be transformed into opportunities for mathematical reasoning and discourse, thereby extending learners' mathematical language and supporting deeper relational understanding (Skemp, 1976).

Illustrative episodes of the use of LRMT-T framework in the context of mother tongue-based bilingual education

The data informing this analytic framework are drawn from two projects, both focused on supporting mathematics primary school teachers to harness the epistemic potential of multiple languages for meaning making in their classrooms. For this paper, we specifically draw on classroom observation data of five Grade 4 teachers and 10 Grade 2 teachers, giving a total of 15 teachers. In what follows, we use data drawn from these teachers to identify and map the affordances and learning opportunities that are made available in these classrooms using the LRMT-T framework. In doing this, we also identify and examine missed opportunities that the framework allows us to tease out. The key purpose is to support the argument we made in the introduction that *the competence that teachers need to develop in harnessing the epistemic potential of multiple languages to teach mathematics for meaning making should be developed* from *the foundational grades*. We illustrate this through two episodes - one from Grade 4 and another one from Grade 2, the details of which are presented below. Pseudonyms are used in the episodes.

Episode 1: The Fish Tank Task

A Grade 4 class in this lesson was working on the distinction between volume and capacity with Teacher S. The concept development component of the lesson had taken place, and the teacher gave learners the classwork below to work on:



The following interaction ensued in the class during corrections of the classwork:

15	T	U number one ubuthini?	What does number one say?
16	LS	A big fish tank has a capacity of 900l	
17	T	Kuthiwa *(it is said)* a big fish tank has a capacity of what?	*it is said* a big fish tank has a capacity of what?
18	LS	Of 900l	
19	T	Of 900l angithi? Already there is 450l in the tank, sesinobani?	of 900l alright? Already there is 450l in the tank, what do we have?
20	LS	450l	
21	T	Kuphi?	where?
22	LS	Ethangini lamanzi	in the water tank
23	T	Uthini ke umbuzo? What does the 450l refers to? lo 450 usho ukuthini? What does the 450l refers to? Yebo Sbonga?	what is the question? What does the 450l refers to? what does this 450l mean? What does 450l refers to? Yes, Sbonga?
24	L	I litre	
25	T	Sorry?	
26	L	U 1 litre	
27	T	[…] Ukuthola u 1 litre, khululeka isho noma yini angithi uyafunda? Yaa ishoke ukuthi uwuthole kanjani lo 1 Litre Sbonga?. Nibaningi nibhale lo 1 litre where do you get u 1 litre Sbonga? … Esacabanga u Sbonga esazosithela, omunye uthini? uthi omunye u 450l umele ini? Ngesingisi,… yebo Letho?	Sbonga says this 450 is 1l. where did you get this 1l Sbonga? Just say how you calculated to get this 1l, feel free to say anything, just read what you have already. Yaa tell me how you got this 1l Sbonga? Many of you wrote this 1l where did you get this 1l Sbonga? What does this 450l stand for? In English…yes Letho?
28	L	U half ka 900l	[It is half of 900l]
29	T	Uthi uLetho u 450l umele u half kabani ka 900l, is it true.?	Letho says this 450l is half of 900l, is it true?
30	LS	Yes	
31	T	Yes, u 450 l uwu half kabani ka 900 but 450l is the water that is inside a tank angithi niyakhumbula? We said ithangi liwubani liwu 900l and there is also kuno 450l inside a tank so lawomanzi angaphakathi ethangini siwabiza ngani? what do we call that water that is inside a tank? Yebo we Mbatha?	yes, 450l is half of 900l, but 450l is the water that is inside a tank, don't you remember? We said the tank is 900l and there is 450l inside a tank so what do we call the water inside the tank? What do we call that water that is inside a thank? Yes Mbatha?
32	L	Nge volume	It is volume
33	T	Uthi uMbatha siwabiza nge volume. Why siwabiza nge volume Mbatha, why are we saying it's a volume?	Mbatha says we call it volume. Why do we call it volume Mbatha? Why are we saying it's a volume?

15	T	U number one ubuthini?	What does number one say?
34	L	Because the tank is not full	
35	T	Uthi because the tank was not full that is why we are calling this 450 a volume. omunye ubezothini, omunye ubezothini ? explaination ye volume ithini what is a volume? What is a volume? Yebo Sqobile?	he says because the tank was not full that is why we are calling this 450l a volume. What would one say? What would another say? What is the definition/explanation of volume? What is a volume? What is a volume? Yes Snqobile?
36	L	Volume is the total amount of… of space	
37	T	Yes, it is a total amount of space in what? Omunye akamsize total amount of space kuphi?	yes, it is a total amount of space in what? Someone help him where is the total amount of space?
38	L	A volume is the total amount of…Volume is the total amount of space around the shape.	
39	T	Uthi is a pace around the shape. Ngiyacabanga ukuthi Khwela is coming from perimeter but now we are talking about what is a volume. I volume yini? it's a total amount of what?	He says a space around the shape. I think Khwela is thinking of perimeter that we did but now we are talking about the volume. What is volume? It's a total amount of what?
40	L	Total amount of a half	
41	T	Of a half angikuzwa useyishyaile nje uSnqobile is a total amount of fluid that .. Qhubeka ke …	a half of what? I don't understand the half but Snqobile has grasped it. It is the total amount of fluid that .. go on then
42	L	[Silence]	
43	T	It's a total amount of fluid or an object inside a container. So njengoba lo 450 ukuphi ukwi ithangi ithangi is what is a container bese kuba lo 450 wani wamanzi. This is an amount of fluid inside what? Inside a container. That is why So lo 450 s what? …a volume. Siyezwana ?	it's a total amount of fluid or an object inside a container. So since the 450l is in the tank, the tank is a container of water. This is an amount of fluid inside of what? Inside a container. That is why this 450l is what?... a volume. Do we get along?
44	LS	Yes	
45	T	So laphaya ku number 1 wakho ubekubuzwe khona ukuthi what does this 450 refers to. Uyabhala wena ukubthi this 450 refers to a volume. U 450 uyini uyivolume ebese kuyabuzwa ukuthi why uthi wena o 450 is a volume. Usuyasho ke wena ukuthi because it is a total amount of fluid inside a container. We are not writing sizobhala if sesiqedile lana. You must have a reason why you are saying this 450 is a volume. This is the	So in number 1 you were asked what this 450 refers to. You then write that this 450l refers to a volume. This 450l is what? It's a volume then you are asked why you say this 450l is a volume. You then say because it is a total amount of fluid inside a container. […]. A container and this water inside this tank represent what? A volume and that 900l tank represents what? It represents capacity, do we understand?

15	T	U number one ubuthini?	What does number one say?
		reason that this 450 is the total amount inside a container. Yiphi (which) container? This tank represent ini (what)? [Teacher continues] A container and lamanzi akuleli tankini represent ini ? ivolume and that 900l wethangi urepresenter inin wona I capacity, siyezwana?	
46	LS	Yes	
47	T	U representer ini I capacity ok, bese kuthiwa (then it is said) how much water is needed to fill up completely? ukuze kugcwale leli tanki leliya (to fill up this tank) that container that has a capacity of 900l how much water is needed?	What does it represent? The capacity, ok? Then it says, how much water is needed to fill up that tank completely? So that this tank…, to fill up this tank, this tank with a capacity of 900l. How much water is needed to fill it up completely?
48	LS	450l	
49	T	Uthi sidinga u 450l uthi sidinga ubani 450l to fill up this container completely or to fill up this tank completely. why uthi sidinga u450l or you saying mhlampe sidinga 20l why saying uthi sidinga u 450l specifically?	He says we need 450l and he says we need 450l to fill up this container completely or to fill up this tank completely. why do you say we need this 450l? or you say maybe we need 20l why you say we need 450l specifically?
50	L	Because it is half because this tank has 450l, and when we divide the 900 by two you get half of 900	
51	T	Very good, uthi uThabile u half because this tank has 450 wase edivider u 900 kangaki kawu 2 wasethola ukuthi u hafu ka 900 uba u 450 that is why a edde u 450wazomenza ini ivolume ezogcwalisela kephi kuleli tank la 900l. ukhona omunye onempendulo ehlukile aphakamise isandla ehlukile, I hope anibhalanga into efanayo. Ukhona onempendulo ehlukile ? ubhale ukuthini, ubhale ukuthini, ufunde ngizwe ubhale ukuthini Zamaswazi uphethe iphepha ke wena ubhale ukuthini, awubhalanga ubhale ukuthini Skhanyiso, ehe ubahle ukuthuni la? ... nimzwile uSkhanyiso ukuthi ubhaleni, nimzwile?	Very good, Thabile says half because this tank has 450l then she divided the 900 how many times, by two and she found that half of 900 is 450, that is why she added 450. What is the volume that will fill this tank of 900l? Anyone else have a different answer, raise your hand. A different answer. I hope you did not write the same thing. Anyone have a different answer? What did you write, you are reading and let me hear what you wrote. Zamaswazi is holding a paper, so what did you write? … did you hear what Skhanyiso wrote, did you hear him?

In relation to Job 1, the LRMT-T framework enables a more fine-grained analysis of teacher noticing by distinguishing between attention to learners' language use, attention to their mathematical reasoning, and the intersection of these two dimensions. This distinction was particularly useful in Episode 1, as it

enabled us to disentangle the ways in which Teacher S enacted Job 1 in her Grade 4 classroom, particularly how she attended to linguistic and mathematical aspects of learners' meaning making. Using our framework, it is evident that Teachers S's attention was primarily on learners' mathematical reasoning, placing her at NSD-N2 and NSD-SD2. For example, Teacher S demonstrates noticing when a learner identifies 450 l as the volume (lines 33–35). She also recognises a potential conceptual confusion when volume is described as "the total amount of space" and subsequently redirects learners towards the mathematical meaning of volume, distinguishing it from perimeter (lines 38–39). These instances indicate that Teacher S attends to learners' mathematical reasoning and identifies moments of conceptual uncertainty. However, there is limited evidence that her noticing extends to learners' use of mathematical language. For instance, learners' expressions such as *"the tank is not full"* (line 34) and *"space around the shape"* are not taken up as opportunities to examine or develop the language through which learners are constructing their mathematical meanings. Consequently, while Teacher S supports learners' mathematical reasoning by addressing conceptual confusion, she does not develop the linguistic resources required for expressing and refining these ideas mathematically. From an LRMT-T perspective, this suggests noticing and supporting mathematical reasoning without a corresponding focus on developing learners' mathematical language, consistent with NSD-N3/NSD-SD3.

We acknowledge the teacher's professional judgement in determining whether, at a particular point in instruction, the pedagogical focus should be on language, mathematical content, or the intersection of both. We posit that the LRMT-T framework enables this distinction to be made analytically, thereby providing a more nuanced account of how teachers attend to and respond to the linguistic and mathematical dimensions of learners' meaning-making. This takes us to Job 2. Using the LRMT-T framework, Episode 1 also shows that Teacher S created opportunities for extended discussion [IMRL-E3]. Learners explained what 450l represents, defined volume, and distinguished it from perimeter, and justified why another 450ll were needed to fill the tank. However, the link between every day and formal mathematical language [IMRL-L1] was less evident. By contrast, Teacher S linked language and representation [IMRL-U3] when she explained that the tank represents the container, the 450l inside it represents volume, and the 900l represents its capacity (Lines 43–45).

Drawing on the LRMT-T framework, the episode demonstrates a sustained enactment of Job 3: Using More than One Language to Teach and Learn Mathematics (UML), with evidence of both spontaneous and pedagogical translanguaging. At the level of spontaneous translanguaging (UML-S), the interaction is characterised by heteroglossic language use (UML-S3), as Teacher S and the learners move fluidly between isiZulu and English, as well as between everyday and mathematical language. For example, Teacher S's utterances such as "Uthini ke umbuzo? What does the 450l refer to? lo 450 usho ukuthini?" (line 23) illustrate the natural interweaving of isiZulu and English in the course of classroom interaction. Similarly, learners draw on both languages in their responses, as in "U half ka 900l" (line 28). Such instances reflect the use of learners' and the teacher's available linguistic repertoires as part of the natural flow of mathematical communication rather than as a pre-planned instructional strategy. There is also evidence of pedagogical translanguaging (UML-P), particularly at the heteroglossic level (UML-P3). Teacher S strategically moves between isiZulu and English to support learners' engagement with

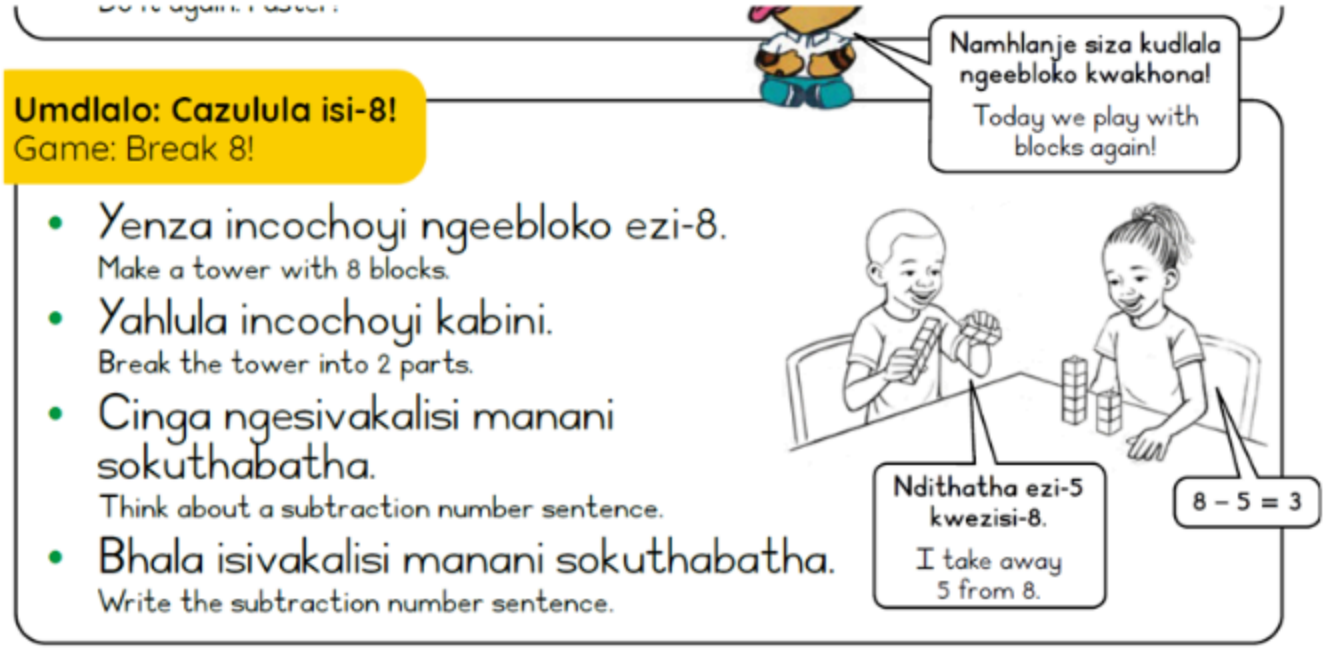
mathematical distinctions, most notably the distinction between volume and capacity. For instance, in line 31, she reiterates the relationship between the 900 litres representing the capacity of the tank and the 450 litres representing the amount of water in the tank, using isiZulu to contextualise and scaffold the explanation while retaining key mathematical terms in English. Similarly, in line 43, the teacher attempts to introduce a more formal definition of volume as “the total amount of fluid or an object inside a container”. She subsequently draws on isiZulu to reconnect this definition to the particular context of the tank and the 450 litres. Here, movement between languages serves a discernible pedagogical purpose: it supports the development of mathematical meaning by linking learners' everyday understandings and contextualised descriptions with more formal mathematical language.

The episode therefore illustrates how UML-S3 and UML-P3 may coexist within the same instructional interaction. While spontaneous heteroglossic practices emerge naturally as teacher and learners communicate, Teacher S also deliberately mobilises more than one language to clarify mathematical ideas and scaffold learners' reasoning. Importantly, however, the analysis also reveals an asymmetry in the linguistic work accomplished through this translanguaging. Although isiZulu is extensively used to elicit responses, clarify questions, and connect learners to the task, English remains the primary language through which formal mathematical definitions and terminology, such as volume, capacity, and container, are articulated. This is particularly evident when Teacher S explicitly requests a response “Ngesingisi” (“in English”) in line 27. From an LRMT-T perspective, therefore, the episode demonstrates a relatively strong enactment of Job 3 through heteroglossic movement between everyday and mathematical language across isiZulu and English. The framework makes it possible to distinguish between spontaneous language movement that arises naturally during interaction (UML-S3) and pedagogically oriented movement deliberately used to advance mathematical understanding (UML-P3). At the same time, the analysis suggests that the pedagogical use of translanguaging is directed primarily towards supporting access to and understanding of mathematical content, rather than towards the systematic development of learners' mathematical language across both languages. The LRMT-T framework thus highlights not merely that more than one language is used, but also the nature, purpose, and pedagogical consequences of movement between languages for both mathematical reasoning and language development.

We will engage with Job 4 from this Episode in the subsequent section.

Episode 2: Using blocks to model subtraction

In this Grade 2 mathematics lesson, learners were playing a game where they use blocks to show addition and subtraction. Although the game was scripted for independent work the teacher called the class together in some discussions while they were playing as seen in the following episode.



Source: Bala Wande Grade 2 Term 1 Week 3 Day 3 (p.26)

66	**T**	**ke kgopela wa tlang…wa…tla o mo thuše ngwanaka. Lebelela Katlego x2. ba tlogo laetša gore o lebetše eng. Ona le leswao le lengwe o le lebetše. Re a leboga sesi Mantebeng. Ke kgopela wa mafelelo x2, a re botše gore tora ya gagwe o hweditše, o hweditše tše kae. Ke tlo kgopela Magaga. re hlaošetše tora ya gago re kwe gore naa di sepela bjang. a re ba botše x2.**	**someone to come help him. Katlego, pay attention, look x2. She is going to show you what you forgot to write. There is a sign that you forgot to write. Thank you Mantebeng. Let's do one last person to tell us what they tower was broken into. Magaga, come explain to us how yours went.**
67	L	šupa hlakantšha le pedi, e lekana le seswai.	seven plus two is equal to eight
68	T	di bale gape ngwanaka. Bala ya mathomo, tee…?	count again my child. Start from one
69	L	tee, pedi, tharo,nne, hlano, tshela	one, two, three, four, five, six
70	T	se se ra gore ke eng le eng?	what does this mean? It means you have…?
71	L	tshela	six
72		ba botše, o hweditše eng?	tell them, what did you get?
73		ke hweditše tše tshela	I got six
74		le tše kae?	and how many?
75		le tše pedi	and two
76		se se ra goreng?	this means that…?
77		se se ra gore…	this means that…
78		tshela…?	six…
79		tshela…	six…
80		hlakantšha…?	plus…?
81		hlakantšha le pedi…	plus two…
82		e lekana le…?	it is equal to…?
83		e lekana le seswai	it is equal to eight
94	T	ke leswao la go hlakantšha. Re a leboga Kgašane. Leswao le, ke leswao la go hlakantšha. Ke mang a ka mpotšang gore naa leswao la go hlakantšha, lentšu le le ngwe le o ka le šomišago ge o nyaka go hlakantšha o ka reng? A re boleleng x3. tlogeleng tora ya rena re boleleng. a re beyeng tora ya rena fase. ke kgopela lentšu le lengwe le o ka le šomišago ge o sa nyake gore hlakantšha. Maphšanya, a re bolele. A re kwe Ndlovu?	it is the addition sign. Thank you Kgašane. This is the addition sign. Who can give me another word we can use in place of addition? Let's talk x3. put your tower down and let's talk. Please give me another word we can use if we do not want to use the word add. let's hear, Ndlovu?

66	**T**	**ke kgopela wa tlang…wa…tla o mo thuše ngwanaka. Lebelela Katlego x2. ba tlogo laetša gore o lebetše eng. Ona le leswao le lengwe o le lebetše. Re a leboga sesi Mantebeng. Ke kgopela wa mafelelo x2, a re botše gore tora ya gagwe o hweditše, o hweditše tše kae. Ke tlo kgopela Magaga. re hlaošetše tora ya gago re kwe gore naa di sepela bjang. a re ba botše x2.**	**someone to come help him. Katlego, pay attention, look x2. She is going to show you what you forgot to write. There is a sign that you forgot to write. Thank you Mantebeng. Let's do one last person to tell us what they tower was broken into. Magaga, come explain to us how yours went.**
95	L	oketša	make more
96	T	o kare go oketša. Ke a leboga. O mongwe o ka reng? Re tlare go hlakantšha x2, akere? Ke yeo re bego re e bopa, ra ba ra fetša ra e hlaloša, ra e bontšha gore e ntšha diripa tše pedi. Sesi Boikgantsho ke mmoledišitše. A re kweng x2. a re boleleng x4. Tlou, ge o sa nyake gore go hlakantšha, o tlare o dirang? lentšu le lengwe le re ka le šomišang bare keng? Go oketša. o mongwe o tlare go dirang? ge re sa oketše re tlare re dirang? Mantebele?	we can say make more. Thank you. What else can someone else say? We can say add x2, right? That is the one we were building and explained-we showed how we can use two pieces. I have already spoken to Boikgantsho. Let's hear x2. let's talk x4. Tlou, if you do not want to use the word add, what can you use? What is the other word you can use. to add on. What else? If we do not want to use add on, what else can we use, Mantebele?
97		go tsentšha	to put in

In relation to Job 1, our framework makes visible how Teacher R attends to learners' reasoning and language use at different moments in Episode 2. Her attention initially focuses on the mathematical correctness of the learners' responses. For example, when Magaga states "*seven plus two is equal to eight"* (Line 67), Teacher R redirects Magaga to re-count the blocks rather than probing learner's reasoning. Later, however, language becomes the focus of her attention/noticing [NSD-N2] when she asks, "*who can give me another word we can use in place of addition?*" (Line 94). Learners respond "*oketša" [..] and "go tsentšha" (to put in)* (Lines 95–97), and Teacher R takes up these expressions for discussion, thereby supporting learners' mathematical language [NSD-SD2]. Using our framework, these instances reveal that Teacher R notices and supports learners' language use. In the extended version of the transcript not captured in Episode 2, there is limited evidence of sustained attention to both language and mathematical reasoning simultaneously. This is why Teacher R is not categorised under level 3 of the 'noticing' category [NSD-N3/SD3] of Job 1.

In relation to Job 2, the framework shows that learners' mathematical talk remains largely procedural [IMRL-E2] (Lines 72–83). Although Teacher R invites Magaga to, "*explain to us how yours went*" (Line 66), the response is limited to a number sentence, "*seven plus two is equal to eight*" (Line 67). Her subsequent prompts "*what did you get*?", "and *how many*?", *"six…*?", *"plus…?*" and "*it is equal to…*?" (Lines 72–83) similarly elicits brief responses rather than extended mathematical explanations. However, Teacher R explicitly links the formal mathematical term "addition" to more informal expressions such as "*oketša"* and "*tsentšha*," creating a unidirectional movement from formal to informal mathematical language [IMRL-L2]. She also links the concrete blocks to the symbolic number sentence [IMRL-U3]. After Magaga incorrectly states 7 + 2 = 8, she directs the learners to recount the blocks and subsequently scaffolds the

expression 6 + 2 = 8 (Lines 67–83). Although this connects the concrete and symbolic representations; the connection remains largely procedural because learners are not invited to explain how or why the blocks correspond to the number sentence. Our framework, therefore, allows us to see both the opportunities Teacher R creates for connecting mathematical register and representations, as well as the limited opportunities she creates for extended mathematical talk.

In terms of Job 3, our framework allows us to examine, not only the movement between natural languages, but also movement between registers within a language. Teacher R's interaction is predominantly in Sepedi, with only isolated English words. More significant is her movement between formal mathematical and informal expressions within Sepedi. This is evident when she asks learners for alternative ways of expressing addition. This purposeful movement between registers within one natural language is consistent with pedagogical monoglossic language use [UML-P2]. Our framework, therefore, makes visible that, using language as a resource for mathematical meaning-making does not solely involve movement between natural languages; but can also involve deliberate movement between registers within the same language.

We now engage with Job 4 comparatively across Episode 1 and 2 because our framework enables us to distinguish between the richness of the task as designed [PRLS-C], how that task is enacted [PRLS-U], and whether the teacher extends its demands for extended language use and mathematical reasoning [PRLS-E]. In Episode 1, the Fish Tank Task requires learners to "support" their answers, thereby creating opportunities for justification and extended mathematical language use [PRLS-C3]. Teacher S sustains this demand during enactment by repeatedly asking learners to provide reasons for their answers. For example, she asks, "*why do your need 450l?*" (Episode 1, Line 49) and subsequently invites other learners to provide different responses (Episode 1, Line 51). Her enactment, therefore, fosters opportunities for learners to explain their mathematical reasoning [PRLS-U3]. These repeated demands for reasons also suggest a classroom norm of providing justifications, where answers are expected to be supported mathematically.

On the contrary, Episode 2 shows a different pattern. The block game provides opportunities for learners to construct different combinations, but the task, as presented, primarily lends itself to producing and representing number sentences rather than requiring explanation or justification [PRLS-C1]. During enactment, Teacher R's sequence of short prompts elicits brief learner responses that lead towards the correct number sentence [PRLS-U1]. For example, although Magaga is initially asked to "*explain to us how you went*" (Line 66), the subsequent interaction focuses on recounting the blocks and constructing 6 + 2 = 8, rather than explaining the mathematical relationship between the blocks and the number sentence. Teacher R also does not extend the task by asking learners to explain why the block represents 6 + 2 = 8 or to justify and compare different combinations [PRLS-E1]. In summary, the evidence from the two episodes shows how Job 4 distinguishes the opportunities provided by the task, from how they are realised through its enactment and extension. In Episode 1, the task explicitly demands justification, and Teacher S sustains this demand; whereas in Episode 2, both the task and its enactment remain largely procedural. The distinction between choosing [PRLS-C], using [PRLS-U], and

extending [PRLS-E] thus, provides a more-fine grained account of how opportunities for learners' extended mathematical language and reasoning are created, or remain unrealised in classroom interaction.

Discussion and conclusion

Anecdotal evidence from South African classrooms suggests that teachers may, at times, conceptualise language policy primarily in terms of strict adherence to the prescribed language of learning and teaching, rather than as an opportunity to strategically draw on learners' broader linguistic repertoires to support meaning-making. Within the context of MTBBE, this interpretation has resulted in a relatively rigid allocation of languages, whereby some particular mathematical topics are taught in the designated home language, while others are taught in English. Such a language-separation approach risks positioning language choice as an end in itself, potentially shifting attention away from the central pedagogical goal of supporting learners' mathematical understanding. In particular, decisions about which language to use may take precedence over considerations of how language can be used to develop mathematical reasoning and conceptual understanding (Hamukwaya & Essien, 2026). It is in this regard that the LRMT-T framework offers an important contribution: rather than treating language and mathematics as separate instructional concerns, it foregrounds their interdependence by encouraging teachers to notice and respond simultaneously to learners' linguistic resources and mathematical reasoning. This provides a more nuanced basis for implementing MTBBE, in which the strategic use of multiple languages serves the development of mathematical meaning, rather than making language the primary focus of instruction.

By using the LRMT-T framework lens, the analysis of two episodes shows that teachers may attend to learners' mathematical reasoning without developing their mathematical language, or attend to mathematical language without creating sustained opportunities for extended reasoning. The LRMT-T framework, therefore, requires attention to how these dimensions work together in developing mathematical meaning. The findings also illustrate how translanguaging can be understood in mathematics classrooms. The presence of more than one language does not necessarily lend to pedagogical translanguaging; movement between languages may be spontaneous without being deliberately used to develop mathematical meaning. The distinction between spontaneous and pedagogical language use, therefore, shifts attention from whether multiple languages are used to what their use accomplishes. Episode 2 further shows that language use, and specifically, translanguaging, need not always involve movements between named (natural) languages. Our framework, therefore, allows the extension of translanguaging to include purposeful movements between formal and informal mathematical registers within the same language and how these movements can support meaning-making.

The framework further highlights the importance of task selection and enactment. Job 4 distinguishes between choosing, using, and extending a task. The Fish Tank Task explicitly invites justification, and Teacher S sustains this demand. In contrast, the Block Task and its enactment remain largely procedural.

Thus, rich mathematical discourse does not follow automatically from a task; but how the teacher enacts and extends the task is equally important. Professional development should, therefore, support teachers, not only to select rich tasks, but also to recognise and extend their potential for explanation, justification, and mathematical reasoning. Classroom norms are equally important. Teacher S's repeated requests for reasons suggest a norm of providing justifications. Where teaching and learning is dominated by short responses, opportunities to notice and develop learners' language and reasoning are more limited. Rich mathematical discourse, therefore, depends on creating norms in which learners' engaging with mathematical ideas are expected forms of participation.

The four jobs in the LRMT framework are not enacted in a vacuum. They are shaped by the norms of practice that govern what is considered legitimate participation, appropriate language use, and valuable mathematical engagement in the classroom. These norms, while often implicit, constitute the pedagogical foundations upon which teachers' practices rest. Essien (2020) argues that in classrooms where norms are limited to procedural engagement and rote participation, learners have few opportunities to engage meaningfully with mathematical concepts or develop proficiency in the language of learning and teaching (LoLT). In such environments, the enactment of the four jobs becomes constrained, as learners' linguistic repertoires (particularly those grounded in home languages) are often marginalised. In contrast, when classroom norms promote the co-construction of knowledge and value multilingual sense-making, they enable teachers to more effectively realise the aims of language-responsive teaching by creating opportunities for meaningful learner participation.

Within the LRMT-T framework, norms of practice support teachers in creating classroom cultures that are dialogic, inclusive, and cognitively demanding. For instance, the job of *noticing* is only meaningful in contexts where learners are encouraged to express their mathematical reasoning. Similarly, *supporting* and *developing* learners' mathematical language depends on norms that legitimise scaffolding, exploratory talk, and the use of more than one language as productive pedagogical moves. *Demanding learners' extended language use* requires a norm of high expectations that positions all learners as capable of engaging with complex ideas and expressing them across different linguistic registers.

Thus, norms of practice are not peripheral to the LRMT-T framework; rather, they are an integral part of LRMT-T because they make certain practices possible. They function as the social and pedagogical infrastructure that enables the enactment of the jobs of language-responsive teaching consistently and meaningfully. Through the roles of noticing, supporting, and developing learners' language and reasoning, teachers can establish classroom environments that recognise and value learners' linguistic resources (repertoires) as essential tools for learning. This includes both movement between informal and formal mathematical language, as well as the use of multiple languages to support equitable access to mathematical meaning-making in multilingual classrooms.

In conclusion, when we argue that the different components of our framework are inextricably intertwined, we mean that examining the enactment of any one component necessarily brings into view its relationship with, and dependence on, the other components of the LRMT-T framework. Thus, while

the framework analytically distinguishes between the different jobs of language-responsive mathematics teaching and the various forms of translanguaging, these distinctions should not be interpreted as suggesting that they operate independently in classroom practice. Rather, the enactment of one component both shapes and is shaped by the enactment of others. For example, what a teacher notices about learners' mathematical reasoning may influence the linguistic resources they subsequently draw upon, the manner in which they move between languages, and the forms of support they provide. Similarly, the use of multiple languages may create opportunities for teachers to notice aspects of learners' thinking that might otherwise remain inaccessible, thereby informing subsequent pedagogical responses. The LRMT-T framework therefore enables the analytical examination of distinct dimensions of classroom practice while simultaneously recognising their dynamic and mutually constitutive nature. It is precisely this interconnectedness that allows the framework to provide a more nuanced account of how teachers attend to, support, and develop both learners' mathematical reasoning and their linguistic resources in multilingual mathematics classrooms, and particularly, in the context of MTBBE.

Declarations

Ethics approval: This research was approved by the University of the Witwatersrand's Ethics Committee with protocol number: H21/11/45.

Consent to participate: Consent for participation was obtained in accordance with the University of the Witwatersrand's Ethics Committee recommendations for Good Research Practice. Participants gave informed and written consent.

Author Contribution: All authors were involved with conceptualisation, data analysis, writing, reviewing & editing of this manuscript. All authors agree with the results and conclusions and approved the final version of the manuscript before submission

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Data Availability: The informed consents provided by the study participants as part of the University approved ethical permissions in this project (clearance number H21/11/45) allowed for research team access to the dataset only, with no permissions for broader data sharing.

Conflict of interest: Anthony A. Essien is an Associate Editor of the journal. Rigorous peer review was not compromised as the journal has systems in place to ensure that peer review is protected from conflicts of interest.

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Footnotes

1. By mathematical learning situations, we refer to a context in which learners are required to make sense of mathematical relationships by coordinating linguistic, symbolic, visual, and/or experiential resources to produce mathematical meaning.

Figures

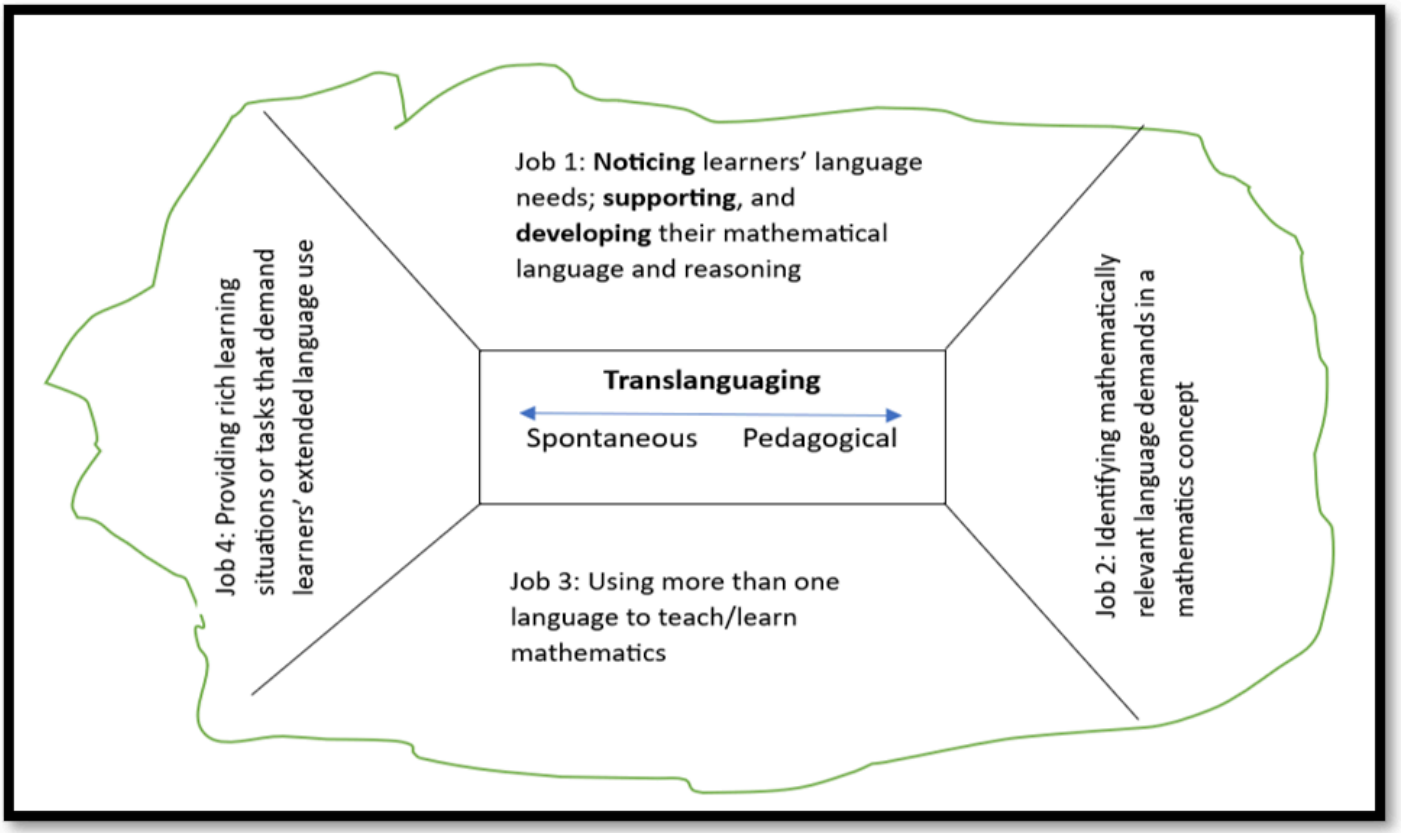


Figure 1

LRMT-Translanguaging framework (Essien, Takane & Hamukwaya, 2026: p. 6)