Teachers' Perspectives of African Languages in Teaching Mathematics: Is There a Place for Sepedi?

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Abstract

Language and mathematics teaching has been a critical issue for decades. The debate in the African context is on using the mother tongue to teach mathematics or, alternatively, to use English with a more teaching-orientated mathematics register. During an ethnomathematics, indigenous games intervention programme, 14 participants from a rural district in the Limpopo province of South Africa were interviewed regarding the challenges they are currently experiencing in teaching mathematics in the Intermediate Phase (Grades 4 to 6). The medium of instruction at these schools is English in the Intermediate Phase, while in the Foundation Phase, the learners are taught mathematics in Sepedi, which is the mother tongue in the district. In the study, we aim to explore how language influences the teaching of mathematics in the Intermediate Phase. We found firstly that English is a barrier to learning for Intermediate Phase learners even though code-switching is used for understanding. Secondly, the debate developed on whether teachers should use mother tongue in Grade 4 or use English which may give the learners the cultural capital to pursue mathematics through later phases. Finally, there may not be a sufficient mathematics register in Sepedi for teachers to engage learners in deeper mathematical discourse and allow them to understand the mathematical concepts. We recommend that teachers be capacitated to use language in various ways when using Sepedi to enhance teaching mathematics. Future research endeavours will include working with a mathematics register in Sepedi and implementing it in mathematics classrooms.

Keywords: language barriers; mathematics register; indigenous language practices

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Introduction

Research on language and mathematics in mathematics education circles has been a topic of debate for a long time (Erath et al. 2021). The concern is mostly aligned with providing fair learning opportunities for learners (Tai 2022). Many former colonial states conformed to English as the language of instruction (Robertson and Graven 2020); we therefore question whether the equitable needs of the diverse learners in the mathematics classroom are met. With South Africa being a former colonial state, the debate on meeting the needs of the multicultural learners in mathematics classrooms persists. Prediger (2019) confirms that English first-language learners outperform learners who speak an African language as their mother tongue when it comes to mathematics. Learners who speak African languages are therefore disadvantaged from obtaining quality mathematics education because of the language barrier. We add our voices to the increasing research focus on equity and access to mathematics for all learners (Erath et al. 2021).

The poor performance of South African learners in mathematics has been brought into focus through international assessments such as the Southern and Eastern Consortium for Monitoring Education Quality and the Trends in Mathematics and Science Study (TIMSS) (Mabena et al. 2021; Reddy et al. 2016). Spaull et al. (2020) reveal that the Progress in International Reading Literacy Study conducted in English literacy studies for Grade 4s in 2006, 2011 and 2016 demonstrate that South African learners struggle to comprehend in English. South Africa has 11 official languages with multicultural inhabitants, yet the poor performance of our learners in mathematics indicates that culturally responsive pedagogies may be missing in our mathematics classrooms.

South Africa did adopt a Language-in-Education Policy in 1997, which allowed the language of instruction in the Foundation Phase (Grades 1–3) to be the home language of the learner (DBE 2010, 6). However, from Grade 4 onwards the language of instruction is generally English which, according to Posel and Zeller (2019), makes English predominate and prevents access to quality education for most South African indigenous learners. At the same time there is the recognition that learners who do have access to the language in which mathematics is taught have the cultural capital and access to mathematics that other learners may not have. The findings of Breinholt and Jæger (2020) confirm that teachers give priority to learners who perform well but the performance of those learners is actually attributed to their having the necessary cultural capital to excel. Learners who may not have the language capital to learn mathematics may therefore then be disregarded or considered to be performing poorly in mathematics.

An ethnomathematics intervention programme was carried out by a team of mathematics education researchers in rural Polokwane, Limpopo. Ethnomathematics is a field of research in mathematics education that focuses on the existence and development of mathematics in all cultural groups. Teaching from an ethnomathematics perspective is said to foster cultural relevance, promote inclusive learning, and enhance

students' appreciation of mathematical practices rooted in their own and others' cultural contexts. During the focus group interview, 14 teachers from one district in Polokwane participated. The teachers indicated that learners in their schools mostly spoke Sepedi as their home language. The focus of this article will be on the teachers' perspectives regarding teaching mathematics in English to Sepedi-speaking learners in the Intermediate Phase. The research question for our article is as follows:

- How do mathematics teachers who teach in a rural district in Limpopo perceive the role of language in teaching mathematics?

The article's content includes literature based on language and mathematics. The critical discussion is framed by Ruíz's (1984) three orientations to language in multicultural contexts while also touching on cultural capital and culturally responsive teaching (CRT). This is followed by a qualitative case study methodology presenting data from the focus group interview that are analysed and discussed, and, finally, the conclusion.

Literature Review

Challenges in Learning Mathematics in Another Language

Mathematical ideas are articulated through language. Language plays a significant role in developing and communicating ideas (Vygotsky 1986). The holistic nature of learning mathematics in another language is complex. Understanding new mathematical concepts requires understanding and using the language of the discipline through listening, reading, writing and speaking (Sharma and Sharma 2023). The role of language in learning has been established in many contexts, with mathematics receiving considerable attention. In the South African context, Robertson and Graven (2020) indicated that learners who are not proficient in their classroom language will find a severe challenge to their mathematical sense-making attempts. Reddy et al.'s (2016, 8) report on South African Grade 5 learners' participation in the TIMSS (2015) noted better scores for those learners who "always or almost always spoke the language of learning and teaching at home" as compared to those whose home language was different from that used in school.

Studies have indicated that mother tongue literacy positively influences mathematical learning (Dahm and De Angelis 2017), which affirms the decision of the Department of Basic Education in South Africa for home language instruction for Grades 1 to 3. In Ghana, Abdul-Ganiyu et al. (2024) found mother tongue instruction to be statistically significant in improving students' mathematics achievement. However, some scholars indicate that insufficient translations from English mathematical terms to the mother tongue affects the teaching of mathematics (Baquiller and Abellon 2021). Adding to the complexity is that teachers have mixed feelings towards the use of mother tongue in teaching mathematics (Chirume 2019).

Code-switching is often a strategy used in classrooms where the language of learning and teaching is different from the students' home language. Mahlambi and Mawela (2021), however, found that code-switching is often not enough to support mathematics understanding in classes where mathematics is taught in English to learners whose home language is not English. Setati (2005) affirms that code-switching is ineffective unless used in conjunction with a mathematics register.

Mathematics Register

The focus of many research studies has been on language and mathematics. Much of the research has recognised the advantages of using the home language to teach mathematics (Mpalami 2022; Phakeng 2018). In addition, South African language policy advocates that the language of instruction in the Foundation Phase (Grades 1–3) should be in the learners' home language (DBE 2010). Consequently, it would be assumed that learning mathematics in the learners' mother tongue would make mathematics easier to learn. However, even though learners do learn in their home language until the end of Grade 3, the many TIMSS studies indicate that South African learners still struggle to perform as well in mathematics as their global counterparts.

One would therefore advocate that there needs to be a mathematics register in the African language, which Pimm (1981) defines as a register in a particular language with applicable meanings for mathematical concepts and functions. Pimm (1981) identified English as the ownership of the mathematical register. Learners who do not have English as their home language could be deprived of quality mathematics education if they were learning in a language that did not have sufficient mathematics register to facilitate understanding. A mathematics register that is pedagogically appropriate for various age groups is an additional problem. It has been affirmed by Kukulska-Hulme et al. (2023) that African learners are disadvantaged for not having English as their home language as there is a creation of cultural capital deficits. Schäfer (2010) and Van Laren and Goba (2013) found that the mathematics register for Xhosa and isiZulu respectively were not sufficient for adequate mathematical learning. However, the study done by Dhlamini and Essien (2023) in the Foundation Phase indicated that the mathematics register in Sepedi was sufficient to learn mathematics proficiently. We therefore conclude that there is a lack of research evidence on the use of a Sepedi mathematics register for Intermediate Phase (Grades 4 to 6) learners.

Language, Culture and Teaching Mathematics

Africanised, indigenised approaches to learning mathematics demonstrate positive outcomes. Ladson-Billings (1995) mandated a culturally responsive pedagogy to advance equal education for all learners. We have acknowledged the work of Dhlamini and Essien (2023), Mpalami (2022) and Phakeng (2018) whose findings support the use of African languages to learn mathematics and accentuate the constructive effects of using African languages to learn mathematics. The use of ethnomathematics as coined

by D'Ambrosio in 1984 emphasises cultural knowledge (including language) in learning mathematics.

Bourdieu's (1977) theory of cultural capital is defined by Deem and Lucas (2007, 118–119) as "the educational qualifications and forms of cultural differentiation such as language, cultural dispositions and general proximity to and knowledge of cultural institution". As Bourdieu stressed, language also differentiates people. We therefore understand that people are differentiated because of their culture, language and even institution. Mathematics is learnt through a language and as Peng et al. (2020) found, language is essential to communicating mathematics knowledge and does facilitate how a learner reasons when they learn. The challenges arise when the learner does not have the necessary language capital of the language of instruction in mathematics. CRT was a theory coined by Ladson-Billing (1995). CRT is based on learners' cultures, languages and societal experiences. With mathematics considered to be a high-status subject and the language of instruction mainly being English from Grade 4 onwards, a more culturally responsive pedagogy, specifically regarding language, is required.

Theoretical Framework

Ruíz (1984) identified three main orientations in debates about language policy and practice in multilingual contexts, namely, language as a problem, language as a right, and language as a resource. Language as problem identifies the challenges of a second or underutilised language in mathematics. The language-as-a-right orientation proposes that bilingualism or using of home language (mother tongue) in learning be a right. Language-as-resource scholars propose and defend the learning gains when using another language to help learners understand mathematical concepts while also breaking down marginalisation and exclusion from mathematics discourse (Martínez 2018). While Ruíz's (1984) formulations are significant in understanding the role of language in classrooms, Martínez (2018) points out that research on language as a resource has focused primarily on learners' perspectives. Martínez (2018) does, however, point out that a few studies found that teachers feel unprepared to support the bilingual use of language in the mathematics classroom.

In this study, we focus on teachers' perspectives. In focusing on the complex and multidimensional nature of teaching mathematics through language, Peirce (1989, 401) proposes that teachers engage in a "pedagogy of possibility", that is, a pedagogy where teachers reconsider which language discourse practices are possible and beneficial for learning, while also being underpinned by an awareness of dominance in language. Martínez (2018, 87) extended this idea by proposing that "bilingualism as enhancer" is relevant in mathematics education. Peirce (1989, 401) stated, "a pedagogy of possibility will take on different forms at different times and in different places". Our study focuses on Sepedi as the home language and mother tongue of learners who are learning mathematics in English at rural Limpopo schools. We try to understand how teachers perceive a pedagogy of possibility and ascertain whether their perspective regarding

language and mathematics teaching stems from a perspective of language as problem, resource or right.

Methodology

The study is qualitative in nature as we sought to interpret how mathematics teachers in one rural district of Limpopo found teaching mathematics in English, which is a language different from the home language of the learners in the classroom. We opted for a qualitative research approach since it stems from an interpretivist paradigm. We acknowledge that teachers' perception of language in teaching mathematics is based on their experiences and the way they interpret the world around them, including their teaching. Interpretivism emphasises understanding the participants' subjective meanings and experiences in their specific social and cultural contexts (Alharahsheh and Pius 2020). Qualitative data would allow us to explore these ideas. Since we were meeting teachers for the first time as a group, we decided that a focus group would facilitate data generation and collection. Focus groups allow group discussions, where participants build on each other's ideas, which reveal deeper insights through collective dialogue (Cohen et al. 2018).

Sampling and Participants

The focus of the study was on 14 schools in one district in Limpopo. Fourteen teachers, one per school, who teach mathematics in the Intermediate Phase, were purposively sampled to take part in the study. Purposive sampling is a qualitative feature and helped us to focus on a specific, unique issue or case (Cohen et al. 2018) – in this case mathematics teachers in rural Limpopo. These teachers also had more than five years of experience teaching Mathematics in this phase. The Intermediate Phase was chosen as we wanted to introduce ethnomathematical games to the teacher participants in subsequent workshops with teachers. At this first contact session with the teachers, we turned our attention to one of the main challenges they highlighted – that of language and mathematics teaching.

Background

Before we introduced the games, a needs analysis was done with the teachers through a focus group discussion. From the needs analysis, we were able to gauge that the participating teachers found language struggles to be a major factor when teaching mathematics in the Intermediate Phase.

Methods of Data Collection

We collected data through a focus group discussion with all 14 participants. According to Cohen et al. (2018) focus groups allow participants to interact with each other rather than with the researcher, so that the views of the participants can emerge. A set of open-ended questions was used to collect data as it allowed for further probing. The participants were invited to answer a question, one person at a time, so that we could

understand their reiterations when transcribing the data. The focus group discussion was video recorded to recognise which participants contributed to the data. We opened the discussion with a general question on challenges that teachers experienced when teaching mathematics. It soon transpired that language was one of the main concerns. We then asked the following question:

- What is the impact of mother tongue instruction on teaching and learning in your schools?

Analysis of Data

The focus group discussion was transcribed verbatim for the purpose of analysis. The transcribed data were checked by both of us for accuracy. The transcripts were read and reread to help make the content more familiar to both researchers. Colour-coding was applied to identify frequently used words, concepts and expressions, and this assisted in the detection of patterns and categories. These were later used to constitute emerging themes (Clark and Braun 2013). To ensure the trustworthiness of the study, we used the member-checking and participant-confirmation techniques. As part of a broader project, ethical clearance for the fieldwork was applied for and granted by the institutional ethics authority (reference no. 2020/09/09/90441435/10/AM). The participants were not referred to by name but rather by numbers so that we could protect their identities. The findings and discussion section is based on the data from the focus group transcripts.

Findings and Discussion

The focus group discussion led to the formulation of three main themes from the data. First, the challenges with mathematics word problems are exacerbated through language issues. Second, progression problems experienced from Grade 3 to 4 were exacerbated by a change in the language of learning and teaching. Third, Sepedi lacked a mathematics register to facilitate teaching mathematics in Sepedi.

Theme 1: Language Issues With Mathematics Word Problems

Word problems are language based, and the participants indicated that the switch to English as the medium of instruction made word problems particularly problematic. A word problem in mathematics usually takes the form of a narrative question based in some context whereby the learners need to understand the language-based question and execute mathematics to solve it, for example, Sipho has 5 apples; if he gives 2 to Sandy, how many apples does he have left? Learners do mathematics in their home language which is Sepedi in the Foundation Phase. They then encounter English for the first time in Grade 4 where they have to learn mathematics in English.

> The challenge that I have with my learners is the language; they don't understand English. More especially, in pursuit of the word problems, they are unable to answer that because of the language. (Participant 1)

For participant 1 the issue is teaching word problems to learners who are not proficient in English. The same concern was articulated by the other participants in the study.

> Word problems, especially the one where they must use multiplication. The problems I must explain in Sepedi so that they can understand which operation they must use. But if I can give them help in the classroom, I can explain, but if not, they won't answer the question because they must write on their own. (Participant 4)

[It is a convention in mathematics education to write a concluding sentence when answering word problem, for example, Sipho has 3 apples left.]

Participant 4 verified that he does code-switch to Sepedi to explain the process when doing multiplication specifically. We anticipate that words used to denote addition and subtraction (for example, more, less) are easier for learners, but words indicating a multiplication process may be more difficult to recognise in English for Sepedi-speaking learners. However, it seems that while the learners can understand what they should do in Sepedi, they are unable to decode from English and answer the question. We can see Ruíz's (1984) orientation of language as a problem according to the statement by participant 1. Ruíz (1984) advises that learning English as a language, in the context of the study, if scarcely utilised, will create challenges for the learners to understand the word problems in mathematics. In the second instance (Participant 4), we can see language as a resource (Ruíz 1984) as the participant code-switches from Sepedi to English to assist learners in the classroom.

Mpalami (2022) also agrees that language could be used as a resource to learn mathematics. However, the learners in participant 4's class are not able to apply the knowledge provided to them via code-switching. Perhaps they struggle as Diouani (2023) suggests because of not using English often in the context that they live in, so they are unable to apply it when doing word problems. We can therefore infer that these learners may be disadvantaged as they do not have the necessary cultural capital to learn mathematics in English. In addition, learners may struggle with learning because they may be "spending too much time shifting between informal and formal ways of communicating ideas while trying to understand the instructions and questions" (Sharma and Sharma 2023, 824).

Erath et al. (2021, 247) synthesised from the literature, six major design principles for using language as a catalyst for teaching: (1) engage learners in rich discourse, (2) establish mathematics language routines, (3) connect language varieties and multimodal representations, (4) include learners' multilingual resources, (5) use macro-scaffolding to combine language and mathematics learning opportunities, and (6) compare language pieces (form, function) to raise learners' language awareness. Diouani (2023) argues that learning a second language can be promoted or impeded by the context the learner resides in. So, if a learner resides and learns in a context in which an African language dominates, learning mathematics through English could impede their performance.

What is evident in our data is that code-switching (micro-scaffolding) appears to be the only strategy used by the teachers to mediate the challenges of teaching mathematics in a second language. Teachers focus on in-the-moment micro-scaffolding whereas macro-scaffolding at a lesson plan level is missing. The focus needs to move beyond teaching vocabulary to focusing on rich discussions (Erath et al. 2021) about mathematical ideas. The social aspects of language development also need to be part of instructional design (Kibler et al. 2014). We see these aspects as part of CRT.

Theme 2: Progression From Grades 3 to 4 Exacerbated by Language Change

In the Foundation Phase (Grades 1–3), the learners are taught in their home language which is Sepedi. However, when they progress to Grade 4 (start of the Intermediate Phase), the medium of instruction for mathematics is English. The participants believe that this language shift negatively influences mathematics learning in the Intermediate Phase. There are already known problems when learners move from Grade 3 to Grade 4 generally (Manditereza 2021; Pretorius and Stoffelsma 2021). Our participants indicate that adding the change of instructional language exacerbates this problem.

> In Grade 4, learners are in class they have been promoted [to], Grade 3, where they were learning Sepedi and they don't understand most of the concepts that they are coming into when they get into Grade 4, because now they have to learn mathematics in English. We teach them in English and code-switch to Sepedi, so that they can comprehend what is going on. (Participant 2)

Participant 2 acknowledges that the change in language impedes the learning of mathematical concepts at Grade 4 level. It seems that the mathematical concepts learnt in Grade 3 in Sepedi do not translate to the way the mathematical concepts are learnt in English. Even though the participant does state that she code-switches, there still seems to be an issue with how learning mathematical concepts converts from Sepedi to English at Grade 4 level. Even in Ghana, Karikari et al. (2020) recommends that English only be introduced as language of teaching and learning in junior high schools in Ghana, especially in rural areas where there is little support for learning mathematics in English.

> Yes. I would say if we choose to teach in mother tongue, we are not doing away with it, it will be taught in an English class for communication purposes. So even if they go to a more diverse area, they still haven't done language skills, but when we are saying teaching maths in mother tongue, strictly mother tongue. So, it must not be, if you are starting with mother tongue, in foundation, let us continue. (Participant 5)

Participant 5 vocalises his beliefs that mathematics should not be taught in the mother tongue from Grade 4 level. He suggests that there should be a separate class for communication which will assist learners to grasp and apply English better when they are learning mathematics. We can see how the view of participant 5 differs from that of participant 2. Participant 2 identifies the issue and code-switches to assist the learners. However, participant 5 seems to believe that the code-switching and perhaps acquiring a mathematics register should occur in a separate communication class. What happens

in the classroom when learning mathematics should therefore be done in the medium of English.

> Okay, before that, I have a question, if we are teaching in mother tongue from primary, so we are going to high school teaching mother tongue as well, but at higher level, what is going to happen there? (Participant 10)

Participant 10's viewpoint agrees with that of participant 5. She foresees what would happen in a learner's academic journey. She actively debates that promoting the mother tongue to learn mathematics will result in further challenges in the learners' academic journey as they have to learn English at some point.

> When teaching in mother tongue, there is a problem, here in the rural areas. It is going to be a challenge for them to proceed to being taught mathematics in English. (Participant 8)

Participant 8 seems to also agree with participants 5 and 10. She believes that the challenge is actually learning mathematics in the mother tongue, which aligns these sentiments with Ruíz's (1984) language as a problem orientation. It can be assumed that she believes that Sepedi may not be easily translated into English when learning mathematical concepts. Barwell (2020) uses the terms "language positive" and "language neutral" classrooms when mathematics is learnt in a second language. Barwell explains that in language positive mathematics classrooms, learners' socialisation into mathematics and language is given explicit attention pertaining to different aspects of language use in mathematics. In language-neutral mathematics classrooms, the role of language in mathematics tends to be more implicit.

There was an active debate among the participants on whether mother tongue or English should be used for teaching mathematics at Grade 4 level. What we can derive from this is that learners who do not have the cultural capital to learn mathematics will be disadvantaged later on in their academic journey. Posel and Zeller (2019) acknowledge that South African indigenous learners are marginalised as they do not have the necessary cultural capital to learn subjects such as mathematics which is considered a high-status subject. In fact, most of the participants in the study urge the use of English to teach mathematics as early as possible, even though learners struggle with learning mathematics through the medium of English. Peng et al. (2020, 595) confirm that language is used to retrieve mathematics knowledge during the development of foundational mathematics skills, however, this "strengthens linguistic thought processes for performing more advanced mathematics tasks". While we advocate a culturally responsive pedagogy which is also valued by Dhlamini and Essien (2023) and Mpalami (2022), most participants disagree and believe that learners need to learn mathematics in English from Grade 4 so that they get the necessary cultural capital to proceed further.

Theme 3: No Register for Mathematical Concepts in Sepedi

Our participants mentioned Sepedi itself as a problem to learning mathematics in, in line with Ruíz's (1984) language as a problem. However, there were also instances where they proposed the language as a resource and language as a right orientation.

> We also have the problem of the language. Sepedi. There are some mathematics concepts that cannot be taught in Sepedi. Learners struggle to understand English. So it is difficult to code-switch to Sepedi for understanding, so I think language is a problem, one of the challenges. (Participant 3)

Participant 5 anticipated that teaching mathematics in Sepedi beyond primary school would be problematic. Venturing into mathematics topics with specific English-only jargon (for example, calculus) would be limiting. Karikari et al. (2022) established that a lack of adequate vocabulary was a major hindrance in teaching mathematics in the mother tongue since translations were problematic. These authors also found that there is a lack of a wide range of terms used in explaining the lesson in the mother tongue. Often mathematical terms need to be explained by using a variety of phrases.

> For some it would have a good impact, but for some, I think going forward, they will not be able to learn more. Because Sepedi and maths, I don't know how to put it, if they have [to] continue further with the education, then it will have a negative impact on them. They will not be able to understand the mathematics in Sepedi [going further]. (Participant 5)

Participant 6 alluded to the need for simplifying the Sepedi language to make learning mathematical concepts in Sepedi possible. The teacher also spoke of modifications that will be needed in Sepedi to enable teaching of mathematics at a higher level to take place.

> I think the biggest problem in South Africa, we need to emphasise it, are we teaching in mother tongue or are we teaching in English? If the policy is saying let us teach in mother tongue, then let us teach in mother tongue, but also the problem is mother tongue, it needs to be simplified. I think if you look at the home language, Shakespeare died down, it has been modified, but our language is . . . African language. You see now it is always very difficult for learners to understand it. (Participant 6)

Participant 6 indicates that even if an African language is used, it does need to be simplified for teaching purposes. He gives English as an example, when it is simplified ("Shakespeare died down") to facilitate understanding.

Conclusion

This study aimed to explore the language challenges that teachers identified in their mathematics teaching. Our interviews with the teachers identified three main concerns: word problems, progression from Grade 3 to 4, and the register available in Sepedi for

teaching mathematics. Our participants indicated orientations of language as a problem and language as a resource. We did not specifically find many instances of language as a right, but it may be implicit in the participants' statements. The teachers' go-to for mediating language challenges was to use code-switching, which indicated that more professional development is needed to equip teachers with design principles to enable them to provide rich mathematical learning opportunities in a multilingual learning situation.

Our participants also displayed conflicting opinions on the value of using mother tongue instruction, and at which point to move to English as the language of instruction. The conflict arises from creating more challenges when learners move beyond the primary school, and at a later stage have to switch to learning mathematics in English.

The identified challenge that Sepedi does not have the relevant mathematics register and related simplified pedagogical language for teaching reflects what happens when languages are marginalised through colonisation. We propose that teachers and learners connect language to mathematical representations through everyday language, classroom language and academic language in their home language. We also recommend that teachers link language to the other forms of mathematical representations (Prediger and Wessel 2013) that they use for teaching (for example, pictures, graphs, indigenous games) to build a mathematics register in Sepedi. We concur with Sharma and Sharma (2023, 844) that "It is to be noted that equity and academic excellence will not be attained until learners' home language is used as a resource in multilingual classrooms".

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