# Landscape analysis of the role of Language in Early Grades Mathematics teaching and learning in South Africa

Anthony A Essien (Wits), Ingrid Sapire (Funda Wande, Wits), Nick Taylor (JET Education Services)

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# Glossary

***Home language (HL):*** Policy uses this term to refer to the language that is spoken most frequently at home by a learner. This is also referred to as the "main language" of a learner in the literature.

***Indigenous language:*** In the context of this study, the term refers to South Africa's nine official indigenous languages namely: IsiNdebele, IsiXhosa, IsiZulu, Sepedi, Sesotho, Setswana, Siswati, Tshivenda and Xitsonga.

***Language of learning and teaching (LoLT):*** Refers to the language medium in which learning and teaching, including assessment, takes place. In South Africa, this could be any of the 11 official languages, other languages approved by the Pan-South African Language Board (PanSALB), Braille and South African Sign Language (Sasl), approved by UMALUSI.

***Monolingualism:*** This term refers to fluency and proficiency in and the use of one language only.

***Bilingualism and multilingualism:*** These terms refer to the ability to communicate effectively in two or more languages, with more or less the same degree of proficiency in both languages. The two terms are often be used interchangeably in the literature.

***Language repertoire:*** The full set of language resources available to a speaker. This consists of several languages (two or more), which may be known partially or fully by the speaker.

***Code-switching:*** Refers to switching between languages, from one language of instruction to another language of instruction during learning and teaching. Speakers make a choice to move between languages when speaking and are aware of this choice.

***Translanguaging:*** Refers to a flexible, fluid use of language which is seen as an internal strategy by which speakers use all of their linguistic resources to communicate. Speakers draw flexibly on their language repertoire to do this and are not aware of moving between languages when speaking.

***Pure language use:*** In the context of this study I use the term pure language use to refer to a speaker using only one language when speaking. The speaker does so, despite in some cases being proficient in other languages.

***Mixed language use:*** In the context of this study I use the term mixed language use to refer to a speaker using more than one language when speaking – and when I refer to mixed language use it may refer to code-switching or translanguaging or a combination of code-switching and translanguaging.

***Purist language use:*** The use of a pure, single language as the language of expression. This derives from the colonialist notion of a single medium of instruction at schools, where one language (medium of instruction) is used as the LoLT by a teacher in a class. The speaker may know more than one language but uses language in its pure form only without mixing languages because of a belief that pure language use is better (purist language use aligns with a monoglossic language ideology).

***Pluralist language use:*** The use of more than one language in a free, fluid mixture of languages as the language of expression. The speaker draws on his/her full language repertoire to say what he/she wants to say because of a belief that mixed language use is better (pluralist language use aligns with a heteroglossic language ideology).

***Language mixing:*** Pluralist or mixed language use.

# 1 Introduction

> *When children learn language they are not simply engaging in one type of learning among many; rather, they are learning the foundations of learning itself… the distinctive characteristic of human learning is that it is a process of making meaning – a semiotic process. (Halliday, 1993, p. 93).*

This quote from the linguist, Halliday, not only puts language at the centre of learning, it also suggests that understanding how language is learned will give insight into the learning process. Bearing this in mind, we report on the role of language use in Early Grade Mathematics (EGM) in South Africa drawing on publications and intervention reports. We identify gaps in the both the literature and interventions which point to urgent further research to inform best practice for the teaching and learning mathematics in the multilingual context.

## 1.1 Zenex call for a landscape analysis on the role of language use in EGM

Language is critical for cognitive development as it provides the concepts for thinking and therefore a means for expressing ideas and asking questions (Vygotsky, 1989). Traditionally, the challenges associated with learning mathematics were largely seen as coming from the cognitive demands of mathematics itself. It is now widely accepted that language is a prerequisite for mathematics learning and teaching (Sharma, 2016). Mathematics is strongly connected with language and to succeed in mathematics, learners must be able to competently understand and use mathematical language (Walshaw, 2009).

According to the Curriculum Assessment Policy Statement (CAPS), learning to communicate mathematically is central to what it means to learn mathematics. Learners are expected to participate in a variety of mathematical talk and written practices, such as explaining solution processes, describing conjectures, proving conclusions, and presenting arguments. The official description of the mathematics learning area emphasises the role that language plays in the expression, development and contestation of mathematics (Setati, 2003).

South Africa has 11 official languages with English and Afrikaans being the most academically developed. The South African legislation and education policy does not prescribe which of the 11 languages schools must use for learning and teaching although according to the policy, education should be in the mother tongue in the early grades. The choice of the language of learning and teaching (LoLT) is the responsibility of the school governing body, which is made up of the school principal, staff members and parents. In terms of the language in education policy (LiEP, DoE, 1997), the language of learning and teaching in a school can only be an official language. While English-speaking learners and most Afrikaans-speaking learners learn through the medium of their home language throughout schooling, and also take it as a subject, African language speakers in Grades 1, 2 and 3 are taught in their home language and then switch to a different medium of instruction (usually English) from Grade 4.

The multilingual nature of South African society makes the development and implementation of language policies complex, especially in education, where nonindigenous languages still play an important role. It also affects how the learning of additional languages is understood and interpreted, especially in an environment where multiple languages are used, and because of the interactions that are possible among the languages and the processes involved in learning them (Cenoz & Genesee, 1998; Essien, 2020; Essien, Sapire & Moleko, 2024-Forthcoming). This is the complex context in which the learning and teaching of EGM is situated.

## 1.2 Background

Research on the role of language in the teaching and learning of mathematics has largely focused attention on high schools. In contrast, evidence on the role of language in primary schools (especially the early grades) is scant. In a recent review of papers published (on language/multilingualism in the teaching and learning of mathematics) in Pythagoras, the academic and professional journal of the Association for Mathematics Education of South Africa, McLachlan and Essien (2022) noted only four out of 31 papers published in primary mathematics from 1994 to 2021 that met the inclusive criteria for their review (a further two papers were on both primary and high school). This is surprising as it is during the early grades that up to 40 percent of students globally study in a language which is not their first or home language, as noted in the Policy Paper 24 (Global Education Monitoring Report, 2016). The early grades are crucial for building the foundations for mathematics. For instance, Taylor and Coetzee (2013) examined the performance of primary school children (Grades 1-6) with African home language compared to their English and Afrikaans home language counterparts. The authors concluded that there is a significant disadvantage when instructions are received in English rather than the home language of the child. Initial drafts of the report included findings for both literacy and mathematics but later drafts only referred to literacy as the findings for literacy were not significant in the case of mathematics.[1] More specifically, research into the state of primary education in South Africa has indicated that students (in some poorly resourced schools) fall behind by as much as 2-3 years below their actual grade by the time they are in Grade 6 (see Hartley, 2007; Spaull & Kotze, 2015; Mohohlwane & Taylor, 2015; Human, Van der Walt, Posthuma, 2015).

These studies do not elaborate on the role of language in this achievement. As shown above, in the complex multilingual context of South African EGM classes – some focus on the use of language and how it contributes to/inhibits learning and teaching is needed. We will engage further with this in the concluding section of this report.

## 1.3 Research questions

This report presents a two-fold landscape analysis: firstly, a review of the literature published on existing research on the role of language in EGM teaching and learning in South Africa is presented and research gaps identified. Secondly, we examined to what extent intervention programmes in South Africa recognise and attend to language-related issues in the design and implementation of their EGM programmes. It is with the above in mind that the study is informed by the following key questions:

1. What research exists on the role of language (and/or multilingualism) in the teaching and learning of mathematics in the early grades in South Africa?
2. How has this body of research contributed to our understanding of the role of language in the teaching and learning of mathematics in the early grades in the multilingual context? What gaps exist in research in this area?
3. To what extent do EGM intervention programmes in South Africa consider the role of language in EGM education, as reported in existing evaluations of these programmes?
4. What recommendations for policy makers, donors, and implementing organisations can be made (based on the literature and early grade interventions programmes) to inform (with a focus on language use in the multilingual context) curriculum development, pedagogy and teacher education?

[1] Ingrid Sapire clarification obtained in conversation with Stephen Taylor, 2019.

Given the direct focus on the role of language in the teaching and learning of EGM in the multilingual context, we propose to draw on Barwell's (2016) elaboration of assumptions about language that frame research in multilingual mathematics education contexts. This is expanded in the theoretical framing section (Section 3). Drawing on Bakhtin (1981) who proposes a view of language as bipolar, where on the one end of the pole is the unitary language (monoglossia) and on the other end of the pole, heteroglossia, Barwell argues that the unitary language perspective is an ideology that reifies languages as distinct and uniform entities where the emphasis is on a single language (use). On the other hand, rather than focusing on discrete, clearly defined languages and associated clearly defined groups of speakers, the heteroglossic perspective looks at language as social practice situated in social and political contexts (Barwell 2016). This perspective is of particular interest in multilingual contexts.

In examining the extant research that has been carried out in EGM in South Africa and evaluations of EGM intervention programmes, we hope to show how the assumptions made in these research studies/programmes are informed either by the unitary or the heteroglossic perspective of language use and what implications can be gleaned for educational policy and teaching practices in EGM education in multilingual South Africa.

# 2 Methodology

## 2.1 Review of the corpus of EGM literature

In engaging with our review of literature on the role of language in EGM in the multilingual context, we developed the inclusive criteria below:

1) The research outputs needed to be in mathematics education in the early grades (Grades R to 4) and focused on language/multilingualism in the teaching and learning of mathematics
2) The research outputs must be published from 2016 to 2021.
3) The research outputs needed to specifically have for context, teaching and learning in early grades in South Africa.

All papers where all three criteria above were present simultaneously in the paper were included irrespective of the geographical location of the publishing authors of the papers.

In terms of journal inclusion criteria, we searched through both mathematics Education journals and general education journals in South Africa. For international journals, we only focused specifically on mathematics education journals using the list of the top 20 mathematics education journals by Williams and Leatham (2017).

## 2.2 Review of intervention programmes

In engaging with our review of literature/reporting related to evaluations of intervention programmes in EGM, both academic publications and grey literature were considered. Although this landscape is more project based than the literature review (Section 2.2), we again developed inclusive criteria, viz:

1) Projects must be based in mathematics for at least one of Grades R to 4.
2) The projects should have been active in at least one of the years from 2016 to 2021.
3) Project reporting on studies based in South Africa may be quantitative or qualitative (or mixed).

All papers/reports where all three criteria above were present simultaneously in the paper/report were included.

# 3 Theoretical orientation

The proposition of language as bipolar giving rise to a spread of language use between the monoglossic and heteroglossic poles mentioned above (Section 1.3) has been interpreted by others to suggest that language use lies on a continuum between multilingualism and monolingualism (García & Wei 2014). The multilingual context and literature relating to teaching mathematics in multilingual contexts has been discussed briefly in the introduction to this report. Multilingual language use may take on more than one form, but monolingual language use takes on one form – the use of only one recognised language. The use of the term multilingual has been generalised to include the use of at least two languages – in other words, bilingual language use may be referred to as multilingual language use (Lewis, Jones & Baker, 2012). In line with this, in this report we use the term monolingual to refer to the use of only one language and multilingual to refers to the presences of two or more languages whereby any of the languages present in the class has a potential of being used (Barwell, 206). In specific instances where bilingual language use (the use of two languages) is noteworthy, this term is used. Not only can language use vary, but it can also be understood in relation to language ideologies whether the users of language are aware of their choices or not, because language ideologies may be articulated or embodied (Kroskrity, 2004). This is of interest in the multilingual South African context because drivers of language use, and the extent to which they support the learning and teaching of mathematics in the early grades, need to be investigated.

Articulated ideologies are made evident when speakers are questioned about their language use choices, and they give explicit reasons for these choices. The explanations they give express their articulated ideology with regard to language use. For example, a teacher who is questioned about the way in which she has given a particular explanation during a lesson, who is able to give reasons for why she used code-switching, is expressing an articulated ideology. Whether her decision is ideologically based or not is a different question[2] but the main point is that when a speaker expresses a choice and reasons for this choice, they articulate the ideology that they follow (Sapire, 2021). They may be aware or unaware of what they are saying. If they do not have reasons for their choice, one could say that they are not aware of what they are saying. If the reasons are not explained on educational or policy grounds, they are considered to make a choice ideologically.

Embodied ideologies are evidenced in the "concrete utterance" made in spoken or written mathematics. This is when speakers/writers use language in written artefacts such as policy documents, textbooks, workbooks and written work produced by teachers or learners or when teaching more generally. As with articulated ideology, speakers/writers may be aware or unaware of choices they make related to language use in the concrete utterance. This is possible since speakers/writers may think actively (showing awareness) about choices they make in relation to their language use or they may just speak/write without being aware of the language use choices they make while doing so.

Language ideologies can also be embodied in written material because choices are also made in the production of written artefacts. The choice of language use in published written materials is

[2] If a teacher says that she follows the policy and the school principal is very strict, she shows compliance to her/his authority but she may have a different view on that decision. Here policy may be seen as non-negotiable. If a principal is not prepared to negotiate with a teacher and as a result that teacher acts ideologically and not rationally – she is not autonomous to make a rational justified decision and this may be at odds with best practice for the teaching and learning of mathematics.

specifically made at some level – it may be that policy makers determine that materials are monolingual, evident for example in the choice made to date with the South African Foundation Phase mathematics material. Materials developers (or other writers) may decide to produce bilingual or multilingual material, evidence of a different embodied language ideology. Writers of the material may or may not be aware of the language ideology informing their writing (if they are acting under instruction and do not give it thought) but the ideology is embodied in the written form of any written artefact. Teachers and learners, producing less formal texts may at times use more than one language when they do so – and they may be aware or unaware of their language use choices – evidence again of the distinction between a writer being aware/unaware in terms of language use choices.

Language policy is not merely ideological but it is important to acknowledge the place of ideology in policy, teachers' practices and teachers' perceptions. As Makoe and McKinney argue, "without an understanding of the language ideologies informing both policy and practices, we will not be able to shift practices in South African classrooms so that learners' full linguistic repertoires can be legitimately used as resources for learning" (2014, p. 659). Language ideologies vary and they are linked to a speaker's (or writer's) orientation towards language. García has linked monoglossia (and on the other side of the spectrum, heteroglossia) to ideology. She does this by speaking about the ways in which language is conceptualised. Monoglossic ideologies treat languages as bounded autonomous systems without regard for the actual language use of speakers, while heteroglossic ideologies recognise multiple language use practices in interrelationships (García & Wei 2014). A monoglossic ideology is linked to a purist view of language which upholds that one, pure language can be used to express oneself meaningfully and that only pure language should be used when speaking or writing. A heteroglossic ideology is linked to a pluralist view of language which upholds that speakers who have a language repertoire of more than one language are able, and should be allowed, to draw on multiple languages when they speak. A heteroglossic ideology acknowledges linguistic diversity. Society does not always recognise or value the existence of speakers drawing on multiple language resources, which is partly what underlies the existence of these two opposing language ideologies.

McKinney writing about what counts as language in South Africa suggests that heteroglossia "provides a multifaceted lens for analysing the complexity of instances of language use within a micro and macro socio-political context" (2015, p. 109). The publications which we sourced present findings based on which the leaning toward particular ideologies may be inferred and a judgement can be made as to whether the ideologies are articulated or embodied. The political nature of the language use arena creates an environment where at times articulation of ideologies can be difficult and use of language may be influenced by ideological rather than pedagogical choices (knowingly/unknowingly). Ideally pedagogy should guide choices. In the next section the literature review is presented.

# 4 Review of EGM literature (2016-2021): Analysis and findings

In mathematics teaching the focus needs to remain the learning of mathematics but in the multilingual context this cannot be done without attention to the role of language in the teaching and learning of mathematics. The first section of this report speaks to our first two research questions:

1. What research exists on the role of language (and/or multilingualism) in the teaching and learning of mathematics in the early grades in South Africa?
2. How has this body of research contributed to our understanding of the role of language in the teaching and learning of mathematics in the early grades in the South African multilingual context? What gaps exist in research in this area?

We focused on three themes in order to understand the issue of language/multilingualism in the teaching and learning of early grade mathematics. These themes represent predominant ways of looking at language use in EGM.

| Themes | Descriptors |
|---|---|
| Teaching and learning EGM in African languages | • Focus on teaching and learning EGM in African languages |
| Responding to the multilingual context in EGM | • Focus on LoLT in relation to spoken languages of teachers and learners in EGM<br>• Focus on available EGM learning materials that are multilingual<br>• Focus on mixed language use in EGM (e.g. code-switching/translanguaging)<br>• Focus on teacher perceptions of language use in EGM (monolingual or multilingual) |
| Transition from mother tongue to English as LoLT in EGM | • Focus on the transition from Foundation Phase to Grade 4 in relation to language use in EGM |

Before presenting the overview of the literature found published in the period 2016-2021 a table of the distribution of the publications is given. Table 1 shows the number of publications according to their focus on one of the three themes:

*Table 1: Distribution of corpus of EGM literature according to language use*

| **Output** | **African language** | **Multilingualism** | **Transition** | **Total** |
|---|---|---|---|---|
| Local journal | 2 | 7 | 4 | **13** |
| International journal | 0 | 6 | 2 | **8** |
| Book Chapter (local) | 0 | 0 | 0 | **0** |
| Book Chapter (international) | 2 | 2 | 0 | **4** |
| **Total** | **4** | **15** | **6** | **25** |

As it can be seen in Table 1, over the period 2016-2021 a total of 25 publications were found that satisfied all of the inclusive criteria. The overwhelming majority of the publications focus on multilingualism (15 publications). There were six publications with a focus on the transition from the Foundation Phase (where the LoLT is predominantly an African language) to Grade 4 (where the LoLT is predominantly English). Finally, four publications focused on the use of African languages in the teaching of mathematics. There were 13 local journal papers, eight international journal papers and four chapters in international books.

In what follows, we provide a deeper thematic analysis of the corpus of literature, paying careful attention to what we perceive to be the overarching language orientations for each of the research outputs.

## 4.1 Teaching and learning early grade mathematics in African languages

The challenges in relation to teaching in the mother tongue have been widely reported on and are not unique to South Africa. They have constituted an area where there has been research interest since

at least the late 1980's hence there is a strong body of research in this area that exists. We found only four publications that focused on teaching and learning mathematics in an African language in South Africa. These are now discussed.

Kotze, van de Westhuizen and Barnard (2017) explore and describe challenges regarding teaching strategies to support isiXhosa-speaking learners in Grade One when the home language of these learners is different from the LOLT in their schools. They go one to recommend that parents should consider placing their child in a school where the LoLT is that of their mother tongue for at least the first three years. They further argue for teachers to apply strategies such as nonverbal modelling, code-switching and audio linguicism while scaffolding is taking place.

The work of Mostert (2019) and Poo and Venkat (2021) examine the linguistic features of certain African languages, particularly isiXhosa and Sepedi, as it concerns number names. Mostert (2019) does this by comparing different early-grade mathematics texts in English and isiXhosa based on five linguistic features: syntactical category, transparency, regularity, length of words and differences between spoken and written language. The paper concludes that the implications of these features for mathematics teaching and learning in the early grades are that there are both constraints and affordances of learning number names in isiXhosa. Amongst others, Mostert (2019) recommends the sensitisation of teachers to the number structure in African languages, and that the practice of using English number words interchangeably with African language number words should be integrated into the teaching of mathematics, rather than discouraged.

The work of Nomlomo and Mbekwa (2020) argue for the use of African languages as a medium of learning and teaching in school science and mathematics despite the general perception that African languages cannot be used in science and mathematics education because of their perceived lack of global status and appropriate terminology. The paper goes on to argue that..."In the case of South Africa all learners should have adequate exposure to and support in their home languages and English. Such an exercise would facilitate additive bilingualism instead of subtractive bilingualism".

In terms of language ideology, Kotze, van de Westhuizen and Barnard (2017), in arguing for multilingual practices in order to support children in classes where they do not have the LoLT as mother tongue, take a unitary perspective to language use in the sense of multiple monolingualism[3]. Nomlomo and Mbekwa take on a more integrated perspective of language use and we see this as a heteroglossic perspective.

Some of the key issues that were drawn out from the above literature review were language of teaching and learning (LoLT) in relation to spoken languages of teachers and learners, standardisation of the African languages, the push for teaching 'straight for English', available learning materials in African languages and teacher perceptions of language use (monolingual).

Successes or pointers towards ways in which the challenges have been addressed/overcome may also emerge and will be documented – particularly with a view to further research needed in the area.

## 4.2 Responding to the multilingual EGM context

While multilingualism is now being spoken of as an international norm, South African teachers and learners have always faced the challenges of multilingual classrooms and reporting on the

[3] The curriculum interpretation of the South African multilingual language policy (DoE, 1997) has resulted in a system of multiple monolingualism, where teaching in the (assumed) home language of learners has been established and monolingual materials are provided. In this way multiple languages are provided for but classes where monolingual teaching is assumed and monolingual materials are provided.

challenges/difficulties experienced in multilingual classes also began in the late 1980s, initially more in the higher grades but in the last decade (2010-2020) more research in the early grades has been carried out. We found 15 publications that focused on teaching and learning mathematics in a way that is responsive to the multilingual context. These are now discussed. Findings and arguments from each of the publications are presented here to give the full spread of what has been written about to date. The presentation of findings from the research shows that there is not unanimity in the way in which 'best practice' for language use in EGM is envisaged or described. There are even contradictions between some of the findings presented. In the conclusion to this report, we consider what further research still needs to be done to clarify 'best practice' in the multilingual EGM context to reduce the confusion and support teachers in this complex context.

Essien (2018) in an overview of research on the roles of language in Kenya, Malawi and South Africa (which are countries with similar language policies) found that policy implementation was fraught with difficulties, one of the primary reasons being the level of development of indigenous languages. The study by Mahofa, Adendorff and Kwenda (2018) investigated how African immigrant early grade learners learn mathematics word problems in the Western Cape Province of South Africa (SA). In recommending that teachers use mixed language groupings (where learners are unable to code-switch) and advocating for the use of the LoLT (English), the study advocates for the multiple monolingualism system rather than recognition of multilingualism.

Mostert (2020) hones in on the use of language in the teaching of number word problems and proposes ways of linking between languages (a particular form of language mixing) in order to promote understanding. The results of her study raise a number of points regarding the relative difficulty of IsiXhosa compare type problems which are also relevant for English (2020, p.12). Robertson and Graven (2020b) make a case for more systematic support for learners' second language development and for legitimation of use of home language in mathematics classrooms where a different language is the official medium. In the same line of thought, Sibanda (2019) calls for the use of mixed language regardless of its form and a move from the construct of 'pure' language calling for the acknowledgement of linguistic differences.

Unlike Robertson and Graven (2020b), and Sibanda (2019) on the one hand, Cekiso, Meyiwa and Mashige (2019) on the other hand, recommend the adoption of multilingual practices such as codeswitching as a short-to medium term solution while more appropriate mathematical terminology in isiXhosa is being developed as a long-term solution. In so doing, this study (Cekiso et al) proposes short term solutions that are heteroglossic to 'bide time' till monolingual isiXhosa education (unitary) could be possible.

Poo (2021) examines mathematical and multilingual moves between representations within Sepedi and English medium classrooms and points to moves between representations and languages featuring in different ways across Sepedi and English classrooms in ways that the literature would suggest are important for learning mathematics.

Desai (2016) states that a pedagogic rather than a political view of language use and the mixing of English into the repertoire allows for a dynamic view of the language resource, and argues that, "[in] multilingual societies people tend to use their linguistic repertoires as resources, not impediments. Educational institutions have to take this as their starting point, instead of ignoring the existing language proficiencies of students" (2016, p.351). Feza (2016) also argues strongly in support of language as a resource in EGM, noting that "although it is not part of language policy, code-switching occurs without planning as teachers argue that it happens as the need arises" (p. 576). Mulaudzi (2016) raises the issue that English as LoLT can be problematic and recommends language mixing as the solution in EGM classrooms.

Madonsela (2015) and Mostert and Roberts (2020) argue for the use of mixed language, allowing the language repertoire of learners to come to the fore. Madonsela argues that allowing use of the full language repertoire in EGM classrooms can help students avoid feeling of language anxiety saying that, "if a single mode of instruction is used, it can sometimes lead to a feeling of language anxiety in a learner" (2015, p. 478). Similarly, Mostert and Roberts (2020) study similarities and differences between IsiXhosa and English with regard to expressions of mathematical terminology in printed texts and argue for care in moving between languages in multilingual contexts.

Robertson and Graven (2019) propose a system of four quadrants in terms of context and cognitive demand in order to categorise language use in meaningful discussions in the multilingual mathematics classroom and they suggest that a good balance (which involves the use of mixed language and the support of language mixing) is what is required to support students to "move beyond everyday ways of meaning-making towards more mathematically rich ways of articulating mathematical reasoning" (2019, p. 231).

Sapire and Essien (2021) argue that language ideology determines language use, when presenting findings about the policy-reality mismatch in multilingual mathematics early grade classrooms. They contend that the South African policy recognises all of the official languages but do so according to a system of multiple monolingualism (Essien & Sapire, 2021), an expression of a unitary perspective of language use.

We found only one study that focused on the use of technology in relation to language in multilingual early grade mathematics classrooms (Pitchford et al. (2021). This study explored how the use of multilingual Apps can aid the teaching and learning of mathematics and concluded that in the South African arm of the study, the fact that the Apps exposed learners to the mathematical register that was to be taught in subsequent classes facilitated children's understanding and accelerated their learning of the isiZulu mathematics register.

Some of the key issues that should be highlighted and drawn out from the review are: language of teaching and learning (LoLT) in relation to spoken languages of teachers and learners (as above but from the multilingual perspective), available learning materials that are multilingual, policy issues in relation to mixed language use (e.g. code-switching/translanguaging), teacher perceptions of language use (multilingual); and the use of technology in creating an enabling environment for teaching and learning in multilingual classrooms. It is also important to note that the research under this theme is mainly heteroglossic except for the work of Mahofa et al (2018) and Cekiso et al (2019).

As above, successes or pointers towards ways in which the challenges have been addressed/overcome may also emerge and will be documented – particularly with a view to further research needed in the area.

### 4.3 Transition from mother tongue to English as LoLT

Curriculum policy on language transitioning has been the topic of discussion for decades and is particularly relevant in post-colonial countries. We found six publications (four in local journals and two in international journals) that focused on the transition from teaching and learning mathematics in an African language to teaching in English over the period 2016-2021. These are now discussed.

Speaking directly to policy issues, J. Sibanda (2017) points to "multiple levels of dissonance (theory-policy, theory-practice and policy-practice) as a factor that militates against learner academic attainment" (2017, p. 1). He argues that theory (for which he draws on Cummins, 2000) and policy

(which is defined by the LiEP, 1997) both represent the ideal are in conflict with practice. His presentation of the conflict in this paper is done in order to argue for extensive further research to inform policy since as he states, "The shift in LoLT should not be an arbitrary policy pronouncement based on the years of learning, but should be dependent on learner proficiency in both the home language [HL] and the FAL [first additional language] to allow for cross-linguistic transfer of skills, and to enable them to profit from use of the FAL as LoLT." (2017, p. 7).

The transition from mother tongue to English as LoLT languages and how to work best within the constraints/affordances of policy are reported on more often in qualitative studies – two of the publications addressed the issues of learner performance in mathematics being affected by the LiEP transition language policy. L. Sibanda (2017) used a case study approach to explore Grade 4 learners' linguistic difficulties in solving problems in the 2013 ANA mathematics paper. She investigated ways in which language may have impacted on learner achievement in the ANA tests of learners from three Grade 4 classes. She concluded that the majority of poor learner performance could be attributed to language, identifying the following possible issues: linguistic complexity of items; length and complex grammatical patterns of the sentences; the use of unfamiliar words; and the use of familiar words (e.g. difference, convert) used in unfamiliar ways. She also highlights that a lack of proficiency in the English language further impacts on these difficulties (2017, p.95). In another quantitative study by Sibanda and Graven (2018), 26 Grade 4 learners were interviewed about their responses to selected ANA test items to investigate their reading and comprehension skills. In conclusion to their study, they challenge the assumption that "mathematics assessments in English can be considered valid" based on their findings that "learners fail to understand the English language of the questions" (Sibanda & Graven, 2018, p. 11).

Very few rigorous data-based studies have been carried out that report on the **impact** of this transition although one example of such a study was carried out by Taylor and von Fintel (2016). They reported on a longitudinal quantitative study carried out on a large dataset constructed by using the Department of Basic Education's Annual Surveys of Schools (ASS) from 2007 to 2011 with the Annual National Assessments (ANA) data for 2012. It was shown that learning in the home language in the Foundation Phase (Grades R-3) has a positive effect on achievement in the Intermediate Phase (Grades 4-6). The effect was significant in the case of literacy, not so for mathematics[4], where although there was evidence of a positive effect of exposure to more home language in the Foundation Phase, this was not statistically significant.

Shifting the focus more to the mathematics teacher, Robertson and Graven (2018) use a transdisciplinary framework to examine mathematics talk when teachers and learners interact in lessons. They draw on three strands of conceptual insight from the disciplines of psychology (Vygoysky), sociology (Bernstein) and linguistics (Halliday) to create a multifocal lens which they use to analyse teacher talk in the context of the teaching of fractions, suggesting that this understanding is richer and enables deeper understanding of the mediation process (p. 1051). Based on their analysis, they advocate for use of the full language repertoire of learners (and teachers) in the interests of, "facilitating students' opportunities to maximally exploit the potential inherent in their linguistic repertoires in the service of mathematical meaning-making" (p. 1025). Still focusing on mathematics teachers, Tshuma and le Cordeur (2019) administered a standardised English language proficiency test on 55 teachers selected from 16 districts in the Eastern Cape. They found a general low English language proficiency in their sample. Drawing on the writing of others (Setati and Howie), Tshuma and le Cordeur (2019) argue that teachers who are not proficient in the LoLT will compromise the learning of mathematics in their classes. Their conclusion states clearly that "Teachers who are confident and

[4] The analysis on the mathematics test scores can be found in the working paper version of this paper which is available at http://www.ekon.sun.ac.za/wpapers/ 2013/wp212013.

proficient in the LoLT are better able to deal with the linguistic needs of IP learners within the South African education system and are more likely to produce better results" (2019, p. 122).

Four of the publications (L. Sibanda, 2017; Sibanda & Graven, 2018; Taylor & von Vintel, 2016; Tshuma & le Cordeur, 2019) espoused a unitary ideology (focusing on languages as distinct entities) while two of them (J. Sibanda, 2017; Robertson & Graven, 2018) suggested value in the use of mixed language (the full language repertoire) – representing a heteroglossic ideology.

The review of literature presented above is evidence that scholars remain split on the relative merits of using a single language or mixed languages in the learning of EGM.

# 5 Review of EGM interventions (2016-2021)

The second section of this report speaks to our third research question:

3. To what extent do EGM intervention programmes in South Africa take into account the role of language in EGM education, as reported in existing evaluations of these programmes?

Before we can address these questions, an overview of the interventions and their approach to language is given since that provides the substance of the discussion.

This section of the review examines and summarises a set of interventions working to support the teaching and learning of early grade maths (EGM) in South Africa. The primary purpose of drawing up this summary is to identify how (if any) intervention projects are mobilising or have mobilised language to promote EGM learning outcomes. This quest was greatly assisted by the recently issued three-volume series on work in the fields of early grade reading and numeracy published in December 2022 by Oxford University Press (OUP). Twenty-one of the 46 chapters across the three volumes focus on EGM, providing important insights regarding teacher and learner content knowledge, pedagogy and the use of language, both in the classroom and in the design and deployment of teaching and learning materials. The intervention programs which serve as the focus of these chapters are listed in Table , together with a number of existing or recent programs not described in the OUP series.

*Table 2: Recent interventions in EGM in South Africa*

| Name | Type of intervention | Research/ evaluation | Approach to language |
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| **Rainbow Workbook Series (DBE Workbooks)**. McKay and Spaull (2022) | Workbooks in Language and Maths, Grades 1-6 and 9, distributed to each child twice annually (Book 1: Terms 1 and 2, Book 2: Terms 3 and 4). | Material reviews | Workbooks produced in all 11 official languages. In the view of one of the architects of the project, the workbooks contributed significantly to consolidating mother-tongue education in the FP and to '… reinforcing mother-tongue literacy beyond Grade 3.'<br>FP maths workbooks: mono-lingual in 11 African languages. |
| **Gauteng Primary Language Mathematics Strategy (GPLMS)**. Essien et al (2015) Fleisch (2018) | Triple cocktail (structured lesson plans, educational materials and coaches | Quasi-experimental | Aim is to support the teaching and learning of mathematics in multilingual classrooms where the language of learning and teaching (LoLT) is not the home language of the learners.<br>Teacher material monolingual (English); learner material bilingual English/African language in all 11 official languages. |
| **Magic Classroom Collective (MCC).** Porteus (2022) | Lesson plans (later replaced by learner workbooks as primary instructional tool), teaching and learning resources, training, coaching | Classroom observation, learner workbook analysis, learner testing. Recommend RCT | Teacher development and support provided bilingually. One of the goals is to develop a more fluent and expansive instructional register in isiXhosa. The elevation of language through materials and teacher instructional support both modelled and legitimated this goal.<br>Teacher and learner materials English/IsiXhosa. |
| **Wits Maths Connect – Primary (WMC-P).** Venkat et al (2022) | Lesson plans, teaching and learning materials, teacher training. | Learner task-based interviews, classroom observation, learner testing. Recommend RCT | No mention of language, except that the learner interviews were conducted with support from mother-tongue speakers.<br>English materials. |
| **South African Numeracy Chair Project, Rhodes University (SANCP).** | After-school interventions: primary mathematics clubs and family maths story-time programmes. | Qualitative + learner testing | Programmes focus on the development of opportunities for learners and families to talk about mathematics, and the materials offer a |

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| Graven et al (2022) | | | bridge between the home and school language of mathematics.<br>All the books are available (monolingual) in English, Afrikaans, isiXhosa, and isiZulu, and translation into other languages is underway.<br>It would seem, from the examples given, that the materials are all monolingual, although one of the references mentions multilingualism (Jorgensen, R. & Graven, M. (2021) *Merging Numeracy with Literacy Practices for Equity in Multilingual Early Year settings*. Springer: Singapore.) |
| **Maths Clubs**<br>Bowie et al (2022) | Aimed at building a strong number sense among primary school learners, but moving beyond unit counting. Teaching and learning materials + facilitator training.<br>Print material and video material. | Reflection in action | Materials are English. Videos are available in some of the official African languages (not clear which/how many). |
| **WCED Lit/Num intervention.**<br>JET (2013) | Training + materials + support from WCED SAs and HODs | Quasi-experimental + classroom observations + interviews | Monolingual training materials in three languages: English, Afrikaans and isiXhosa |
| **Grade R Math Project (R-Maths).**<br>Hazell et al (2019); Spenser-Smith et al (2022) | Materials + SA and lead teacher training (cascade). | Quasi-experimental + interviews + case studies | Resources and materials in the LoLT (monolingual). Concept Guide, four term Activity Guides, Poster Book and text in the classroom kit offered in English, Afrikaans and isiXhosa. Training materials offered in the language of learning and teaching (LoLT) of the teachers to support the development and understanding of mathematics language and concepts. The programme presents seven principles to guide teaching and learning and provides a framework for whole class and small group activities. Daily planning and continuous assessment is integrated into the design. |

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| **Grade R Mathematics and Language Improvement Project.** JET (2021) | Teacher training + SAs and FP DHs + materials | To be determined. | Concept Guide, four term Activity Guides, Poster Book and text in the classroom kit offered in all 11 South African language with English text in parallel. Classroom and training materials support the development and understanding of mathematics language and concepts. The programme presents eight principles to guide teaching and learning and provides a framework for whole class and small group activities. Daily planning and continuous assessment is integrated into the design. |
| **Bala Wande** Sapire et al (2022); Makaluza and Mpeta (2022); Venkat and Morrison (2022) | Structured pedagogy: Materials + coaches; Teaching assistants + materials; Materials (print and manipulatives) | RCT + lesson obs + case studies | Learner workbooks and Teacher Guides, in Afrikaans, Sepedi and isiXhosa (for implementation in EC, WC and LP), are all bilingual each having parallel text in English. Supports the development of mathematics language by moving naturally between languages when speaking about mathematics. The Bala Wande dictionary helps teachers use more than one language to explain mathematical words. Code-switching allows teachers and learners to draw on all of their language skills (translanguaging) to learn, rather than being limited to one language. Materials for Grade R (Sepedi) and Grades 1-3 (IsiXhosa, Sepedi, Afrikaans.) |
| **Mental Starters Assessment Project.** Venkat and Graven (2022) | 6 mental strategies identified to equip children to perform arithmetical operations without using unit counting: Conceptual development (≠ coverage and pacing, or 'generic' interventions). Success first established on small scale before scaling up, | Action research, including learner pre- and post-tests set by teachers. | Materials have been translated into all 11 languages (monolingual), under the auspices of the DBE. |

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| | by involving subject advisors (Build Your Timber, BYT).<br>Teaching and learning materials + training. | | |
| **Formative Assessment Project.** Kanjee and Bhana (2022) | Teacher workshops (G2, with HODs + work with SMT) to support formative assessment classroom strategies. Teacher materials (portfolios and classroom posters) | RCT, but confined to effects of programme on teacher pedagogical practices and not on learning outcomes. | Materials in English only, although this is not the HL of most participant teachers. |
| **Shikaya NumberSense Mathematics Programme**. Brombacher and Roberts (2022) | The programme aims to improve learner performance in mathematics. The teacher is considered as the change agent and apart from supplying learner materials for learners (Number Sense workbooks for each child) the teacher is the focus of the all training – workshops and classroom-based support. Workbooks are supplied to learners as they complete the previous one: in this way, children work 'at the right level' for their mathematical development. | Cross-sectional EGMA data, with internal controls. RCT recommended | In the majority of schools, the intervention is conducted in English, in two schools in isiXhosa and in another two schools in Afrikaans.<br>Materials are all monolingual English. |
| **JumpStart** Moloi et al (2022) | JumpStart works with a district, applying five key mechanisms: (1) teachers and teacher training, (2) NumberSense learner workbooks (see previous entry above) (3) individual attention from teaching assistants or interns who each have a tablet (4) coherent mathematics pedagogy and (5) real time monitoring of learning (formative assessment). | Cross-sectional EGMA data, with internal controls. RCT recommended | No mention of stance on language use, except to mention that the EGMA test was administered to children in the language of teaching and learning at the school which, in the urban environment of Gauteng, included English, Sepedi, Sesotho, Tshivenda, isiXhosa, isiZulu and Xitsonga.<br>Use of NumberSense learner materials for classroom support (English monolingual). |
| **Teaching Maths with Understanding (TMU).** DBE (no date) | Teacher training + teaching material and learner activity books | None available. There are 212 sets of materials available on the NECT website, but no research revealing insights into how they are received by teachers and learners, how they are used in classrooms, nor | Language needs to be used in such a way that learners are able to express their thoughts as clearly as possible, while they grapple with the mathematical concepts that they are learning. The use of language should not interfere with the learners' ability to speak about what they |

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| | | information concerning their impact. | are doing and make conceptual generalisations. The practices of code-switching and (more recently) translanguaging speak about flexible language practices.<br>Training materials: English only.<br>Teaching resources English only and Learner Activity Books: African lang, in parallel with English (bilingual). The learner resources are bilingual, based on the assumption that presenting the activities in two languages will help learners to learn the maths words in both their home language and in English.<br>Bilingual dictionaries.<br>Available in Sepedi, Tshivenda, Xitsonga, IsiXhosa and IsiZulu. |

## 5.1 The role of language in EGM interventions

It follows from the preceding discussion that, while the optimal use of language is important in all topics and at all levels of maths education, the most important priority must be to understand how to mobilise language most effectively in, first, assisting teachers to achieve a flexible understanding of the principle of cardinality, and, second, to equip them to facilitate the achievement of this key conceptual step by their learners.

Discussions around the use of language in promoting EGM learning in these studies fall into three intersecting fields: the role of home language, the proficiency of African-language teachers in English and the use of multiple languages to promote teaching and learning. The complex, interlocking nature of these three issues is demonstrated in responses to interviews conducted by Essien et al (2015) with teachers participating in the Gauteng Primary Language and Mathematics Strategy (GPLMS). These isiXhosa-speaking FP teachers indicated that they preferred using English in teaching (if they were given a choice), a preference motivated by three reasons. First teachers felt that the **mathematics register** in the materials provided was not always adequate for their purpose. Second, they felt that the translations in the **mother tongue were very long** compared with the English versions. And third, they felt that, because their **training was in English**, it made sense for them to teach in the language in which they had been trained. Further difficulties are added in classes in which **more than one home language** is spoken by learners and in schools where **parents show a strong preference** for their African-speaking children to be instructed in English. We attempt to untangle this net of five issues in the following discussion.

## 5.2 Challenges in relation to language use: Home language, English or mixed language?

### 5.2.1 Foundation Phase

Essien (2018) and Feza et al (2022) summarise a large number of studies, many located in Africa, which show a significant advantage to learning in one's home language in the early grades. McKay and Spaull (2022) concur, noting that UNESCO (2010) makes a strong case for mother tongue instruction as a means of improving educational quality. A recent World Bank report (2021) agrees, noting a universal consensus that children should learn to read and calculate in their home language.

Against this body of evidence, how is the preference for instruction in English by mathematics teachers be countered? The Magic Classroom Collective (MCC) project referred to above is one of the most ardent proponents of the use of home language in the teaching and learning of EGM, and the programme design attempts to answer this question in a number of ways. Focusing on Grades R to 3, one of the primary goals of MCC is to legitimate and extend teachers' instructional narrative in EGM in the language of teaching and learning (in this case isiXhosa.) (Porteus, 2022). In-service teacher training and support is conducted bilingually by MCC, while Fort Hare University, home to the MCC, offers a bilingual (Nguni-English) Bachelor of Education (Ramadiro, 2022). The goal of this BEd course is that student teachers should not be simply taught an African language, but rather that African language fluent student teachers are supported to develop an instructional register to *teach* maths and literacy efficiently *through* an African language (Porteus, 2022).

The fact that 5 of the 15 interventions described in Table  do not provide materials in learners' home languages is indicative that the principle of mother-tongue instruction is not being taken up as a central issue by teacher educators across the country. The overall conclusion to be drawn from this standoff between teachers who prefer teaching mathematics in English, even in the earliest grades, and those who advocate for mother-tongue instruction is that, until the mathematics register is fully

developed in African languages and internalised by teachers, some or other form of multilingualism in the classroom seems a pragmatic solution.

### 5.2.2 Mother tongue schooling beyond Grade 3

South Africa's Language in Education Policy (LiEP) makes provision for mother-tongue schooling, at both primary and high school levels, depending on the wishes of parents (DoE, 1997). The LiEP has run into friction in a few schools whose policy has changed, or mooted to be changed, from Afrikaans to an African language or English. However, the idea of schooling in an African language beyond Grade 3 is a novel idea about which little is known.

An exception to this general state is the Mother Tongue Based Bilingual Education program (MTbBE) Project (2011 - 2016) piloted in the Cofimvaba district of the Eastern Cape. The objective of MTbBE is to develop isiXhosa as a language so as to widen epistemic access to subjects other than the mother tongue; to enhance the quality of learning achievement and bilingual language competence at the primary level, by teaching in, with, and from the first language throughout the primary education cycle (Mbude, 2020). In particular, the project incrementally extends the use of isiXhosa as a medium of instruction and assessment for mathematics and science from Grade 4 to Grade 7.

A sample of 70 underperforming schools, based on the 2011 ANA scores, were selected for the pilot. In pilot schools three subjects were taught in isiXhosa and three in English. A control group of schools continued to teach all subjects in English. Learning outcomes for the two groups were compared, using the 2014 ANA results for Grade 6; for the first time, the ANA tests were administered in isiXhosa in pilot schools. Mbude (2019) reports significantly higher performance of pilot schools in English as First Additional Language (EFAL), Mathematics and Natural Science and Technology.

Attributing the poor performance of the majority of African-speaking learners to the fact that they are constrained to learn in English from Grade 4, Tyler et al (2022) call for the bilingual education of all children, citing MTbBE as model to be implemented more widely. However, while the MTbBE has produced promising results to date, Mbude acknowledges limitations to the generalisability of her findings, and recommends that a rigorous study be undertaken to investigate more precisely the relationship between home language instruction and learning outcomes.

### 5.2.3 Bi-/Multilingualism

While Tyler et al (2022) undoubtedly have a point regarding the difficulties experienced by African-language speakers in accessing subject knowledge in English, the situation is far more complex than merely one of language medium, as seen in the list of 5 issues mentioned above. Most obvious is the question regarding FP learning: if learning depends only on the LoLT, then why are FP learners achieving so poorly in maths, when, with few exceptions, the LoLT is the mother-tongue of the majority of learners?

The poor state of development of the mathematics register in African languages and unfamiliarity with some terms which do exist, including the number names, is a major impediment to learning in these languages. This situation is one reason for designing bilingual classroom materials, for both teachers and learners, with text in English provided in parallel with the African-language text. This is a practice adopted by only 5 of the interventions shown in Table , indicating that, while this practice is growing in frequency, it is one which is far from being widely accepted by teacher educators.

In addition, designing multilingual materials and deploying multilingual routines present teacher educators with a new set of challenges. For example, Essien et al (2015) noted that the extent of code-

switching between Home Language and English varied considerably between teachers participating in the GPLMS. In some classes, all explanations were given in Home Language but all numbers were stated in English. This, in our opinion, represents a missed opportunity for the teachers to take advantage of the transparent number structure in the African languages as described by Mostert (2019). In others, there was fluid movement between home language (HL) and English in the broader talk and explanations as well. Language issues played out in the observed lessons in terms of inaccuracies and ambiguities relating to important mathematical ideas. This observation points to the need to work with stakeholders to develop consensus around phrasing for fundamental number ideas in the home languages is desirable. This is important in the South African context where the Home Languages are not yet well developed as languages of scholarship.

Bi- and multilingual classroom activities not only provide teachers and learners with an additional perspective for understanding the maths concepts involved, but they also promote the development of English proficiency, which assumes critical importance from Grade 4 for the large majority of South African learners for whom the medium of instruction changes from home language to English at this point.

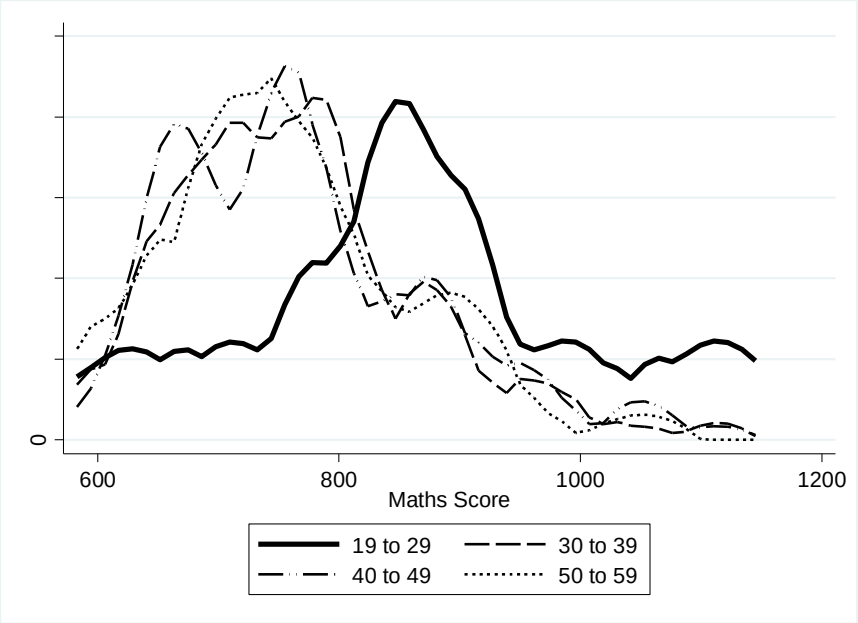
### 5.2.4 Teacher proficiency in the language of teaching and learning

The distinction between basic interpersonal communication skills (BICS) and cognitive academic language proficiency (CALP) points to the importance of the latter in learning school subject matter at relatively sophisticated cognitive levels (Cummins, 1979; 1981). Proficiency in the latter in English poses a very significant challenge to African language speakers who transition to English as LOLT in Grade 4. In the first instance, this is a problem regarding teacher CALP proficiency in English. According to the report of a Task Team established by the Minister of Basic Education into the quality of the National Senior Certificate students who matriculate in EFAL (as opposed to HL) leave school with a very rudimentary CALP architecture (DBE, 2014).

To aggravate this situation, students applying to education faculties to study to be teachers are among the academically weakest matriculants of any NSC cohort, scoring poorly on the annual national benchmark tests administered to the majority of university applicants (CETAP, 2020). Seeming oblivious to this situation, education faculties make little progress in improving the subject content knowledge of BEd students in language or maths (Bowie et al, 2019; Roberts, 2022; Taylor and Mawoyo, 2022). In the light of this history, it is not surprising that primary school teachers exhibit poor subject knowledge in both languages and maths (Taylor and Taylor, 2013; Venkat and Spaull, 2015; Taylor, 2019; Tshuma and Le Cordeur, 2019).

There is some evidence that the universities are doing slightly better in enhancing teacher knowledge than was the case with the colleges of education. Thus, younger teachers, educated in the universities since the reorganisation of the ITE landscape since 2000, perform better on the SACMEQ teacher tests than their older peers, but at a mean of around 50% on tests based on the curriculum which their learners are expected to master (Figure 1) this achievement is nowhere near what is needed to equip teachers to teach the current curriculum.

*Figure 1: Teacher mathematics scores by age, SACMEQ III (2007)*




Source: Armstrong, 2016

# 6 Teaching and learning mathematics - Teacher content knowledge and teaching expertise

While this report focuses on publications and interventions that give insight into the nature and role of language use in EGM, what we will show is that too few studies shed light on best practice for language use in the multilingual mathematics context that will mobilise this language use to language to promote EGM learning. Arguably one of the most important new insights in the OUP series into the complex relationships between teacher knowledge, pedagogy and children's learning are provided by Porteus' (2022) chapter on the Magic Classroom Collective (MCC) initiative. Porteus concludes that, after 7 years of intensive work with rural teachers in the Eastern Cape, their "… relationship with 2-digit additive relations remained fragile, highly reliant on unit counting" (79). The relationship between this fragile knowledge and language needs to be understood and ideas for ways in which language can be harnessed in order to strengthen teachers' (and learners') conceptual understanding has not yet been adequately researched. Since language is the main tool (or one of the main tools) used to build conceptual understanding, studies that wish to gain insight into how to harness this tool to best effect to improve understanding need to begin with well-defined problems in relation to the mathematics or mathematical concepts involved. From here they should identify the language involved in the study of the concept and investigate what, if any, issues in relation to the language used in the study of the concept may exist. The role of language in the building of the concept defined can then be studied – to expose areas where it is not being used optimally and why and to investigate ways in which this can be changed so that the power of language can be harnessed to promote learning. This study should be located within research on teacher development and thus a clear and deep understanding of what promotes and what constrains the development is worth noting.

First, while interventions aimed at strengthening teachers' pedagogy (pacing, sequencing and progression and the use of structured classroom materials) appear to be having significant positive effects on learning outcomes, this does not necessarily impact positively on teachers' content knowledge. This finding calls to mind the tongue-in-cheek definition of a lecture as a process in which the notes of the lecturer pass into the notes of the students without passing through the minds of

either. An obvious conclusion follows from the MCC research: if teacher content knowledge is to be improved, it requires explicit attention. Porteus concludes that: "The next horizon of teaching and learning improvement is likely dependent on improving teachers' meaning making in mathematics" (p. 82), and in future, classroom materials should be designed so as to "… serve learner conceptual progression, as well as teachers' instructional meaning making' (p. 82; emphasis in the original). This raises the question: how can language be used to support teachers (and learners) to improve meaning-making in mathematics?

The second finding of the MMC research is that teachers themselves employ the same unit counting procedures to perform arithmetic operations that have been so widely observed among learners throughout the primary school, most notably by Schollar (2008) nearly 15 years ago. The point is that, if teachers do not adequately grasp the most fundamental mathematical issues themselves (and most notably the principle of cardinality), then neither monoglossic nor heteroglossic approaches to the use of language in classrooms will be of much use in conveying these concepts to their learners. Extensive reference is made to this phenomenon among learners in six of the 21 maths chapters in the OUP series. However, to date, there have been very few, if any, studies on the extent to which teachers themselves use unit counting measure to perform the four operations. The conceptual problem at the root of this phenomenon is a poor understanding of number – since numbers are the 'raw material' of mathematical operations and much mathematical work it is not surprising that mathematical outcomes remain below par. The problem of unit counting (as shown by Porteus and others) is not confined only to teachers but is still widely exhibited by learners across South Africa. The questions that can be asked is: what language issues are imbedded in the transition from unit counting to using the number structure for arithmetic? How can language be used as a tool to attend to this situation?

Unit counting practices among learners is accompanied by the widespread mathematical 'stunting' (Spaull et al, 2022) exhibited by a majority of the sample of over 3000 Grade 1 learners assessed in the EC and LP (Spaull et al, 2022). More specifically, only two-thirds of this sample exhibited Level II abilities in Fritz et al's (2020) 5-level conceptual framework. Of even greater concern is that 86% of these Grade 1 learners could not achieve Level III (Cardinality). From a language use point of view, we need to analyse what is needed by teachers and learners to overcome this 'stunting'. There is a rich mathematical terminology involved here, some should be well understood by teachers as the interpret and implement the curriculum. Level II indicates that, in addition to learners being able to count (Level I) they also understand the sequence of numbers (Ordinality): for example, the idea that 7 lies to the right of 5 on the number line. Achievement of the cardinal principle indicates an ability to understand the connection between quantity and number, including the understanding that quantities can be decomposed into smaller units. Learners do not need to use this complex mathematical terminology but they need to be able to apply the properties of number while they work with numbers or they will remain stuck at the level of unit counting.

It seems obvious that learners' use of sub-optimal methods derive from what they learn from their teachers, although few studies to date have investigated in detail the precise conceptual nature of teacher knowledge, or of the relationship between certain pedagogical routines in the classroom and the conceptual architecture of learners. Very few studies have systematically investigated the role of language in relation to any of these.

# 7 Understanding the challenges of language use in the South African multilingual context: ideologies at play

South African EGM is situated in an arena where language use and development are political (Clarkson, 2016; Mohohlwane, 2020; Phakeng, 2017). Historically poor achievement in mathematics has only slightly improved over the past 25 years and there is increasing pressure on teachers (and the Department of Education) to improve the situation. Covid has not made the situation any easier. The theoretical orientation of our review specifically drew on ideology because language ideologies may be creating tension that works against the meaningful learning and teaching of mathematics in the early grades.

Every day, teachers (and learners) use language in mathematics classes. The literature presents findings on different kinds of productive language use and the programmes being implemented have different ways of dealing with the multilingual context that bear evidence to the different theoretical positions in the literature (Sapire, 2021; Essien & Sapire, 2022). These can be understood in terms of ideologies – where a purist ideology favours monolingual (pure) languages use while a pluralist (heteroglossic) ideology would favour mixed language use (code-switching or translanguaging). What is most important, in the long run, is that language use should be harnessed to support the most effective learning of mathematics in EGM classes. This, as it can be seen from the review is under-researched and in addition to this, the review of programmes shows that there is insufficient engagement with the problems that confront teachers in relation to language use in the multilingual context. Clearly, there is work to be done.

Variations in language use should also be acknowledged and value in the variation needs to be exploited (or it needs to be understood where variation is not appropriate and why). The relationship between LoLT and actual languages spoken in classrooms needs to be honestly acknowledged, and issues that this relationship raises need to be researched more fully so that they can be addressed. Teachers' and learners' perceptions and experiences of language use need to be heard and built on, in the context of the teaching and learning of mathematics and pedagogy needs to drive best practice, not ideology.

# 8 Conclusion

Essien (2018) notes a paucity of research in three core areas: longitudinal research on the role of language in EGM; research on how teachers are and should be trained to teach mathematics in the early grades in multilingual settings; and quantitative studies on the role of language in the teaching and learning of mathematics in early grades in the three countries, South Africa being one of them. These issues are still pertinent in South Africa as the extant literature and the review of intervention programmes show us.

It follows from the preceding discussion that, while the optimal use of language is important in all topics and at all levels of mathematics education, the most important priority must be to understand how to mobilise language most effectively in, first, assisting teachers to achieve a flexible understanding of the principle of cardinality and other key concepts, and, second, to equip them to facilitate the achievement of these conceptual step by their learners. Each of these tasks represents a significant challenge, and are most likely to be achieved during the initial education of teachers, given that much more time is available when compared with the limited time that can be spent on training with in-service teachers, and the fact that students fresh from school are more amenable to new ideas than their older counterparts. Nevertheless, given the poor state of both conceptual and pedagogical

knowledge held by practising teachers, in-service interventions should continue to explore this terrain, while research on these initiatives needs to be more sharply focused on the role of language in facilitating or inhibiting learning early number concepts.

Heteroglossic perspectives advocate for flexibility in the use of language. But flexibility (as opposed to rigidity) is a double-edged sword: on the one hand, it can mean, 'do whatever you like in term of language use'. But to be able to do 'whatever one likes' in a way that promotes meaning making around the mathematical concept at hand, one needs to have a good understanding of the discourse practices associated with the content. Consider the practice of translanguaging for example: what makes for a good 'translanguaging practice? Or Code switching: what makes for a good code-switching practice? This evokes the need for content-specific language responsive teaching practices in the mathematics multilingual classrooms. This is where, in our opinion, research and developmental work need to focus going forward. Doing this will help answer the key question we posed at the beginning regarding 'best practice' for language use in multilingual EGM South African classrooms.

Finally, what the corpus of literature does not tell us is how learners where a monoglossic perspective was used faired compared to those where the teachers espoused the heteroglossic perspective. Such research can be dovetailed with the language responsive teaching practices that are content specific.

# 9 Recommendations

Finally we address our fourth research question, drawing on the literature that has been presented and the lessons learned from programme implementation in the multilingual context. We had formulated the research question as follows: What recommendations for policy makers, donors, and implementing organisations can be made (based on the literature and early grade interventions programmes) to inform (with a focus on language) curriculum development, pedagogy and teacher education?

International trends in language and multilingual issues in the teaching and learning of mathematics are shifting to language-responsive teaching of mathematics (Erath & Prediger, 2021; Erath et al., 2021; Essien, Chitera, & Planas, 2016; Prediger, 2019; Prediger & Neugebauer 2021), which advocates for the development of the necessary knowledge and practices needed for the integration of 'mathematics [content] and language learning in a mathematics-specific way' (Prediger, 2019, p. 368). Such research, which draws on the heteroglossic perspective to language, will entail, among others, empirical research that takes into account both the communicative and the epistemic functions of language as tools for thinking and knowledge acquisition (Prediger, 2019). We recommend that this content-specific language responsive teaching and learning be carried out at different levels, viz, in pre-service teacher and at in-service teacher levels.

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