Mother Tongue-Based Bilingual Education in South Africa: An Analysis of Vocabulary Adaptation in Grade 4 Mathematics Workbooks

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DECLARATION

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DEDICATION

With a heart full of gratitude, I dedicate this dissertation to my circle of strength, Ba ga Malemela pebe ya tswako. Ba ga sidingwana sa Batau. Ba ga Mma Selemela. Ba morita moroba kalala. Ba segata ka boya.

To the loving memory of my late father, Johannes Masilo Malemela whose influence continues to shape everything I do.

To my mother, Magalane Anna Malemela, Tlou ya Mamphela. If this dissertation tells any story, it is the story of your sacrifices and prayers. Thank you for carrying me in ways no words can fully capture and for always reminding me of the heights I could reach. Everything I am and everything I will become is because of your sacrifices. Ke leboga go menagane.

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This work is a reflection of the love, guidance, and sacrifices of my family**.**

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ABSTRACT

This study investigates the adaptation of mathematical vocabulary in the Grade 4 Mother Tongue-Based Bilingual Education (MTBBE) workbooks for isiXhosa and Sesotho in South Africa. As the Department of Basic Education extends home language instruction beyond Grade 3, there is limited evidence on whether translated materials support conceptual understanding in Mathematics, a subject that relies heavily on specialised terminology. The study examines how mathematical terms are presented in the workbooks, their accessibility to learners, and their role in developing isiXhosa and Sesotho as academic languages.

A mixed-methods approach was used. A corpus-based analysis using R software examined the frequency, distribution, and contextual use of mathematical terms across the English, isiXhosa, and Sesotho workbooks. This was complemented by a qualitative analysis of selected terms focusing on their linguistic structure, meaning, and adaptation strategies.

The findings reveal that most mathematical terms in the isiXhosa and Sesotho workbooks are borrowed from English and adapted mainly through phonological and orthographic changes. While this localises the terms, it may not necessarily enhance comprehension. Many adapted terms are lengthy or unfamiliar, which may pose difficulties for Grade 4 learners in developing literacy skills. Only a limited number of terms are created from isiXhosa and Sesotho internal resources, resulting in a strong reliance on borrowing rather than on the development of conceptual terminology.

Although isiXhosa and Sesotho differ in their grammatical and phonological systems, both languages display similar borrowing patterns. These patterns raise concerns about the extent to which current adaptation practices support the long-term intellectualisation of African languages. The study concludes that while MTBBE workbooks improve access to learning materials in African languages, greater attention is needed to develop clear, consistent, and meaningful mathematical terminology. The findings highlight the need for

coordinated terminology development and improved translation strategies to support both comprehension and language development in Mathematics education.

SUMMARY

This study analysed how mathematical vocabulary is adapted in the Grade 4 isiXhosa and Sesotho workbooks developed for the Eastern Cape Mother Tongue-Based Bilingual Education (MTBBE). Guided by the aims of identifying terms that may challenge learners, evaluating whether linguistic choices support language development, and examining strengths and weaknesses in adaptation practices, the study compared the isiXhosa and Sesotho workbooks with the English source text. The study adopted a mixed-methods approach, combining corpus-driven frequency analysis in R with in-depth qualitative interpretation, through which the dominant adaptation strategies were systematically identified. The findings show that in both the isiXhosa and Sesotho workbooks, most mathematical terms are English borrowings that have been adapted primarily through phonological and orthographic modifications. Overall, the study highlights both the value of MTBBE materials and the need for deliberate terminology development to strengthen isiXhosa and Sesotho as languages of teaching and learning in Mathematics.

Key terms: Mother Tongue Based Bilingual Education (MTBBE), Vocabulary adaptation, Workbook analysis, Mathematics, Terminology, African languages, Intellectualisation, Learner comprehension, Sesotho, isiXhosa, Grade 4

LIST OF ACRONYMS

CAPS	Curriculum Assessment Policy Statement
DBE	Department of Basic Education
ECDoE	Eastern Cape Department of Education
IIAL	The Incremental Introduction of African Languages
KWIC	Key Word in Context
LiEP	Language in Education Policy
LoLT	Language of Learning and Teaching
MTBBE	Mother Tongue-based Bilingual Education
PanSALB	Pan South African Language Board
PIRLS	Progress in International Reading Literacy Study
SACMEQ	Southern and Eastern Africa Consortium for Monitoring Educational Quality

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CHAPTER 1: INTRODUCTION

1.1 Background of the Study

Studies consistently reveal that the majority of Grade 4 learners in South Africa from language groups other than English and Afrikaans struggle to read for meaning (Department of Basic Education, 2023a) International studies such as the Progress in International Reading Literacy Study (PIRLS) highlight the literacy challenges faced by South African learners. Spaull (2023) reports that the PIRLS 2021 results revealed that 81% of Grade 4 learners in South Africa cannot read for meaning in any language. He adds that this shows a decline in literacy progress, undoing the improvements from the previous cycles where the percentage of learners unable to read for meaning dropped from 87% in 2006 to 82% in 2011 and 78% in 2016. Notably, English and Afrikaans schools did not experience a decline in reading proficiency between 2016 and 2021.

The inequalities highlighted in the PIRLS results are closely tied to South Africa's current Language in Education Policy (LiEP) (Department of Education, 1997), which states that English becomes the Language of Teaching and Learning (LoLT) from Grade 4 onwards, following an initial period of instruction in learners' home languages in Grades R-3. In South Africa, the LoLT may be any of the eleven official languages, as well as other languages approved by the Pan South African Language Board. It may also include Braille and South African Sign Language (SASL), both of which are recognised for use in the education system (Saphire and Roberts, 2023). In practice, English and Afrikaans have historically been the dominant languages of learning and teaching in South Africa. While policy permits the use of all official languages, the Department of Basic Education has acknowledged the need to expand the use of African languages as LoLTs through initiatives such as the Eastern Cape Mother Tongue Bilingual Education Pilot Project (Motshekga, 2023).

To address the learning gap that often arises when learners transition from home language instruction in Grades R–3 to English in Grade 4, the South African Department of Basic Education introduced Mother Tongue-Based

Bilingual Education (MTBBE) in 2025, marking the official start of its incremental implementation from Grade 4 upwards. MTBBE is an educational approach in which learners are taught primarily through their home language. In the South African context, MTBBE extends the use of the home language as the LoLT beyond Grade 3, particularly in subjects such as Mathematics, to improve comprehension and address learning barriers associated with early transition to English (Department of Basic Education, 2024c). The implementation of MTBBE in South Africa aims to improve comprehension, develop African languages with sufficient educational resources, and promote social cohesion by celebrating linguistic diversity and unity (Department of Basic Education, 2024c).

Since 2010, there has been a substantial migration of South African learners from Mathematics to Mathematical Literacy, indicating a growing preference for Mathematics literacy over core Mathematics (Mhlolo, 2025). This trend is further reflected in learners' performance, as Mhlolo (2025, p. 5) notes that "the percentage of learners who passed at the 50% level (2008–2022) has never been higher than 30%, while the highest percentage of learners who passed at the distinction level in this period was 4.3%." In response to these persistent challenges, and as part of broader efforts to improve Mathematics teaching and learning, learner workbooks were adapted into Sesotho and isiXhosa to support learners' understanding of mathematical concepts through their indigenous South African languages, thereby advancing the objectives of MTBBE (Mbude, 2019).

This study explores how vocabulary items in MTBBE isiXhosa and Sesotho Grade 4 Mathematics workbooks have been adapted, focusing on the linguistic choices and strategies used when the target languages lack a direct equivalent for English mathematical terminology. By analysing these adaptations, the study aims to better understand the role and effectiveness of the workbooks as a language learning resource of MTBBE. Specifically, the study identifies vocabulary items that may pose comprehensibility challenges for Sesotho and isiXhosa learners.

The findings provide a basis for evaluating whether the linguistic choices support the language development goals of MTBBE. Additionally, the study will identify strengths and weaknesses in vocabulary adaptation to enhance educational resources for South African learners and support the intellectualisation of African languages in education.

1.2 Research Problem

This study examines the adaptation of mathematical terms in the Grade 4 isiXhosa and Sesotho workbooks developed for MTBBE in South Africa. The limited availability of mathematical vocabulary in these languages poses a challenge to learners' full comprehension of mathematical concepts in their mother tongue, which is a key goal of the MTBBE approach. Addressing this challenge is important as it directly affects learners' ability to read for meaning and succeed academically, especially given South Africa's ongoing literacy crisis (Spaull, 2023).

The limited availability of mathematical vocabulary in isiXhosa and Sesotho highlights broader issues related to the development and intellectualisation of African languages as mediums of instruction. By analysing the linguistic adaptations in these workbooks, this research will examine the strategies used to support the objectives of MTBBE.

Existing studies have explored mother tongue education, language policy, and terminology development in African languages, they have largely focused on theoretical, pedagogical, and policy-level discussions (Mbude, 2019; Mostert, 2020; Makalela, 2022; Essien, Sapire, & Taylor, 2023). There is limited research that provides a detailed, corpus-based analysis of how mathematical vocabulary is actually adapted in classroom materials, particularly in isiXhosa and Sesotho. Furthermore, previous studies have not systematically examined how English-derived terms are linguistically integrated into these languages within specific subjects such as Mathematics at the primary school level. This study addresses this gap by analysing vocabulary adaptation patterns in Grade

4 MTBBE Mathematics workbooks using corpus-based methods. The findings aim to give insights into effective vocabulary development for South African languages and ultimately contribute to better educational resources and the intellectualisation of African languages in education.

1.3 Aims of the Study

The study aims to examine the adaptation of mathematical vocabulary in the MTBBE Grade 4 isiXhosa and Sesotho Mathematics workbooks by:

1. identifying mathematical vocabulary items that may present comprehension challenges for Grade 4 learners;
2. comparing the approaches to vocabulary adaptation used in the isiXhosa and Sesotho workbooks to identify similarities and differences;
3. evaluating the extent to which the linguistic choices used in the workbooks support the promotion and development of isiXhosa and Sesotho as languages of learning and teaching; and
4. identifying strengths and weaknesses in the vocabulary adaptation strategies to inform the development of future MTBBE educational resources and contribute to the intellectualisation of African languages.

1.4 Research Questions

1. a. How have mathematical vocabulary items been adapted in the MTBBE Grade 4 Mathematics workbooks for isiXhosa and Sesotho?

b. Which specific mathematical vocabulary items in the isiXhosa and Sesotho workbooks may pose comprehension challenges for Grade 4 learners, and why?

2. What are the similarities and differences in the approaches to vocabulary adaptation within the isiXhosa and Sesotho workbooks?
3. To what extent do the linguistic choices in the vocabulary adaptation of the workbooks support the promotion and development of isiXhosa and Sesotho?
4. What insights can be gained from the adaptation of vocabulary in the isiXhosa and Sesotho workbooks, and how can these inform the development of future MTBBE materials?

1.5 Envisaged Areas of Contribution

The significance of this study lies in its contribution to the body of research on isiXhosa and Sesotho as languages of learning, particularly within specialised subjects such as Mathematics. By examining how mathematical vocabulary is adapted in MTBBE workbooks, the study offers insights that can help address long-standing linguistic gaps in African languages, especially at a time when South Africa is moving toward broader bilingual education.

The findings may provide evidence that could assist the Department of Basic Education and policymakers in refining the MTBBE model, especially by identifying weaknesses in how mathematical concepts are currently adapted into isiXhosa and Sesotho. These insights can inform the development of learning materials that are more linguistically appropriate and accessible for learners. In addition, the study highlights areas where teachers require support, such as strategies for introducing, explaining, and reinforcing complex mathematical terms, which could strengthen teacher training programmes.

Ultimately, this research contributes to the intellectualisation of African languages by demonstrating the need for deliberate terminology development and by advocating for the use of indigenous languages as credible and effective mediums of teaching and learning.

1.6 Overview of the Structure of the Dissertation

This dissertation is organised into five chapters. The above introductory chapter provided the background and context of the study, focusing on the role of language in Mathematics education and the implementation of MTBBE in South Africa. It outlined the problem of limited development of mathematical terminology in African languages, particularly Sesotho and isiXhosa, where reliance on adapted English vocabulary remains prevalent. The chapter further presents the research aims, objectives, and key research questions guiding the study. In addition, the significance of the study is discussed, highlighting its contribution to African language development. The scope of the study is also

addressed. Overall, this chapter establishes the foundation of the research problem and justifies the need for the study.

Chapter 2 critically examined existing literature on language use in Mathematics education, with particular emphasis on MTBBE, vocabulary development in African languages. It also explored theoretical perspectives on the relationship between language and conceptual understanding in Mathematics, as well as the challenges associated with translation and adaptation practices. The chapter identified a critical gap in the literature, namely the over-reliance on vocabulary adaptation rather than the deliberate development and intellectualisation of African languages.

Chapter 3 outlined the research design and methodological approach adopted in the study. It described the selection of Grade 4 Mathematics workbooks in Sesotho, isiXhosa, and English as the primary data sources. The chapter detailed the research approach and design, followed by an explanation of the procedures for data collection and analytical techniques employed, including the use of R software to examine patterns of vocabulary usage and adaptation.

Chapter 4 presented the findings of the study, focusing on patterns of vocabulary usage across the selected Mathematics workbooks in Sesotho and isiXhosa. The analysis examined the extent to which translation, borrowing, and adapted terms are employed, with results systematically presented through tables, graphs, and statistical outputs generated in R. The findings revealed a clear dominance of vocabulary adaptation and highlighted predominant use of mathematically vocabulary that has been adapted from English through phonological and orthographic modification. At the same time, the results showed significant gaps in the development and standardisation of mathematical terminology in African languages. A key argument in this chapter is that while MTBBE workbooks improve access to learning materials in African languages, there is a need for coordinated terminology development and improved translation strategies to support both comprehension and language development in Mathematics education.

Chapter 5 concluded the study by synthesising the key findings, contributions, limitations, and implications for practice and further research.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The role of language in education is important in shaping learning outcomes, particularly in multilingual societies like South Africa where learners experience a gap disconnect between the language they speak at home and the Language of Learning and Teaching (LoLT) used at school. As the country continues to navigate its rich linguistic diversity, increasing attention has been directed toward implementing language policies that prioritise the use of learners' mother tongues in education. The transition towards MTBBE marks a crucial step in the transformation of South Africa's education system, as it seeks to bridge the gap between learners' home languages and the official language of instruction. Reflecting on this policy shift, August-Mowers (2025) describes the MTBBE rollout as a long-awaited milestone in multilingual education with the potential to advance decolonial educational goals. This shift is further supported by evidence showing that the early transition to English as the LoLT in Grade 4 contributes to significant comprehension challenges, as many learners have not yet developed sufficient proficiency in English to access the curriculum effectively (Okoye, 2012; Mbude, 2019; Fesi and Mncube, 2021; Spaull, 2023; Department of Basic Education, 2024d). This is further evidenced by findings from the Progress in International Reading Literacy Study (PIRLS) and the Trends in International Mathematics and Science Study (TIMSS), which showed that learners who were taught and assessed in a language they spoke at home achieved higher scores than those who learned through a different language (Van Staden, Bosker & Bergbauer, 2016).

Figure 1 below illustrates the relationship between learners' exposure to the LoLT at home and their academic performance. It shows that more frequent exposure to the LoLT at home is generally associated with higher Mathematics scores. UNESCO (2003, p. 14) notes, "It is an obvious yet not generally recognised truism that learning in a language which is not one's own provides a double set of challenges, not only is there the challenge of learning a new language but also that of learning new knowledge contained in that language."

This underscores the critical role that language plays in learning, as learners who are taught in English, particularly those whose home languages are African languages, may face additional linguistic barriers that affect their academic achievement. Recognition of these barriers has been a key motivation for South Africa's shift towards MTBBE.

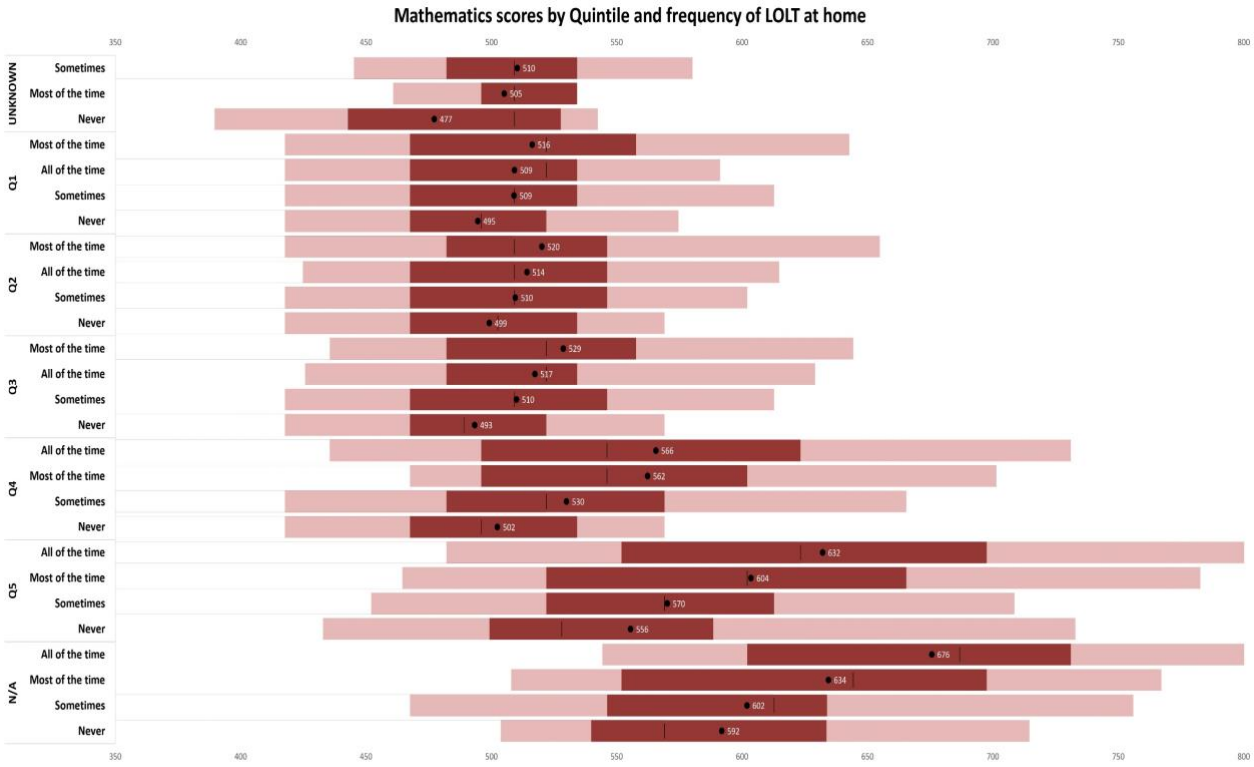


Figure 1: TIMMS Mathematics scores by Quintile and frequency of LOLT at home (DBE,2024a)

The literature review highlights key debates in the field, including the role of language in cognitive development, the linguistic challenges faced by learners in multilingual contexts, and the effectiveness of MTBBE in improving educational outcomes. It also traces the historical development of language policies in South Africa, focusing on the shift towards MTBBE, and examines the linguistic barriers learners encounter in subjects such as Mathematics. The review further explores the intellectualisation of indigenous languages and global trends in mother tongue education. Importantly, it identifies gaps in existing research, particularly the lack of studies comparing how mathematical terminology is translated in isiXhosa and Sesotho workbooks, and how such translations, especially those involving English lexical borrowing, may affect learner comprehension.

Structured into several key sections, the literature review situates MTBBE within the linguistic and policy context of South Africa. It begins by tracing how historical and contemporary language policies have shaped the status of African languages in education. The review then examines the Language in Education Policy (LiEP) (Department of Basic Education, 1997) and the national shift toward extending home-language instruction, drawing on evidence from local and international assessments to show why this transition is necessary. It further explores the linguistic and cognitive demands of learning Mathematics in African languages, highlighting gaps in terminology and structural challenges that affect learners' comprehension. This is followed by a discussion of the intellectualisation of isiXhosa and Sesotho, emphasising the importance of corpus planning, terminology development, and standardisation for these languages to function effectively as academic mediums. Finally, the chapter concludes by outlining the theoretical frameworks that underpin the study.

2.2 History of Language Policies in South Africa

Language has played a central role in shaping South Africa's recent history and has influenced the education, governance, and social structures (MacFarlane, 2024). The country's language policies evolved through successive periods of colonial and political dominance, each reinforcing linguistic hierarchies that favoured certain languages over others. From the early Dutch settlement in 1652 to the British occupation and missionary activity, language was systematically used as a tool of control, marginalising indigenous languages while privileging European ones (Makalela, 2015). These historical patterns created lasting effects on language use that continue to affect the education system, especially for learners whose first language is an African language.

From the Dutch settlement onward, language functioned as a mechanism of control. Dutch, and later English, became the languages of administration, schooling, and social status, while indigenous languages were marginalised. These colonial practices created lasting linguistic inequalities that continue to shape South African education (Makalela, 2015). Nineteenth-century missionary activity introduced literacy in African languages, but it remained

framed within colonial priorities and did not establish them as fully developed academic languages (Makalela, 2015). As a result, African languages entered formal schooling in a structurally disadvantaged position.

By 1910, this hierarchy was well established, with only English and Dutch recognised as official languages. The replacement of Dutch with Afrikaans in 1925 politicised language policy further, aligning it with Afrikaner nationalism. Under apartheid, English and Afrikaans were privileged, while African languages were confined to subordinate roles (Makalela, 2015). Within Bantu Education, learners could use their home languages only in early grades before transitioning to English or Afrikaans. This model limited academic development in African languages and constrained access to higher-order cognitive engagement (MacFarlane, 2003). The 1976 Soweto Uprising highlighted the political stakes of language policy, as students rejected Afrikaans not just as a medium of instruction but as a symbol of linguistic domination (Makalela, 2015). Together, these patterns show that language has long functioned as a tool of power rather than a neutral medium, and the legacy of this inequality remains evident in South African classrooms today.

2.3 The Constitution and Language Rights

The democratic transition in 1994 ushered in a new era of linguistic inclusivity. The 1996 Constitution recognised eleven official languages: Sepedi, Sesotho, Setswana, siSwati, Tshivenda, Xitsonga, Afrikaans, English, isiNdebele, isiXhosa and isiZulu, and mandated that the government promote historically marginalised languages (Chapter 1, Section 6). Section 29(2) further guarantees the right to receive education in the language of one's choice where reasonably practicable (Republic of South Africa, 1996, Section 29). These provisions reflected a shift from linguistic domination to linguistic equity. However, as Nugraha (2019) and others observe, the practical realisation of multilingual education remains limited. English continues to dominate as the language of instruction and upward mobility, while African languages often remain confined to early schooling. The difference between what the

Constitution promises and what happens in classrooms shows the lasting effects of historical language inequalities.

Following the recognition of indigenous languages as official languages, Alexander (1998, pp.274–275) highlighted the following:

> Sociolinguists, lexicographers, terminologists, terminographers, translators, interpreters, and other language and educational specialists, together with enlightened political leadership, will have to concert their efforts in order to create the framework within which the harmonisation of the Nguni and Sotho language varieties respectively can take place. Any African 'renaissance' will be stillborn unless this process is initiated (pp. 274–275).

These words captured the scale of work needed to strengthen African languages so that they could fully function as languages of knowledge, learning, and intellectual engagement.

More than two decades later, Alexander's (1998) insight still holds. Although significant progress has been made in recognising African languages through policy, the challenges he described remain. Research continues to point to the lack of standardised terminology and limited linguistic resources in African languages (Mandende, Ramuedzisi & Huyssteen, 2019; Sapire & Roberts, 2023). Nearly three decades after the adoption of the LiEP in 1997, South Africa has entered a new phase of language-in-education reform through the phased implementation of the MTBBE programme.

Tshotsho (2013) argued that the South African government had not adequately provided the necessary human and physical resources to promote multilingualism. Furthermore, the status of languages such as English and Afrikaans remains higher than that of indigenous African languages as they continue to function as languages in education and economic activities. This discrepancy between policy and practice has persisted for decades, with African languages still not fully integrated into the schooling system and more especially in key subjects such as Mathematics.

Almost thirty years after the LiEP was introduced in 1997, South Africa is only now beginning to see the full rollout of the MTBBE programme. This delay highlights the slow pace at which language policy ideals are being translated into practice and the ongoing struggle to develop African languages as effective languages of teaching and learning. This delay, considering the current state of progress in terms of using African languages as languages of teaching and learning, shows that transforming language policy requires more than declarations; it requires efforts towards language development, standardised terminology and the creation of educational materials that reflect local contexts.

2.4 Language in Education: Policies and Frameworks

South Africa's constitutional commitment to linguistic diversity laid the foundation for a series of education policies that promote multilingualism and support mother tongue instruction. These policies seek to redress the historical marginalisation of African languages while improving learners' conceptual understanding and educational outcomes. The following section reviews the major policy developments that have informed the implementation of MTBBE in South Africa.

2.4.1 Language in Education Policy (LiEP) 1997

The LiEP of 1997 outlines a framework for promoting additive multilingualism, supports the development of all official languages, and seeks equitable access to education (Department of Basic Education,1997).

The key aims of the policy are to promote learners' home languages as the foundation for learning, develop previously marginalised indigenous languages, and facilitate the acquisition of additional languages for social, economic, and cultural purposes (Republic of South Africa, 1997).

While the LiEP set ambitious goals for promoting multilingual education, its implementation has been uneven, as mentioned in (Makalela, 2022). Within the South African education system, African languages are used as languages of teaching and learning in Grades 1–3, after which English or Afrikaans becomes

the dominant medium of teaching and learning. The Department of Basic Education (2023c) points out that the shift from using mother tongue in schools to English from Grade 4 onwards makes it a critical transition year in the South African school system. The Department of Basic Education (2023c, p.4) notes that learners whose home languages are African languages are suddenly expected to learn and engage with content in English, a language in which they may have limited proficiency, as the Grade 4 curriculum requires them to “read for meaning.” This widespread difficulty has been termed the “Grade 4 slump”, and it reflects learners’ struggle to understand and interact with English texts at a level that supports meaningful learning (Department of Basic Education, 2023c, p.4).

2.4.2 The role of the Pan South African Language Board (PanSALB)

The PanSALB plays a crucial role in advancing multilingualism and supporting the development of African languages. Established to give effect to the Constitution, PanSALB goes beyond preserving languages by facilitating language standardisation, developing terminology, conducting language research, and protecting language rights, thereby equipping schools and policymakers with the tools needed to integrate African languages effectively into teaching (Pan South African Language Board, 2018). Consistent with this mandate, PanSALB's vision is to serve as the custodian of multilingualism in promoting social cohesion in South Africa, while its mission includes promoting multilingualism, creating conditions for the development and use of all official languages, advancing previously marginalised languages, advocating for language rights, and initiating and conducting research to support language development and implementation (Pan South African Language Board, 2025).

2.4.3 Incremental Introduction of the African Languages (IIAL) Policy

The IIAL Policy builds on the Language in Education Policy (LiEP) and the language development initiatives of the PanSALB by addressing the relationship between language proficiency and learner achievement. The policy recognises that "poor learning outcomes in South Africa are to a great extent a result of poor language proficiency and utility" (Department of Basic Education,

2013, p. 5). It further notes that findings from the Annual National Assessments (ANA), Progress in International Reading Literacy Study (PIRLS), Trends in International Mathematics and Science Study (TIMSS), Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ), and the National Senior Certificate (NSC) examinations have consistently confirmed this relationship, providing a strong rationale for strengthening the teaching and learning of African languages. In response, the IIAL Policy seeks to strengthen African languages as both home and additional languages, expand access beyond English and Afrikaans, and advance the broader goals of multilingual education by improving learners' language proficiency and educational outcomes (Department of Basic Education, 2013).

2.4.4 South African National Literacy Strategy and Plan 2024–2030

The South African National Literacy Strategy and Plan 2024–2030 consolidates ongoing efforts to strengthen literacy in African languages by addressing the persistent literacy gaps experienced by learners whose home languages are African languages (Department of Basic Education, 2023c). The strategy recognises that many reading models, originally designed for English, do not adequately account for the structural and typological differences of African languages, which limits learners' ability to "read for meaning." To address this, the National Literacy Strategy and Plan outlines key principles that guide literacy development as follows:

- "Recognising the linguistic diversity and the unique position of South Africa as a multilingual society
- Valorising the duality of reading literacy as both a skill and a social practice at the same time
- Understanding African languages as typologically different languages with unique literacy predictions that are different from English and other Germanic language
- Encouraging intersections between English, Afrikaans and Indigenous African languages literacy is vital for cross-literacy transfer (multilingual orientation)." (Department of Basic Education, 2023c, p.9)

In practical terms, the Department of Basic Education emphasises positioning African languages as the foundation for reading literacy. This includes expanding the availability of reading materials in African languages, ensuring learners have access to libraries, and developing culturally relevant teaching and learning support materials that reflect South Africa's diverse linguistic and cultural heritage (Department of Basic Education, 2023c).

2.4.5 Curriculum and Assessment Policy Statement (CAPS) for Mathematics

The Department of Basic Education's Curriculum and Assessment Policy Statement (CAPS) for Mathematics provides the official framework guiding the teaching and learning of Mathematics in South African schools (Department of Basic Education, 2011). CAPS emphasises that Mathematics education should develop learners' ability to think critically and to apply mathematical knowledge meaningfully in a range of contexts, including economic, environmental, and everyday situations (Department of Basic Education, 2011). Central to this aim is the accurate understanding and use of mathematical terminology, number vocabulary, symbols, and procedures, as learners are expected not only to perform calculations but also to interpret and apply mathematical concepts in problem-solving situations.

Within this context, MTBBE is intended to support learners by ensuring that mathematical concepts are introduced through a language they understand well. Mathematics involves more than just doing sums correctly; it requires that learners develop a clear understanding of concepts. Given the cognitive demands of Mathematics, the use of the home language should enable learners to understand concepts more clearly and to synthesise information across tasks. Effective MTBBE implementation depends on the use of mathematical terminology that is clear, familiar, and conceptually meaningful. Without careful language adaptation, MTBBE cannot fully support learners' understanding or improve success in Mathematics.

The Grade 4 Mathematics curriculum is organised into five main content areas: Numbers, Operations and Relationships; Patterns, Functions and Algebra; Geometry; Measurement; and Data Handling. Among these, Numbers, Operations and Relationships receive the greatest weighting, reflecting their foundational role in establishing numeracy and supporting later mathematical learning (The Department of Basic Education, 2011). Successful engagement with these content areas relies heavily on learners' comprehension of specialised mathematical vocabulary, as conceptual understanding in Mathematics is closely tied to language proficiency (The Department of Education, 2024c).

2.4.6 Synthesis of the Policies and Frameworks

The post-apartheid constitutional commitments to language diversity laid the foundation for a series of education policies and frameworks aimed at redressing these inequalities and promoting multilingualism. Policies such as LiEP, the establishment of PanSALB, the IIAL and the National Literacy Strategy and Plan 2024–2030 collectively work to position African languages as foundational for learning, to ensure access to linguistically and culturally appropriate resources, and to support learners through mother tongue instruction. While the LiEP policy is progressive on paper, as Makalela (2022) observes, the reality in classrooms tells a different story. The structure of language use in schools remains largely dominated by English and Afrikaans, despite the South African Constitution's advocacy for multilingualism. Makalela (2022) highlights this as a continuing irony, where learners are taught in their home languages only until Grade 3, after which English becomes the primary language of learning and teaching from Grade 4 onwards. He notes that there have been very few genuine attempts to extend mother tongue education beyond Grade 3. Furthermore, Makalela (2022, p.7) argues that the current system "sets African language-speaking learners up for failure", as they are expected to learn in languages that are not their own. He contends that this linguistic structure perpetuates inequality and reproduces "an unjust and inequitable society that mirrors the new forms of colonial and apartheid periods" (Makalela, 2022, p.7).

2.5 MTBBE in South Africa: Obstacles and Opportunities

2.5.1 Teacher preparation and language of instruction

Despite the policy commitments to mother tongue education in South Africa, challenges remain in translating these objectives into classroom practice. One of the obstacles includes inadequate teacher preparation which undermines the realisation of multilingual education and threatens the success of initiatives aimed at promoting mother tongue education. Without adequate investment in training teachers who are competent in African languages, the system risks perpetuating English-dominant instruction, which contradicts the very goals of MTBBE to strengthen conceptual understanding through learners' home languages. Ntaka and Gustafsson (2024) highlight the shortage of teachers trained to instruct in African languages as a key challenge for multilingual education. Maepa, Linden, Blose and Moretsi (2024) mention that the popularisation of African languages remains limited due to the scarcity of research published in these languages and the historical restriction of mother tongue instruction beyond Grade 3. The planned rollout of the MTBBE programme is intended to support the popularisation and development of African languages by increasing their use in schools and fostering their practical development (Maepa et al., 2024). Guzula (as cited in University of Cape Town, 2025) further reinforced this view by emphasising that teacher training initiatives must be created in such a way that they match with the languages of instruction. However, while Afrikaans and English-speaking teachers are trained to teach literacy in their respective languages, teachers responsible for literacy instruction in indigenous African languages continue to receive their professional training predominantly in English (Guzula,as cited in University of Cape Town, 2025). Ntaka and Gustafsson (2024) and Guzula (as cited in University of Cape Town, 2025) highlight, while the demand for Foundation Phase teachers proficient in African languages is high, most teacher training programmes are delivered in English, and that leaves African language educators less equipped to deliver instruction to learners in their own languages. This misalignment between teacher preparation and language policy undermines the goals of MTBBE and perpetuates English-dominant instruction.

2.5.2 Teaching and learning materials, terminology and language development

Ngubane and Ngwenya (2025) emphasise that the limited availability of teaching and learning materials in African languages, particularly in technical and scientific subjects, continues to hinder the effectiveness of bilingual education. These challenges reveal that while MTBBE has commendable intentions, achieving its full potential requires addressing deeper systemic gaps related to teacher training, material development, and linguistic policy alignment

Mandende, Ramuedzisi and Huyssteen (2019) further emphasise that when South African languages were elevated to official status in the post-apartheid era, a significant responsibility was created to develop robust terminology. Such development is essential to enable these languages to function effectively in education and in the broader system. Sapire and Roberts (2023) further highlight a persistent challenge in South African Mathematics education: much of the mathematical terminology used in schools has not yet been officially standardised by PanSALB across all 12 official languages. This process of terminology standardisation is still ongoing, but the authors suggest that, in the interim, adopting a flexible approach to language use in the Foundation Phase could enhance learners' understanding of mathematical concepts. By allowing teachers to incorporate multiple languages strategically, learners can build stronger foundational skills in Mathematics, facilitating smoother transitions to higher grades and supporting long-term conceptual development (Sapire & Roberts, 2023).

Moreover, the lack of standardised terminology, especially in technical subjects like Mathematics, poses a significant challenge. PanSALB's efforts to develop national term banks and support terminology standardisation are commendable, yet progress remains slow. As Sapire and Roberts (2023) note, mathematical terminology in African languages is still being developed, and in the absence of standardised terms, educators often resort to code-switching or

borrowing from English, which can confuse learners and hinder conceptual understanding.

2.5.3 Policy implementation and structural barriers

Ngubane and Ngwenya (2025) argue that although MTBBE is grounded in strong educational principles and aims to promote inclusive learning, its implementation is constrained by a range of structural, linguistic, and practical challenges. They note that South Africa's multilingual reality makes it difficult to select a single language of learning and teaching without marginalising others, especially given that many learners come from households where multiple languages are spoken. This complexity, they suggest, raises important questions about language identity and equity in the classroom.

While the post-apartheid Constitution and subsequent policies such as the LiEP, the IIAL, and the National Literacy Strategy and Plan (2024–2030) reflect a commitment to multilingualism and linguistic equity, their practical enactment has been slow and marked by inconsistencies. Historically, language has been used as a tool of exclusion and control, with colonial and apartheid regimes favouring European languages while marginalising African ones. This legacy continues to shape educational outcomes as African languages remain underdeveloped in terms of standardised terminology, orthographies, and academic resources. Despite constitutional recognition of 12 official languages, English and Afrikaans continue to dominate as languages of instruction, particularly beyond Grade 3, reinforcing linguistic hierarchies that disadvantage African language speaking learners.

2.5.4 Societal attitudes

Societal attitudes also complicate the implementation of MTBBE. Many parents and educators continue to associate English with socioeconomic mobility and academic success, viewing African languages as less capable of conveying complex or scientific knowledge. This perception, rooted in historical inequalities, contributes to resistance against mother tongue instruction and limits the prestige of indigenous languages in educational settings.

Despite these challenges, the theoretical foundations of MTBBE affirm that a strong foundation in the mother tongue enhances cognitive development and facilitates the acquisition of additional languages, thereby supporting academic achievement. Policy intentions, resource limitations, societal perceptions, and historical legacies make the implementation of MTBBE in South Africa a complex and multifaceted endeavour. While the policy direction is promising, its success hinges on systemic reforms in teacher training, resource development, and public attitudes toward African languages.

2.6 Advancing Multilingual Education: The Shift Towards Mother Tongue-Based Bilingual Education (MTBBE)

In response to ongoing calls for stronger support of mother tongue instruction from language experts, former Minister of Basic Education, Angie Motshekga, in 2024 announced a significant shift towards the national implementation of the MTBBE initiative, which then began in 2025. The phased rollout began with Grade 4 learners in subjects such as Mathematics, Natural Science, and Technology, and is gradually expanding to cover the entire primary school curriculum by 2028 (Department of Basic Education, 2024c).

The MTBBE rollout represents a decisive step by the Department of Basic Education to translate longstanding language policies into tangible practice. While South Africa has had progressive policies and frameworks in place, these policies largely set the vision for multilingual education without fully ensuring consistent implementation in classrooms. Many of the challenges they sought to address, such as the marginalisation of African languages beyond the early grades and the lack of teacher preparedness, persisted over the years. By committing to a phased national rollout of MTBBE beginning in Grade 4, the Department is now actively enforcing the principles outlined in these policies, providing learners with structured support in their mother tongue while gradually introducing additional languages. According to Chumbow (2013), the mother tongue educational approach promotes the continued development of learners' first languages while progressively introducing a second language. This understanding aligns with the broader principles of mother tongue-based

education advocated by Benson (2004) and UNESCO (2003), which emphasise the importance of establishing strong literacy and conceptual foundations in the home language before learners' transition to learning through an additional language.

The MTBBE programme was piloted in the Eastern Cape Department of Education (ECDoE) from 2011 to 2020 in the Cofimvaba district, and it provides concrete evidence of the benefits of home-language instruction. Initially implemented in 72 primary schools and later expanded to 12 additional districts by 2018 (Mbude, 2019), the pilot aimed to improve educational outcomes, particularly in Mathematics and Science, and to provide empirical evidence that mother tongue instruction contributes to stronger academic performance. Mbude's (2019) investigated the mother tongue-based bilingual education mathematics pilot and her findings showed that the use of isiXhosa and Sesotho, languages familiar to both teachers and learners, provides a strong foundation for teaching and learning.

2.6.1 The Global Landscape of Mother Tongue Education

Across the world, countries have adopted various forms of mother tongue education to align with their linguistic and cultural contexts. For example, South Asian countries have adopted a multilingual education (MLE) approach, integrating home languages into their educational systems.

A study by Perez (2019) examined MTB-MLE programmes in Southeast Asian countries, which were implemented in Malaysia, the Philippines, Singapore, Thailand, and Vietnam (Djite, 2011). In the Philippines, for instance, a well-structured framework ensures that MTB-MLE serves as the medium of instruction for all subjects from preschool to Grade 3. In Thailand and Vietnam, they implement MTB-MLE selectively, using it in specific areas and subjects.

In all five countries, there are supportive language policies in place to facilitate MTB-MLE implementation (Perez, 2019). Perez (2019) notes several best practices, with one key practice being active community involvement. This

approach encourages local communities to participate in the development of educational materials used in schools, allowing them to contribute to the creation of relevant terminology that reflects their linguistic and cultural context. Additionally, another best practice is a strong emphasis on elevating local languages and ensuring they are given high prestige within the education system. Dagalea et al. (2022) further emphasise that the successes and challenges of the MTB-MLE program programme require a realignment of strategies and goals to more effectively address the unique linguistic, economic, and cultural conditions of each community.

Across South Asian countries, several challenges have emerged in implementing MTB-MLE. One key issue is teacher training. While Singapore has a well-organised system that provides sufficient support for educators, other countries struggle with inadequate training, affecting the effective delivery of mother tongue education. Another challenge relates to language status in Malaysia, Thailand, and Vietnam, where some mother tongue languages lack written forms, diminishing their prestige compared to English and other official languages (Perez, 2019).

2.6.2 Mother Tongue Education in African Contexts

Magocha, Mutasa, and Rammala (2019), drawing on Bamgbose (2000), note that several African countries have implemented African languages as media of instruction at the primary school level. In countries such as Ghana, Nigeria, Kenya, Uganda, Zimbabwe, Malawi, Botswana, and Lesotho, African languages have been used as the medium of instruction during the early primary years. Other countries, including Tanzania, Somalia, Ethiopia, Eritrea, and Madagascar, have adopted full primary or late-exit models, in which African languages remain the medium of instruction throughout primary education. Nigeria has also implemented a late-exit approach through the Yoruba Pilot Project (Bamgbose, 2000, as cited in Magocha, Mutasa, & Rammala, 2019).
Evidence from these initiatives demonstrates the potential benefits of mother tongue-based education. For example, the Ife Six-Year Primary Project (Afolayan, 1984) and the Rivers Readers' Project (RRP) in Nigeria are widely

recognised as two of the most successful literacy programmes implemented through mother tongue instruction on the African continent. Building on these successes, several pilot initiatives have been introduced across Africa to promote the use of African languages as media of instruction in primary schools.

While some African countries have fully implemented mother tongue education, many others, including Ghana, are at least piloting or conducting research in this area. Despite the varying stages of implementation, studies consistently identify the language of instruction as a major barrier to learners' success in Mathematics. Karikari et al. (2022) conducted a study on the impact of using the mother tongue as the language of instruction in teaching Mathematics in rural primary schools in Ghana. Like many African nations, Ghana grapples with low Mathematics performance at all educational levels, which remains a significant concern. Karikari et al. (2022) state that Mathematics is a compulsory subject in Ghana, and learners must pass it to advance to the next grade. However, English is the sole medium of instruction, which presents a major challenge, especially in rural areas where learners lack proficiency in English. This creates an additional barrier to understanding mathematical concepts, further adding to the existing educational challenges in these communities. The study conducted in Ghana found that Mathematics achievement was significantly higher when lessons were taught in students' home language in rural upper primary classes. Based on these findings, the study recommended that the government allow teachers to instruct Mathematics using the learners' mother tongue, gradually introducing English as the language of instruction at the Junior High School level in rural areas (Karikari et al., 2022).

Although the implementation of MTBBE has been advanced as a national policy imperative, its principles are also grounded in several educational and linguistic theories that emphasise the importance of mother tongue instruction in multilingual learning environments, as highlighted in the following sections.

2.7 Theoretical Foundations of MTBBE

This study is informed by several key theoretical perspectives on mother tongue education, including theories of academic language development, Benson's Mother Tongue Education Framework, and Cummins' Developmental Interdependence Hypothesis. Collectively, these theories emphasise the importance of establishing a strong foundation in learners' home languages to support critical thinking, language proficiency, and academic achievement (Benson, 2004; Cummins, 1979; Cummins, 1980).

2.7.1 BICS and CALP Framework

Cummins' framework (1980) examines the relationship between language proficiency and academic achievement for bilingual learners, and distinguishes between two types of proficiency: Basic Interpersonal Communication Skills (BICS) and Cognitive Academic Language Proficiency (CALP). BICS refers to the everyday language skills we use in social contexts. These skills are cognitively less demanding and develop more quickly and independently in both first languages and second languages. On the other hand, CALP involves more complex abstract tasks that are used in academic learning. These skills take longer to develop, and they rely on foundational proficiency in the primary language (Genesee, 2004). According to Cummins' framework (1980), learners need a strong foundation in their mother tongue to be able to develop CALP. A strong BICS foundation in one’s mother tongue not only supports the development of CALP in the mother tongue but also facilitates the transfer of academic language skills for second language learning. This theory argues that the development of a strong foundation in learners' mother tongue facilitates the transfer of Cognitive Academic Language Proficiency (CALP) to a second language, ultimately contributing to improved academic achievement.

2.7.2 Developmental Interdependence Hypothesis

Cummins's (1979) Developmental Interdependence Hypothesis suggests that proficiency in bilingual children's second language depends on the strength of their first language in terms of cognitive abilities such as reading, comprehension, and critical thinking. These skills can transfer and support the

learning of the second language. Furthermore, if a bilingual learner has a good foundation of vocabulary and concepts in their first language, they will likely achieve good competence in the second language without losing competence in their first language. The developmental interdependence theory suggests that bilingual children who have less developed skills in their first language may have limitations in their second language development because skills in the first language form a foundation for learning the second language. This theory is relevant to MTBBE as it highlights how building strong skills in the learners' mother tongue promotes cognitive and literacy development. By strengthening their first language, learners are better equipped to acquire and use skills in the second language.

2.7.3 Benson's Mother Tongue Education Framework

Benson (2004) argues that the successful implementation of mother tongue education requires significant linguistic and material development to support the learner's academic progress in both their first and second languages, particularly when the learner's primary language will be used throughout their primary schooling, as is the case with MTBBE. Benson (2004) also mentions that investment in these materials is particularly crucial for languages that may lack established orthographies or standardised grammar, as is the case with isiXhosa and Sesotho, which are the focus of this research.

According to Cooper (1989), language planning is a fundamental component of successful mother tongue education. Drawing on Cooper's framework, Benson (2004) identifies three key processes necessary for effective language planning. The first is the harmonisation of dialects and language varieties to ensure linguistic consistency. The second is language standardisation through the development of orthographic and grammatical norms, enabling the production of clear and consistent educational materials. The third is intellectualisation, which involves expanding a language's vocabulary and expressive capacity so that it can communicate specialised academic concepts.

2.7 Structural Features of Sesotho, isiXhosa and English

To better understand the findings of this study, this section provides a brief overview of the linguistic features of Sesotho, isiXhosa and English that are relevant to the analysis. The discussion focuses on aspects of morphology and phonology because these are the linguistic features examined in the analysis of the workbooks.

Sesotho is an agglutinative language characterised by a highly productive morphological system. Central to this is the noun class system, where nouns are marked by prefixes indicating class and number. These prefixes govern agreement across sentence elements (verbs, adjectives, possessives, demonstratives) (Demuth, 1992). The Sesotho verbal structure further reflects morphological complexity, consisting of ordered morphemes such as subject markers, tense/aspect markers, optional object markers, the verb stem, and verbal extensions (e.g., causative, applicative, passive). This layered morphology facilitates semantic expansion within a single lexical item and influences how new terms are incorporated into the grammatical system (Demuth,1992). Syntactically, Sesotho follows a basic Subject–Verb–Object order but allows multiple alternative word orders due to its agreement system, which clearly marks grammatical roles (Demuth,1992). Phonologically, Sesotho exhibits a complex sound system that includes distinctive consonants, a range of vowel phonemes, and a tonal system that contrasts high and low tones to signal meaning (Demuth, 1992). Overall, the structure of Sesotho demonstrates a high level of grammatical sophistication, integrating morphology, syntax and phonology into a systematic and productive linguistic system.

isiXhosa is characterised by a rich interaction between morphology, syntax and semantics, particularly within the noun phrase (Visser, 2008). At the core of its grammatical structure is a noun class system in which nouns are marked by class prefixes, and these elements play a crucial role in agreement and interpretation. The noun phrase in isiXhosa is often analysed as a Determiner Phrase (DP), where the noun prefix functions as a determiner that contributes features such as specificity and definiteness (Visser, 2008). Agreement is

central to the structure of the language; subject and object agreement markers are encoded in the verb, and these markers interact with the noun phrase to signal grammatical relationships and interpretive features such as specificity (Visser, 2008). The presence or absence of an object agreement prefix in the verb, together with the presence or absence of the noun preprefix, determines whether a noun phrase is interpreted as specific or non-specific (Visser, 2008). Structurally, isiXhosa has a systematic morphosyntactic structure in which verbs encode grammatical information such as subject and object relations and tense, while noun phrases mark definiteness and specificity.

English is a structurally complex Indo-European language characterised by a systematic interaction between syntax, morphology, phonology and semantics. At its core, English grammar is concerned with the principles governing the formation of words, phrases, clauses and sentences (Huddleston, 2002). The structure of English is primarily divided into two main components: syntax, which deals with how words combine to form larger units such as phrases and sentences, and morphology, which concerns the internal structure and formation of words (Huddleston, 2002). Unlike agglutinative languages such as Sesotho and isiXhosa, English morphology is relatively less complex, relying more on word order and auxiliary elements than on extensive affixation to encode grammatical meaning.

Syntactically, English follows a relatively fixed Subject–Verb–Object (SVO) word order, which plays a crucial role in determining grammatical relationships, since the language has limited agreement marking compared to Bantu languages. English relies mainly on word order to show grammatical relationships, with a fixed structure where sentences are made up of smaller parts such as noun phrases and verb phrases (Huddleston, 2002). Morphologically, it uses limited markings, such as -s for plural and -ed for past tense, with word formation through prefixes and suffixes being relatively simple (Huddleston, 2002).

Overall, these structural differences highlight that while English relies more on word order and limited morphological marking, isiXhosa and Sesotho encode meaning within complex word forms, and this has important implications for understanding processes such as vocabulary adaptation, morphological integration and variation observed in the corpus.

2.8 Language and Learning in Mathematics

Despite growing recognition of the importance of mother tongue instruction for cognitive development and learning, significant challenges remain in fully implementing multilingual education, particularly in establishing African languages as languages of instruction in subjects such as Mathematics and Science. This has generated ongoing debates about the use of indigenous languages in academic contexts, particularly concerning the terminology used in Mathematics.

Essien, Sapire, and Taylor (2023) highlight a key observation from the Gauteng Primary Language and Mathematics Strategy (GPLMS) where isiXhosa teachers expressed a preference for using English as the Language of Learning and Teaching. They noted that the mathematical register in the materials provided was limited, because it is still underdeveloped in many African languages, with limited or unclear terminology that does not always effectively convey mathematical meaning and the translations into isiXhosa were significantly longer than the English ones. This points to the challenges faced by teachers in trying to use an African language when teaching Mathematics. These challenges further emphasise the need for strategies that address the use of indigenous languages in specialised subjects like Mathematics and Science.

The challenges associated with the development and use of mathematical terminology in African languages have also been explored in Mostert (2020) who examined the linguistic features of isiXhosa, particularly in relation to number names in early-grade Mathematics texts. Mostert (2020) identifies three key challenges in translating Mathematics from English to isiXhosa. First, direct translations often lack context, leading to misinterpretations of

mathematical concepts. Second, these translations result in inconsistencies in mathematical terminology, as isiXhosa, like many other African languages, has not yet fully developed a standardised mathematical register.

Mostert (2020, p.41) contextualises this issue by illustrating how language-based differences can affect mathematical understanding by using this example: in English, "3 × 4" is interpreted as "three groups of four" (4 + 4 + 4), while in isiXhosa, it is understood as "three repeated four times" (3 + 3 + 3 + 3). This highlights the lack of development in the mathematics register for African languages. Mostert (2020) further emphasises that when materials are translated from English into other official languages, the language differences are not considered, and it is often by translators who do not necessarily have the mathematical knowledge to make informed decisions about what would be the most pedagogically and conceptually useful translation.

A key issue highlighted by both Essien et al. (2023) and Mostert (2020) is that African languages have not been sufficiently developed for mathematics instruction. Mathematics materials are often initially produced in English and then translated, and this process fails to account for language-specific structures and the cognitive impact of translation choices on learners. This challenge is further explored by Nomlomo and Mbekwa (2013), who examined teacher and learner perceptions of using isiXhosa as a medium of instruction in Mathematics and Science in selected primary schools in the Western Cape. Their findings indicate that while learners engage more actively when taught in their home language, teachers face significant challenges due to the lack of direct terminological equivalents for key scientific and mathematical concepts in isiXhosa.

Another challenge is that some translated terms remain unfamiliar in everyday isiXhosa, which makes them difficult for learners to understand. For instance, matter is translated as *inkqunto* (meaning "actual thing"), a term that is seldom used in daily conversations. While this translation may be correct, it does not align with learners' intuitive understanding, often forcing teachers to rely on

borrowing English words or code-switching to help students grasp the concepts (Mostert, 2020).

Mandende et al. (2019) highlight a critical challenge in the development of terminology for South African languages. They note that multiple institutions often create terms independently, leading to a proliferation of terminology for the same or similar concepts, sometimes even within a single language. This lack of coordination creates inconsistencies that impede the broader development of African languages as academic and instructional tools. According to Mandende et al. (2019), the National Language Service (NLS) is tasked with coordinating and managing terminology development nationwide, while PanSALB is responsible for overseeing and authenticating official terminology lists. However, duplicated terms remain a persistent issue. The authors argue that establishing a centralised model for terminology management where all existing terms are consolidated and regulated to prevent duplication would ensure consistency and strengthen the development of African languages as effective languages of teaching and learning.

The key takeaway from this section is the urgent need for the intentional development of African languages in education. The current state of the mathematics register in isiXhosa and other African languages highlights significant gaps that require further attention. These findings are directly relevant to the present study, which investigates how isiXhosa and Sesotho translations of Grade 4 Mathematics workbooks handle mathematical vocabulary. By analysing whether these translations support or hinder understanding, this study contributes to ongoing discussions on language and Mathematics education, emphasising the need for structured vocabulary development in multilingual classrooms.

2.9 Vocabulary Adaptation in Educational Materials

The development of appropriate educational materials in multilingual contexts often involves deliberate vocabulary adaptation, especially in specialised subjects such as Mathematics and Science. In contexts where indigenous

languages lack direct equivalents for technical or scientific concepts, translators and language developers employ various strategies to create or modify terms that convey the intended meanings effectively. These processes are essential in supporting the implementation of MTBBE, where learners must access complex academic content in their home languages.

2.9.1 Translation and Adaptation

Bassnett (2013) defines translation as the process of rendering text from a source language into a target language while preserving the meaning and structure of the original. The goal of translation is accuracy, ensuring fidelity to the source text and readability for the target audience. In contrast, Milton (2009) conceptualises adaptation as a more creative process that modifies a text to suit a new linguistic, cultural, or educational context. Unlike translation, which prioritises equivalence, adaptation focuses on relevance, accessibility, and cultural alignment.

Within the context of MTBBE, this distinction is critical. Translators of Mathematics materials in indigenous languages often engage in adaptation rather than direct translation, since English mathematical vocabulary frequently lacks direct lexical equivalents in languages such as isiXhosa and Sesotho. Adaptation, therefore, enables the restructuring of meaning to align with the grammatical and semantic systems of these languages, ensuring that learners can engage meaningfully with mathematical concepts.

2.9.2 Strategies for Vocabulary Adaptation in Indigenous Languages

Mabela and Ditsele (2024, pp.6–7) identify three key strategies for adapting terminology in contexts where languages lack equivalents: “borrowing, transliteration, and coinage or compounding.” Borrowing involves the direct transmission of a term from another language, often with morphological and phonological modifications to fit the recipient language’s structure. For example, in Northern Sotho, borrowed words are typically adjusted to align with the language’s phonological patterns. For example, in Northern Sotho, the English terms television and temperature are adapted as *thelebišene* and

themphereitšha, respectively (Mabela & Ditsele, 2024, p. 6). Transliteration, by contrast, substitutes letters from one alphabet with those of another while preserving the original sound. This strategy becomes necessary when orthographic combinations in the source language are absent in the target language. Examples include the adaptation of *glass* as *galase* and *helicopter* as *helikhophthara* (Mabela & Ditsele, 2024, p. 7). The third strategy, coinage and compounding, entails the creation of new words derived from existing linguistic resources to express meanings equivalent to English scientific or mathematical terms. The English terms compressive force and camouflage are coined in Northern Sotho as *kgatelelopitlelo* and *boiphihlakalefelo*, respectively. These new terms are often descriptive, facilitating comprehension through familiar linguistic elements (Mabela & Ditsele, 2024).

The adaptation strategies identified by Mabela and Ditsele (2024) are highly relevant to this study and offer a theoretical lens for examining how translators navigated lexical gaps when developing Mathematics terminology in the workbooks under review. Understanding whether borrowing, transliteration, or coinage was used helps us understand how language was creatively adapted for educational content.

2.10 Intellectualisation of Indigenous Languages

Building on the previous discussion of MTBBE, it becomes clear that for initiatives of this nature to be fully effective, there must be a concerted effort towards the intellectualisation of indigenous languages. As noted earlier, the success of bilingual education in South Africa relies heavily on the availability of well-developed and contextually relevant terminology in learners' mother tongues. The intellectualisation of these languages is a key factor in this process, as it directly addresses the challenges of integrating African languages into academic disciplines like Mathematics and Science

African languages have long suffered from neglect, particularly in terms of corpus and status planning (Kaschula & Maseko, 2014; Khumalo, 2017: Mabela & Ditsele, 2024). This lack of development has contributed to the widespread

perception that these languages are inadequate for academic and technical subjects. As a result, English and Afrikaans have been preferred in educational settings, further marginalising indigenous languages. The intellectualisation of African languages is therefore not only essential for the success of programmes like MTBBE but also for ensuring that these languages are recognised as viable mediums for teaching complex subjects such as Mathematics and Science.

Khumalo (2017) describes intellectualisation as a process of expanding and modernising a language so that it can effectively function in all domains, including Mathematics and Science. Khumalo (2017) also highlights the importance of terminology development, noting that the absence of subject-specific vocabulary often hinders the use of African languages in academic contexts.

Building on these insights, it is evident that for MTBBE to succeed, African languages must possess the necessary terminology to facilitate learning in scientific and technical subjects. While some progress has been made, particularly in developing terminology for Science and Technology (Mabela & Ditsele, 2024), there is still a long way to go in ensuring that indigenous languages can fully serve as mediums of instruction in these critical fields. Mabela and Ditsele (2024) acknowledge recent strides in intellectualising African languages, particularly in Science and Technology, signalling that South Africa is moving in the right direction. However, significant challenges remain and they require sustained efforts in policy implementation, resource allocation, and curriculum development.

Ultimately, the intellectualisation of African languages is not just about language development but about enabling meaningful access to knowledge and ensuring that learners can engage with academic content in their own languages. This is especially relevant in the context of MTBBE, where strengthening indigenous languages as mediums of instruction is a necessary step toward achieving equitable and effective education.

While South African languages are gradually expanding their academic and technical vocabularies, a valuable comparison can be drawn from the development of Kiswahili. Ipara & Mbori (2009) observe that Kiswahili has made significant progress in various sectors, including electronic media. They note that the development of a 3,000-word Kiswahili computer glossary illustrates deliberate efforts to expand the language's technical vocabulary and support its use in digital technologies

Additionally, Kiswahili is increasingly used across various fields, establishing itself as a capable language for conveying scientific and technological knowledge. This serves as a powerful example of how African languages can thrive with targeted efforts to develop and standardise their terminology, offering a potential model for South African languages. Similar initiatives have emerged in other African contexts.

For example, the African Academy of Languages (African Academy of Languages [ACALAN], n.d.) has supported projects to standardise scientific and technological terminology in languages such as Hausa and Amharic. In Tanzania, Kiswahili has long been the language of instruction at primary level and is increasingly being used in secondary and tertiary education, supported by official policies that promote terminology development in fields like Mathematics, Health, and Environmental Science (Mhina, 2015). Additionally, in Zimbabwe, Shona has undergone vocabulary development for technical subjects, including Mathematics and agriculture, with government-supported dictionaries and textbooks (Chimhundu, 2002).

2.11 Chapter Summary

This literature review has examined the historical and policy foundations of language in education, the linguistic barriers in Mathematics learning, and global perspectives on MTBBE. While existing research highlights the benefits of MTBBE, it has not fully explored the complexities of translating mathematical terminology into indigenous languages, particularly isiXhosa and Sesotho. This research builds on the foundational work of scholars like Mbude (2019), who

investigated the implementation and outcomes of the MTBBE programme in the Eastern Cape. By focusing on how isiXhosa and Sesotho translations of Grade 4 Mathematics workbooks handle mathematical vocabulary, this study contributes to ongoing discussions on bilingual education in South Africa. This study addresses this gap by analysing how these languages handle mathematical vocabulary, shedding light on the effectiveness of current translation strategies. The findings will contribute to the broader discourse on language and education in South Africa, offering valuable insights for policymakers, curriculum developers, and educators working towards more effective multilingual education strategies.

CHAPTER 3: RESEARCH METHODOLOGY

This chapter outlines the methodological framework that guided the study and explains the rationale behind the research choices made throughout the research process. The chapter begins by situating the study within the guiding paradigm that shapes the study's design. It details the research approach and design, followed by an explanation of the procedures for data collection, including the selection of the workbooks, the data cleaning and preparation processes, and the analytical techniques employed. The chapter concludes with a discussion of reliability, validity, replicability, and ethical considerations, highlighting the measures taken to ensure the integrity of the data.

3.1 Research Paradigm

Paradigms provide the underlying framework for research, shaping how reality is understood, how knowledge is constructed, and how inquiry is conducted (Kuhn, 1996; Guba & Lincoln, 1994).

This study was guided by a positivist paradigm, which is based on the idea that knowledge should be generated through scientific methods such as observation, measurement and reasoning with the aim of producing objective and reliable findings. At its core, the scientific method involves a process of experimentation used to explore observations and answer questions (Kivunja & Kuyini, 2017). While the study is grounded in positivism, it is informed by constructivist principles, particularly the recognition that meaning is context-dependent and shaped through interaction with data. In this regard, the study adopts a nuanced position in which empirical analysis is complemented by interpretive insight (Omodan, 2024). Constructive positivism recognises that multiple, socially constructed realities exist while retaining rigour and systematic investigation within these realities. Knowledge is therefore co-constructed through engagement between the researcher and the data, allowing for interpretation of meaning within specific contexts rather than the pursuit of a single objective truth (Omodan, 2024).

This paradigm aligns closely with the study's aim of examining vocabulary adaptation in Grade 4 Mathematics workbooks within South Africa's MTBBE because it allows the researcher to interpret how meaning is constructed, specifically how these vocabulary choices support learning and language development. Although a corpus-based approach was employed to analyse textual data, the study was fundamentally concerned with the educational and sociolinguistic meanings behind vocabulary choices in isiXhosa and Sesotho.

3.2 Research Approach

This research adopted a mixed-methods approach, which, according to Almeida (2018), combines qualitative and quantitative research methods within a single study to gain a more comprehensive understanding of the research problem. A mixed-methods design allows the researcher to draw on the strengths of both qualitative and quantitative approaches, resulting in richer and more detailed insights than would be possible if only one method were used (Almeida, 2018). In this study, the mixed-methods approach allows for both the identification of clear linguistic patterns in the data and the interpretation of how meaning is conveyed in the mathematics workbooks.

In this study, qualitative and quantitative approaches are integrated to provide a comprehensive understanding of the research problem. Qualitative research, as explained by deMarrais, Roulston & Copple et al. (2024), seeks to explore the meanings expressed by individuals or texts, with a focus on human behaviour, social interactions, and interpretation within specific contexts. Although qualitative inquiry often engages with experiential and sensory dimensions, it also involves the systematic analysis of written and spoken texts to identify patterns, meanings, and underlying structures. Creswell (2009) expands this description of qualitative research as a process characterised by emerging questions and flexible procedures, where data are typically collected in participants' natural settings. In qualitative research, analysis follows an inductive approach, moving from specific observations to broader themes, with the researcher playing an active role in interpreting and constructing meaning from the data. Quantitative research is concerned with testing objective theories

by examining relationships among measurable variables (Creswell, 2009). These variables are typically operationalised through structured instruments, producing numerical data that can be analysed using statistical techniques. Creswell (2009) further explains that this approach emphasises objectivity, hypothesis testing, and the systematic application of deductive reasoning to determine whether theoretical expectations are supported by empirical evidence.

The qualitative analysis is deliberately integrated with corpus-based quantitative methods, reflecting a mixed-methods orientation that combines interpretive depth with empirical rigour. This integration strengthens the analysis process by ensuring that insights are not derived solely from subjective interpretation but are supported by quantifiable linguistic evidence. The quantitative results generated through corpus analysis, such as word frequency counts, provide an objective overview of how mathematical vocabulary is distributed and used across texts.

The qualitative component of the analysis enables an in-depth examination of how specific mathematical terms are contextualised and adapted, revealing the linguistic and pedagogical considerations shaping vocabulary choices. By integrating quantitative and qualitative methods, the study can identify both measurable patterns in vocabulary use and nuanced differences in meaning, form, and grammatical behaviour. Through the combined use of corpus linguistics and qualitative textual interpretation, the research systematically examines patterns of vocabulary adaptation across isiXhosa and Sesotho. This mixed-methods approach not only supports detailed cross-linguistic comparison but also provides an evidence-based foundation for informing the development of future MTBBE materials.

Within this mixed-methods framework, qualitative research plays a central role, as it prioritises the interpretation of meanings conveyed by educational texts within their broader social contexts (deMarrais et al., 2024; Cropley, 2023). It involves the systematic examination of written material to uncover underlying

structures and communicative intentions (Walliman, 2022). When complemented by corpus-based tools, this qualitative focus is enhanced by quantitative evidence, allowing the analysis to move beyond surface observations and capture both the pedagogical aims and linguistic realities embedded in the Grade 4 MTBBE Mathematics workbooks.

3.3 Research Design

The study adopted a case study design, which Cropley (2023) describes as an approach focused on the in-depth investigation of real-life, bounded systems, drawing connections between specific settings, events, and the meanings individuals attach to them. Case studies often employ multiple forms of data, including document analysis, direct observations, and contextual interpretation (Cropley, 2023). Based on this overview, a case study design was appropriate for this study as it allowed for a focused, context-based analysis of the Grade 4 isiXhosa and Sesotho workbooks and their vocabulary and language use. The concept of a bounded system was central to case study research because it delimits the scope of investigation and so allowed the researcher to focus on elements most relevant to the research aims (Coombs, 2022).

In this study, the boundary was established by focusing on Grade 4 Mathematics workbooks in isiXhosa and Sesotho. This clear delimitation enabled a focused analysis of how mathematical vocabulary was adapted in these specific languages and at the Grade 4 level. The boundaries of the case were selected purposefully to ensure that the research addresses aspects of vocabulary adaptation that are most significant for teaching and learning outcomes at this level (Coombs, 2022).

Coombs (2022) further notes that a successful case study depends on the identification of key themes within the case to ensure effective and meaningful research outcomes. In this study, by focusing on the workbooks as a bounded case, it was possible to systematically examine how specific mathematical vocabulary items are adapted across the two languages, and how translation and adaptation strategies are applied. The case study approach thus allows for

a detailed analysis of the workbooks, thereby facilitating an in-depth understanding of how specific vocabulary items are translated, adapted, or coined.

At a broader level, Hancock and Algozzine (2017) highlight that case study research typically centres on a particular phenomenon such as an individual, an organisation, a programme, an activity, or a situation studied within its natural context and bounded by space and time. In addition, the power of case study research lies in its richly descriptive nature, drawing from multiple data sources to uncover the depth, complexity, and meaning of the phenomenon being investigated (Hancock & Algozzine, 2017). This emphasis on context and meaning aligned well with the aims of this study, which sought to understand not only *how* vocabulary is adapted in these learner workbooks, but also *why* those adaptations may influence learner comprehension and educational equity in MTBBE classrooms.

The case study design is particularly valuable because it allows for a holistic investigation. This includes not only analysing how mathematical vocabulary has been translated and adapted but also reflecting on the educational intentions behind these adaptations and their potential impact on teaching and learning in multilingual contexts. The depth and flexibility of the case study approach support the study's broader aim of potentially generating insights that can inform the improved implementation of bilingual education policies and contribute meaningfully to language planning in South Africa.

3.4 Data Collection

The primary data for this study consisted of the Grade 4 Mathematics workbooks in isiXhosa, Sesotho, and English. All three workbooks are published by the Department of Basic Education, which ensures consistency in terms of curriculum coverage, instructional design and learning outcomes across the different language versions. Because the workbooks for each language are produced as parallel versions of the same curriculum materials. The English workbook serves as the reference text for comparative analysis in this study.

While all three language versions are aligned to the same curriculum content and learning outcomes, the isiXhosa and Sesotho workbooks they are linguistically adapted to ensure that the curriculum is communicated appropriately in each language, resulting in differences in vocabulary and word frequencies.

These three texts form the corpus used for analysis. In linguistics, a corpus refers to a large, structured collection of authentic language samples that are gathered to represent a particular language or variety of language use (Stefanowitsch, 2020). Unlike invented examples, the data in a corpus are drawn from real-life communication, making them both natural and contextually meaningful.

This study uses a specialised corpus. Hunston (2002) explains that a specialised corpus is particularly valuable when a researcher aims to investigate a specific type or use of language. Such corpora are often self-compiled to capture the linguistic features of a well-defined domain, such as “newspaper editorials, geography textbooks, academic articles, lectures, casual conversations, or student essays” (Hunston, 2002, p. 14). In this study, the Grade 4 Mathematics workbooks form a specialised corpus because despite their limited number, they provide focused, authentic examples of mathematical language in MTBBE workbooks and allow for a detailed examination of vocabulary adaptation across isiXhosa and Sesotho.

Flowerdew (2004) notes that specialised corpora are especially useful in the study of academic and professional discourse because they enable researchers to focus on a clearly defined context or field. By doing so, the researcher can perform a more detailed and context-sensitive analysis of the language used within that domain. Flowerdew (2004) also notes that this approach accommodates the integration of both quantitative and qualitative methods in that the corpus can be analysed statistically to identify patterns such as word frequency, distribution, and collocations, while also allowing for in-depth qualitative interpretation of how these patterns function in context. In this way,

the researcher is able to move between numerical trends and close textual analysis to develop a more comprehensive understanding of how language operates within the given context,

Access to Grade 4 Mathematics workbooks was obtained through formal institutional channels to ensure compliance with ethical standards and research protocols. An internal request, outlining the objectives and scope of the study was submitted and subsequently reviewed and approved in accordance with the Department of Basic Education research guidelines (refer to Annexure A). The isiXhosa and Sesotho workbooks were provided by the Eastern Cape Provincial Department of Education via secure electronic transfer. The English workbook (Department of Basic Education, 2023), being publicly accessible, was retrieved from the DBE website. These procedures ensured that all materials were acquired through legitimate and verifiable channels, maintaining their integrity as official educational resources.

3.5 Data Analysis

The data for this study were analysed using a corpus-based textual analysis approach, which uses a mixed methods approach to systematically examine language patterns in written texts. According to Flowerdew (2012), corpus-based textual analysis involves examining how language is used in real texts by identifying patterns, word choices, and structures through corpus tools. This approach focuses on language in use, exploring how words and phrases function within a particular context. It often combines both quantitative and qualitative techniques to uncover recurring patterns such as text organisation and repeated word combinations or phrases. Flowerdew (2012) further notes that corpus-based textual analysis enables researchers to identify patterns in how a text is structured and what it means, showing both how the language is used and what it is trying to communicate. For this study, corpus-based textual analysis provides the tools to systematically identify patterns in word choice, phrase structure, and the adaptation of mathematical concepts. By examining these patterns, the approach can reveal how language in the isiXhosa and Sesotho workbooks is used to convey meaning and support comprehension.

For the analysis, the Grade 4 Mathematics workbooks in Sesotho and isiXhosa, along with the original English version, were compiled into a corpus. Using corpus linguistics methods, word frequencies, concordances, and patterns of co-occurrence were analysed to examine how mathematical vocabulary had been adapted. This approach allowed for a systematic comparison of key mathematical terms across the three languages. As Vosiljonov (2022) notes, corpus linguistics is a powerful tool for exploring vocabulary structure and change, particularly in multilingual contexts, and R served as the computational platform for this analysis. R is a free language and environment for statistical computing and graphics (R Core Team, 2025). It offers a range of functions for data manipulation, statistical calculations, and visualisation. The software includes efficient data-handling and storage capabilities, as well as built-in tools for analysing data and displaying results graphically (R Core Team, 2025).

To ensure that the analysis remained focused and manageable, this study concentrated on specific mathematical themes as outlined in the Grade 4 CAPS. These themes include numbers, operations, and relationships; patterns, functions, and algebra; space and shape (Geometry); measurement; and data handling. CAPS assigns different weightings to these content areas, with greater emphasis placed on number operations and number patterns to ensure a strong numeracy foundation (Department of Basic Education, 2011). These themes were selected because they contain a high concentration of subject-specific vocabulary at the Grade 4 level, and often present both conceptual and linguistic challenges when translated into African languages.

Number operations cover addition, subtraction, multiplication, and division, as well as place value, factors, and multiples. Number patterns and sequences introduce learners to relationships between numbers and early algebraic thinking. Geometry includes the properties of two- and three-dimensional shapes, symmetry, and position and direction, while measurement involves length, mass, capacity, time, and simple calculations of perimeter and area (Department of Basic Education, 2011). Focusing on these themes allowed the study to examine how key mathematical concepts are expressed and adapted

in isiXhosa and Sesotho. Pedagogically, these terms are central to the curriculum and foundational for learners' understanding of more complex concepts. They appear frequently in the workbooks, making them crucial for teaching and learning. These terms are linguistically significant because they frequently lack direct equivalents in isiXhosa and Sesotho, requiring strategies such as borrowing, transliteration, coinage, or compounding to convey meaning accurately.

3.5.1 Corpus Compilation

A specialised corpus was created using the three Grade 4 Mathematics workbooks in English, isiXhosa, and Sesotho as source texts. These workbooks were selected because they are the primary instructional resources used to teach Mathematics in Grade 4 classrooms, and they have been designed to guide daily teaching and learning by presenting mathematical concepts through worked examples, explanations, learner activities, and exercises that learners engage with. In addition, the content is organised in line with the CAPS curriculum, and analysing these workbooks provides insight into the actual linguistic input learners receive when learning Mathematics. This makes these workbooks particularly suitable for investigating vocabulary adaptation within the MTBBE context. Grade 4 is a critical year in South African schools, as learners are expected to "read for meaning" (Department of Basic Education, 2024). This means that they must not only decode words but also understand and apply mathematical concepts. By examining Grade 4 workbooks, this study focuses on the point at which learners' developing academic language skills start to play a key role in their understanding of Mathematics.

3.5.2 Quantitative Data Analysis

The first step in creating the corpus involved converting the workbooks into plain text format to allow for analysis. Some sections of the workbooks were image-based, requiring the use of Optical Character Recognition (OCR) software to accurately extract the text. After extraction, each document was carefully checked against the original workbook to ensure that no content was missing or distorted during the conversion process. The OCR was carried out using Adobe

Acrobat Pro DC, while corpus cleaning and analysis were performed in RStudio (R Core Team, 2025) using the *quanteda* package for corpus processing and quantitative text analysis (Benoit Watanabe, Wang, Nulty, Obeng , Müller & Matsuo, 2018), and the *tidytext* package for tidy text mining (Silge & Robinson, 2016).Tidy text mining is when the text is converted into a structured format in which each word is treated as a unit of analysis, enabling systematic identification of patterns such as word usage and co-occurrence, Each workbook was stored as a separate plain-text file (.txt), labelled according to language and all files were encoded in UTF-8 format to preserve special characters. Further cleaning was conducted in R, where symbols and mathematical calculations were removed.

The cleaned corpus was processed and analysed in R using a suite of specialised packages designed for text analysis and data management. The quanteda package (Benoit et.al., 2018) provided the framework for building and managing the textual corpus and for tokenising the text, supported by packages such as quanteda.textstats and quanteda.textplots for basic statistics and visual summaries of textual data. Text files were imported into R using readtext (Benoit et al., 2025), which is specifically designed to read text documents and provide a format directly compatible with corpus tools such as quanteda. Data cleaning and organisation utilised functions from the tidyverse suite, including readr for reading and structuring text data (Wickham et al., 2025), while visualisation of results was carried out with ggplot2 (Wickham, 2016), and multi-plot arrangements were composed using patchwork (Pedersen, 2020). The writexl package (Harrison, 2019) was used to export cleaned datasets and analytical results as Excel files for verification, reporting, and ease of access. Together, these tools enabled a structured and systematic analysis of the corpus, including the creation of word-frequency lists, counting term occurrences, and displaying patterns through graphs. Using R ensured that all steps were clear, consistent, and reproducible, allowing reliable comparison of mathematical vocabulary across the English, isiXhosa, and Sesotho workbooks.

Following the data cleaning process, a predetermined multilingual word list was manually developed before the corpus analysis. In this study, predetermined refers to a vocabulary list that was compiled before the corpus analysis was undertaken. The selection of terms was informed by the Grade 4 mathematical content areas prescribed in the CAPS for Grade 4 Mathematics, ensuring that the word list captured the core mathematical concepts and terminology that learners are expected to acquire. The English mathematical terms appearing in the Grade 4 English Mathematics learner workbook were first identified and extracted. The equivalent terms in the isiXhosa and Sesotho learner workbooks were then manually matched to the English terms using the Department of Arts and Culture dictionary (2013). These aligned terms were compiled into a predetermined multilingual word list, which provided a standardised lexical framework for the corpus analysis. The word list served as the reference against which the three language versions of the workbook were analysed in the subsequent chapter. The complete multilingual word list is presented in Annexure D. Establishing the vocabulary list in advance enabled the analysis to focus on curriculum-specific mathematical terminology and provided a standardised basis for comparing the English, isiXhosa and Sesotho workbooks.

The R scripts used for the data processing, analysis, and visualisation presented in this dissertation are freely available in a public GitHub repository at: https://l1nq.com/w1q15es

3.5.3 Qualitative Data Analysis

The qualitative component of the study was guided by qualitative content analysis, which Zougris (2025, p.3) describes as a method used to analyse “texts, symbols, images, linguistics, semantics, syntax, and pragmatics”. It forms the foundation of qualitative methodologies, including critical and interpretive analyses (Zougris, 2025). This approach is particularly suitable for analysing the workbooks and interpreting how meaning has been constructed.

The qualitative analysis involved carefully reading all three workbooks to examine how mathematical concepts were presented and explained. This included reviewing instructions, examples, and activities to observe the use of adapted terms in context. Furthermore, the analysis assessed adaptation strategies through a manual comparison of isiXhosa, Sesotho, and English terms. This step investigated the structural properties such as word length, how the words sound, how they are formed, and how clear their meanings are. By reviewing the workbooks, the researcher was able to identify subtle features that computerised methods could not detect, such as whether borrowed words matched how the language is normally used, or if some difficult terms were used in ways that might make them harder to understand for learners.

Thirdly, qualitative interpretation was applied to the Key Word in Context (KWIC) results generated through R. While the KWIC tool identified the occurrences of selected mathematical terms and displayed their surrounding context, qualitative analysis was required to interpret how these terms functioned within the instructional language of the workbooks. Examining the words preceding and following each keyword enabled the researcher to understand how mathematical vocabulary was used in authentic classroom contexts and to identify recurring patterns in its use across the English, isiXhosa and Sesotho workbooks.

Lastly, qualitative analysis played a role in compiling and evaluating collocations. While R software tools can identify words that frequently appear together, they often capture patterns that are statistically frequent but semantically random. To ensure meaningful analysis, the collocations in this study were compiled manually, through close reading of the workbooks. This allowed for careful attention to how multi-word expressions conveyed mathematical concepts.

3.6 Reliability and Validity

To ensure the reliability of the study, thorough measures were taken at each stage of the corpus compilation and analysis process. All texts were manually

cross-checked against the original workbooks after conversion to plain text to identify and correct any omissions or conversion errors. Data cleaning was conducted systematically to ensure that the corpus accurately reflected the linguistic content of the workbooks and provided a dependable basis for analysis. The study is replicable, as all pre-processing and analysis steps were performed in R using documented scripts. The R scripts used for the data processing, analysis, and visualisation presented in this dissertation are freely available in a public GitHub repository at: https://l1nq.com/w1q15es
Furthermore, the use of R reduced the potential for human error and helped maintain consistency throughout the analysis.

Additionally, the researcher was guided by the supervisor in developing the analytical framework for the study. A tutorial was developed specifically for this study to support the analytical process. The researcher worked through this tutorial and refined and extended the code where necessary.

In addition to procedural reliability, content validity and contextual and linguistic validity were considered. Content validity was ensured by using the official DBE Grade 4 Mathematics workbooks in isiXhosa, Sesotho, and English as the primary data sources. These workbooks are representative of the Learning and Teaching Support Materials (LTSM) used in MTBBE classrooms, ensuring that the corpus reflects authentic educational content.

Contextual and linguistic validity was strengthened by interpreting the findings within the broader framework of MTBBE, African language development, and terminology planning. The analysis was grounded in an understanding of the grammatical and phonological features of isiXhosa and Sesotho, as well as the educational context in which these materials are used. This helped ensure that the interpretation of adapted mathematical terms was meaningful within both the linguistic and educational context of the study.

3.7 Ethical Considerations

Permission to access and use the Grade 4 Mathematics workbooks was obtained from the Department of Basic Education (see Annexure A). Although the study does not involve human participants, it engages with educational materials that reflect official policy. The analysis was therefore conducted with careful attention to accurately represent the content and purpose of these materials, ensuring that interpretations of language adaptations remained objective and evidence based. The study does not seek to criticise the MTBBE policy or its implementation; rather, it aims to generate insights that may inform the refinement and effectiveness of mother-tongue-based instructional materials. Findings are presented constructively, highlighting patterns, adaptations, and potential areas for improvement without making evaluative judgments about the Department's work. In this way, the research maintains academic rigour while contributing to the broader discourse on language policy and bilingual education in South Africa.

Qualitative document analysis also presents specific ethical considerations because the interpretation of texts depends on the researcher. To address this, several measures were implemented to ensure that the analysis remained fair, transparent, and methodologically sound. The researcher followed systematic and replicable procedures, including clearly defined coding categories and consistent criteria for identifying adaptation strategies. Throughout the analysis, care was taken to represent the workbook content accurately and to avoid over-interpretation or assigning meanings not supported by the data.

Annexure B contains the ethics approval letter for the study, which was granted by the College of Human Sciences Research Ethics Committee (CREC) under Ethical Clearance Number 7318. It serves as evidence that the study complied with the required ethical standards and institutional guidelines governing research.

3.7.1 Conflict of Interest

As a current employee of the Department of Basic Education, which is responsible for implementing the MTBBE policy, I occupy a dual position, both as researcher and employee, which may present a potential conflict of interest. To ensure that this did not influence the integrity of the study, several measures were implemented to distinguish my work responsibilities from my role as an independent researcher.

Firstly, all the data used in this study consisted of publicly available learner workbooks and formally authorised workbooks obtained through official DBE research procedures. No confidential departmental documents, discussions, or privileged information were accessed or used at any stage of the research process.

Secondly, all conclusions in the study are based solely on the textual content of the workbooks and the quantitative analysis, rather than on any insider knowledge of policy processes or departmental operations. Furthermore, the study does not critique individuals, confidential systems, or internal decision-making and therefore does not place the researcher's employment at risk.

3.7.2 Confidentiality of Data

The data for this study consists of the Grade 4 Mathematics workbooks in English, Sesotho, and isiXhosa, which are publicly available educational materials developed and distributed by the Department of Basic Education. These workbooks are not confidential in nature as they are freely accessible to schools, teachers, and the public through official DBE platforms. Since the research focuses solely on the textual content of these materials, no personal, institutional, or sensitive information is involved.

As such, issues of confidentiality are minimal. There is no interaction with human participants, and no private data is collected or analysed. The study does not involve learner assessments, teacher input, or any form of classroom observation. Therefore, the ethical obligation regarding data confidentiality

primarily involves ensuring that the workbooks are used responsibly and cited appropriately, in line with academic and institutional standards.

To ensure data security during the research process, the compiled corpus and all associated analytical files were stored securely on password-protected devices. Access to the corpus was limited to the researcher and the study supervisor to ensure research integrity by reducing the risk of data tampering, loss or misuse.

3.7.3 Beneficence and Maleficence

The findings of this study have the potential to contribute meaningfully to the improvement of educational resources, particularly as South Africa continues to advance its commitment to mother tongue education and the practice of teaching learners in their home or first language. The study may support the broader aim of developing African languages as legitimate and effective mediums of instruction. This in turn advocates for learners to engage with educational content in a way that reflects their linguistic and cultural identities, thereby enhancing comprehension, participation, and academic success in line with the goals of MTBBE.

At the same time, the study may expose certain limitations in the implementation of the MTBBE, or in the strategies used by the Department of Education to adapt academic content into indigenous languages in terms of the development of learning materials. Identifying gaps or inconsistencies in these areas may reveal weaknesses in the current approach to mother tongue education in South Africa.

The findings will be presented in an objective manner. The analysis will highlight both strengths and areas for improvement, to support the refinement of MTBBE policy rather than undermine it. The goal of this study is not to criticise but to offer practical, research-based insights that can enhance the effectiveness, inclusivity, and long-term sustainability of mother tongue education in South Africa.

3.8 Chapter Summary

This chapter outlined the methodological framework guiding the study. Situated within a constructive positivist paradigm, the research employed a mixed-methods design combining corpus-based quantitative analysis with qualitative document analysis to examine the adaptation of mathematical vocabulary in the MTBBE workbooks. The chapter described the corpus compilation and data preparation process, the use of R to generate frequency counts and KWIC analyses, and the qualitative interpretation of vocabulary within its instructional context. It also addressed reliability, validity, replicability, and ethical considerations to ensure academic rigour. Together, these methods provide a robust foundation for the analysis presented in the following chapter.

CHAPTER 4: FINDINGS AND DISCUSSIONS

This chapter presents the findings of a corpus-based analysis of Grade 4 Mathematics workbooks in English, isiXhosa, and Sesotho. The study used a mixed-methods approach. Quantitatively, corpus analysis was conducted using R to examine term frequencies, distribution patterns, KWIC (Key Word in Context) and collocation structures across the three languages. Qualitatively, an in-depth manual review of the workbooks was conducted to uncover linguistic features that require interpretation through human evaluation rather than automated analysis.

The chapter is divided into three main sections. It begins with an overview of the key results, highlighting the main trends observed in the text data. This is followed by a statistical analysis of the text data, including frequency distributions, adaptation patterns, and contextual usage. The chapter concludes with a discussion that interprets these results qualitatively as part of the in-depth manual review of the workbooks, in relation to the key research questions and existing literature.

4.1 Corpus Description

A total of three workbook texts were analysed, consisting of three Grade 4 Mathematics in English, isiXhosa and Sesotho respectively. The resulting corpus comprised a total of 32,212 tokens, with each language contributing a different number of tokens depending on the length and structure of its respective workbook. In this study, tokens primarily consist of single words and serve as the basic units for frequency and distribution analysis. This process makes it possible to systematically compare vocabulary use across the different versions of the workbooks.

Table 1 presents the total token count for each language and illustrates how each workbook contributes to the overall corpus. The Sesotho workbook contains the highest number of tokens (12,959), followed by English (11,115) and isiXhosa (8,138). This variation is expected given differences in morphological structure across the languages. Sesotho forms longer words by

combining multiple morphemes; this typically results in fewer tokens rather than more. The increased number of tokens in Sesotho is therefore more likely attributable to differences in translation and pedagogical adaptation strategies rather than morphological structure. The Sesotho workbook likely expands or elaborates on concepts to enhance learner understanding, leading to increased repetition of key terms and explanatory phrases. isiXhosa often conveys grammatical relationships through prefixes and infixes, resulting in fewer stand-alone words. English generally uses shorter, more isolating forms, placing it between the two African languages in terms of token density. These tendencies likely contribute to the observed differences in token counts across the three workbooks.

Table 1: Total Corpus Token by Language

Language	Total tokens
English	11115
isiXhosa	8138
Sesotho	12959

4.2 Data Analysis

This section presents the findings of the study and integrates both predetermined and frequency-based analyses of mathematical vocabulary across the languages. The results provide insight into how core mathematical concepts are represented in the workbooks across different languages, especially where direct equivalents are unavailable.

4.2.1 Frequency Analysis of Predetermined Terms

The analysis focused initially on ten predetermined mathematical terms per language (included in Annexure D) which were selected from key Grade 4 Mathematics themes that included number operations, measurement, geometry, and data handling. These terms are key concepts that learners need to understand and are central to several mathematical topics.

Figure 2 presents the absolute frequency of ten predetermined mathematical terms across workbooks. In this study, absolute frequency refers to the actual number of times each term occurs in the texts, including within explanations, examples, and learner activities. Examining absolute frequency provides an initial indication of how often key mathematical concepts are introduced and reinforced across the three language versions of the MTBBE materials.

The figure uses a faceted dot plot, with each dot representing a mathematical term and its frequency of occurrence within a specific language corpus. The x-axis shows frequency values (approximately marked at 20, 40, and 60), while the colour gradient indicates frequency magnitude, with lighter (yellow) tones reflecting higher frequencies and darker (purple) tones indicating lower frequencies.

Across all three languages, fractions, calculation, digits, and geometric shapes are consistently represented. More specifically:

- **In the English corpus,** high-frequency terms include fraction (58), calculate (41), and litre (47), indicating strong emphasis on numerical operations and measurement. Terms such as triangle and circle also occur frequently.
- **In the Sesotho corpus,** *Frakshene* (71) is the most frequent term, exceeding its English counterpart. Other high-frequency terms include *khaltjhuleitha* (48) and *dilithara* (33). Phonological adaptation is evident in *traenkele*, *sekele*, and *dayakeramo*, reflecting lexical borrowing as a dominant strategy.
- **In the isiXhosa corpus,** Frequent terms include *frekshini* (66) and *khalityhuleyitha* (46), with measurement and numeric structure represented through *ilitha* (30) and *dijithi* (27). Terms such as *trayengile* (20), *sekile* (10), and *dayagram* (18) show phonological adaptation from English, though some items like *ophareyshini* (7) and *sekile* (10) appear less frequently.

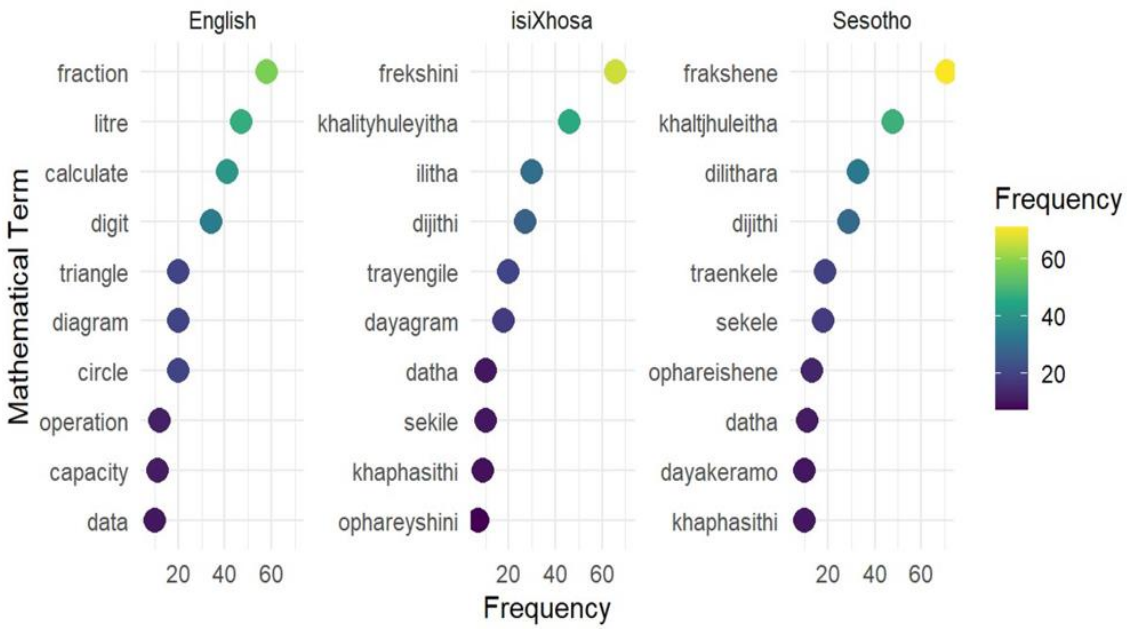


Figure 2: Frequency of Mathematical Terminology by Language

4.2.2 Frequency Analysis of the Most Frequently Occurring Terms

Beyond the analysis of the predetermined mathematical terms, an additional data-driven frequency analysis was conducted to identify the mathematical terms that naturally occurred most frequently within each workbook. Unlike the predetermined terms, which were selected in advance based on their relevance to the curriculum, meaning they were identified because they are explicitly expected or prescribed in the Grade 4 mathematics syllabus and teaching guidelines, the terms reported in this section were identified solely based on the actual frequency of occurrence in the texts.

This analysis involved running a frequency count across the full corpus of the English, isiXhosa, and Sesotho Grade 4 Mathematics workbooks to determine which mathematical terms appeared most often, regardless of prior selection. By examining the top ten terms based on these counts, the study provides an empirical indication of which mathematical concepts receive the greatest emphasis in the MTBBE materials.

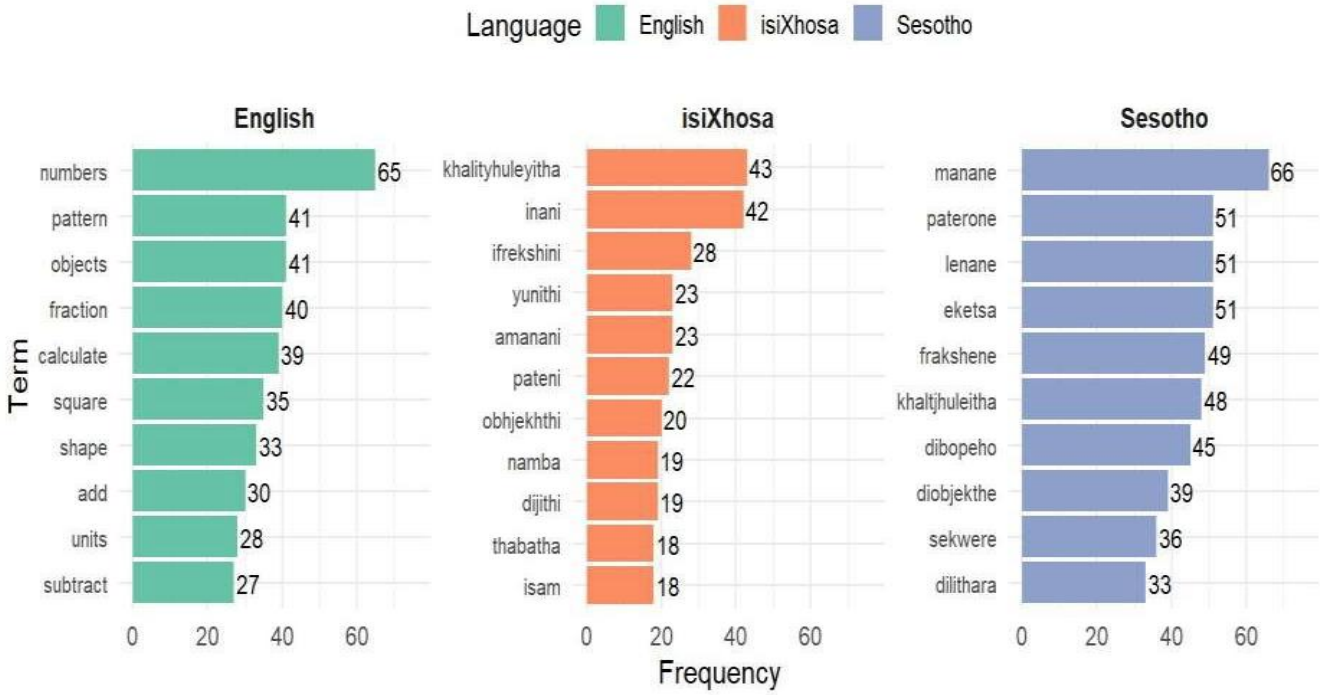


Figure 3: Frequency of the Ten Most Frequently Occurring Mathematical Terms Identified Through Corpus Analysis

Figure 3 shows the frequency of the ten most frequently occurring mathematical terms identified through corpus analysis in each language. The plot displays the absolute frequency of these terms.

Across the three languages, the results show that similar basic mathematical words are commonly used as there is a high degree of overlap between these. These include terms related to numbers, calculation, fractions, patterns, and shapes. This shows that these concepts are central to Grade 4 Mathematics teaching in English, Sesotho, and isiXhosa. While this reflects strong curriculum alignment, the Sesotho and isiXhosa data reveal frequent use of borrowed and adapted terms.

The patterns in Figure 3 show that each language highlights a slightly different set of mathematical ideas, revealing how vocabulary choices reflect the emphasis and accessibility of the content in the MTBBE workbooks. The figure helps to show not only which terms dominate each workbook, but also how frequently adapted or borrowed terms appear across the languages.

- **In the English corpus,** *numbers, pattern, objects*, *fraction*, and *calculate* dominate, reflecting emphasis on core number concepts, patterns, and operations.
- **In the Sesotho corpus**, high-frequency terms such as *manane* (numbers), *lenane* (numbers), and *eketsa* (add*)* are clearly indigenous, as they are derived from Sesotho roots and reflect internal grammatical and semantic patterns. In contrast, items like *frakshene* (fraction), *dilithara* (litres), *diobjekthe* (objects)*,* and *khaltjhuleitha* (calculate) are borrowed from English and display the characteristic features of transliteration, where English sounds and spellings are reshaped to fit Sesotho phonological constraints through vowel insertion and the use of noun-class prefixes such as di-. These patterns closely align with the vocabulary-adaptation strategies described by Mabela and Ditsele (2024), who identify borrowing, transliteration, and coinage/compounding as the three dominant methods used when African languages lack established terminology for technical subjects. Bassnett (2013) further distinguishes transliteration as a strategy that preserves source-language sound patterns while modifying their orthographic form, which explains why terms such as *frakshene* and *dilithara* retain clear English phonetic traces.
- **In the isiXhosa corpus,** a similar pattern appears in isiXhosa. Terms such as *inani* (number), *amanani* (numbers), *thabatha* (subtract*)* are indigenous and conform to established isiXhosa noun-class and verbal systems. Meanwhile, forms such as *khalityhuleyitha* (calculate), *ifrekshini* (fraction), *yunithi* (unit), and *obhjekthi* (object) are transliterations of English items adapted to isiXhosa's sound structure through processes such as vowel epenthesis, consonant adjustment, and the addition of prefixes like i- and u-.

These adaptations reflect what Nkomo (2019) describes as the tendency for technical terminology in African languages to rely heavily on English lexical roots that are phonologically reshaped but not conceptually indigenized. When viewed alongside the theoretical distinctions made by Bassnett (2013) and Milton (2009) between translation, adaptation, and transliteration, the data confirm that both isiXhosa and Sesotho rely primarily on borrowing-based strategies rather than coinage, despite coinage being positioned in the literature

(Mabela & Ditsele, 2024) as essential for the long-term intellectualisation of African languages.

4.2.3 Cross-Language Differences in Vocabulary Adaptation

As the isiXhosa and Sesotho Grade 4 Mathematics workbooks were translated from the English workbook, some degree of borrowing and adaptation of English mathematical terminology was expected. The workbooks nevertheless show consistent cross-language patterns in how English mathematical terms are integrated into isiXhosa and Sesotho. These adaptations fall broadly into three strategies: direct borrowing, phonological adaptation, and morphological integration. While the two languages draw on the same broad strategies, they differ in the extent to which each strategy is applied. These differences shape how learners encounter mathematical terminology and influence the degree to which the terms feel linguistically “natural” within each language.

Table 2 was developed from both the corpus findings and the literature on translation and terminology development in African languages. The mathematical terms included came from two sources: a predetermined list of key terms, manually compiled by the researcher based on curriculum relevance, and high-frequency terms that emerged naturally from the corpus through qualitative and quantitative analysis. Each term was aligned with its English equivalent to facilitate cross-language comparison and was subsequently analysed according to its linguistic structure, pronunciation, and word-formation processes to determine whether it represented borrowing, transliteration, or coinage.

Table 2: Adaptation Strategies for Mathematical Terminology

English Term	Sesotho Term	isiXhosa Term	Adaptation Strategy
capacity	khaphasithi	khaphasithi	Borrowing
calculate	khaltjhuleitha	khalityhuleyitha	Transliteration
fraction	frakshene	frekshini	Transliteration / Borrowing
data	datha	datha	Borrowing
litre	dilithara	Ilitha	Transliteration
operation	ophareishene	ophareyshini	Transliteration
digit	dijithi	dijithi	Transliteration / Borrowing
triangle	traenkele	trayengile	Transliteration
circle	sekele	sekile	Transliteration
diagram	dayakeramo	dayagram	Transliteration
fraction	ifrekshini	frakshene	Transliteration / Borrowing
object	obhjekhthi	diobjekthe	Transliteration / Borrowing
unit	yunithi	yuniti	Transliteration / Borrowing
digit	dijithi	iidijithi	Borrowing
operation	ophareyshini	ophareishene	Transliteration / Borrowing
ratio	ireshiyo	reshio	Transliteration / Borrowing
circle	isekile	sekele	Transliteration / Borrowing
triangle	itrayengile	traenkele	Transliteration / Borrowing

The main classification framework used in the table was drawn from Mabela and Ditsele (2024), who identify these three strategies as dominant in African-language terminology development. Guidance from Bassnett (2013) and Milton (2009) was used to distinguish transliterations, which preserve the pronunciation of English terms while adapting them to the orthographic and phonological conventions of the target language. Nkomo (2019) further informed the classification by demonstrating that many African-language technical terms retain recognisable English roots despite phonological adaptation. Consequently, terms that remained clearly traceable to English, even where noun class prefixes or other grammatical markers had been added, were classified as borrowings or transliterations rather than newly coined terms. Indigenous mathematical vocabulary drawn from existing African-language

lexicons, such as *inani*, *thabatha,* and *manane,* was excluded from the analysis because these terms do not represent adaptations from English.

The corpus demonstrates that measurement terminology in both languages relies heavily on adapted English borrowings rather than newly coined equivalents. For example, litre appears as *dilithara* in Sesotho and *ilitha* in isiXhosa. In Sesotho, the borrowed form is integrated through vowel insertion and the addition of the plural noun class prefix di-, while isiXhosa adapts the consonant structure to conform to its phonological system. Similarly, capacity is rendered as *khaphasithi* in both languages, illustrating the phonological approximation of the English source rather than the creation of indigenous terminology.

Although both languages rely extensively on borrowed terminology, the adaptation strategies differ. Sesotho generally retains more of the original English pronunciation while integrating borrowed terms into its grammatical system through noun class and plural markers. Examples include khaltjhuleitha (calculate), frakshene (fraction), diobjekthe (objects), and dilithara (litres), with the recurring di- prefix demonstrating consistent morphological integration. By contrast, isiXhosa more frequently reshapes borrowed terms to conform to its phonological and morphological patterns through vowel insertion, consonant modification, and noun class prefixes. Examples include khalityhuleyitha (calculate), ifrekshini (fraction), itrayengile (triangle), and idayagram (diagram). These patterns indicate that while both languages incorporate English mathematical terminology, isiXhosa generally applies more extensive phonological adaptation, whereas Sesotho places greater emphasis on grammatical integration through its noun class system.

Overall, Table 2 illustrates how English mathematical terminology is systematically incorporated into isiXhosa and Sesotho through established translation and terminology development strategies. The findings demonstrate that vocabulary adaptation in both languages reflects a balance between preserving the recognisability of English technical terms and ensuring their

compatibility with the grammatical and phonological systems of the target languages.

Figure 4 illustrates the frequency of English mathematical terms according to their adaptation strategies in the isiXhosa and Sesotho workbooks. While Table 2 categorises individual terms by strategy, the figure highlights how frequently each strategy is used across the dataset, making it easier to compare the relative dominance of borrowing, transliteration, and mixed strategies in the two languages. This visual representation reveals broader distributional patterns that are less evident in the tabulated data: borrowing is the most commonly used strategy in both languages, transliteration is used moderately, and mixed strategies are less frequent. Terms such as “calculate” and “capacity” are consistently borrowed, while terms like “digit” and “fraction” often employ mixed strategies. This suggests that the choice of adaptation depends on the term itself, with some words being easier to borrow directly and others requiring a combination of strategies to fit the target language.

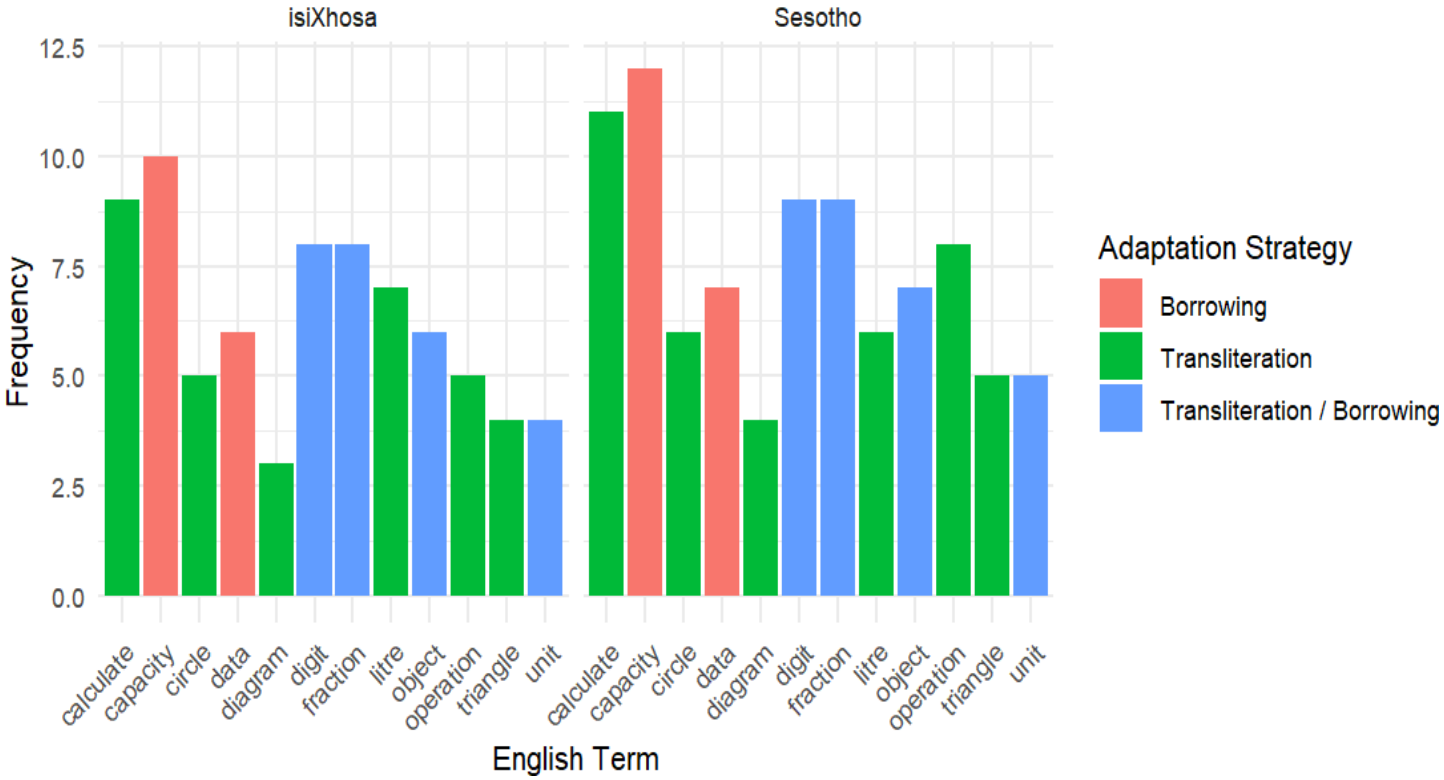


Figure 4: Frequency of English mathematical terms according to their adaptation strategies in the isiXhosa and Sesotho

4.2.4 Key Word in Context (KWIC) Findings

To examine how mathematical terms function within instructional contexts, a KWIC analysis was conducted for the Grade 4 Mathematics workbooks in English, isiXhosa, and Sesotho. KWIC analysis showed how selected mathematical terms appear authentically in the workbooks. By displaying the keyword together with its surrounding context (pre- and post-words), the method allowed for a clearer understanding of how mathematical vocabulary is used in instructional language. The table below presents selected examples chosen to illustrate typical usage patterns and highlight notable adaptations across isiXhosa and Sesotho. The examples in Table 3 were selected to provide a representative view of how terms appear in context; they are not complete, but they effectively demonstrate the recurring patterns identified in the analysis.

The mathematical terms in all three languages are used predominantly within instructional contexts rather than in isolation. Across the English, isiXhosa and Sesotho workbooks, terms such as calculate, fraction and ratio occur mainly in learner activities and teacher-directed instructions, for example "Write the fraction...", "Calculate the answer..." and "Find the ratio...". This indicates that mathematical vocabulary is introduced through task-based learning, where learners are expected to apply concepts while completing exercises.

The adapted isiXhosa and Sesotho terms perform the same instructional functions as their English counterparts. Although many of these terms have been borrowed or phonologically adapted from English, they are embedded within grammatically appropriate isiXhosa and Sesotho sentence structure.

Table 3: KWIC Examples Across Languages

Language	Term	Context (pre + keyword + post)	Translation
isiXhosa	khaltjhuleitha	“Bhala umphumo …khaltjhuleitha …”	“Write the result …calculate. “
isiXhosa	frakshene	“Bhala le frakshene ngokwesahluko esilandelayo”	“Write the fraction in the following section”.
isiXhosa	ireshiyo	“Fumana i ireshiyo yabafana nabafazi”	“Find the ratio of boys and girls”
Sesotho	khalityhuleyitha	“Etsa… khalityhuleyitha karabo e felletseng”	“Calculate the answer in full”
Sesotho	frekshini	“Bhala frekshini ka mokhoa o lekanyelitsoeng”	“Write the fraction in its simplified form”.
Sesotho	reshio	“Etsa qeto ya banna ho basadi reshio”	“Determine the ratio of males to females”
English	calculate	“ ..now calculate the total sum”	
English	fraction	“Write the fraction as a decimal number”	
English	ratio	“Calculate the ratio of boys to girls”	

4.2.5 Patterns of Mathematical Collocations

In Mathematics, meaning is often conveyed not just through single words, but through combinations of words that naturally occur together, which are known as collocations. This section examines such patterns in the isiXhosa and Sesotho MTBBE Grade 4 Mathematics workbooks. Collocation analysis shows how mathematical concepts are packaged as multi-word units, revealing how complex ideas are expressed, structured, and made accessible to learners.

The collocation examples included in Table 4 were chosen manually and purposefully to illustrate the types of multi-word mathematical expressions that most clearly show how isiXhosa and Sesotho adapt English mathematical

terminology. These examples were selected because they represent key Grade 4 mathematical concepts and function as collocations rather than single words. Their meaning is carried by multi-word combinations (e.g. bar graph, frequency table), which cannot be reliably identified through automated frequency counts alone. When corpus tools were used, they often returned word combinations that were statistically frequent but conceptually unrelated. For this reason, the collocations were identified manually through close reading of the workbooks. This approach made it possible to focus on meaningful expressions and to examine how complex mathematical concepts are linguistically packaged and presented to learners in the isiXhosa and Sesotho MTBBE materials

Table 4: Patterns of Mathematical Collocations by Language

Term	**isiXhosa**	**Sesotho**
bar graph	ibha grafu	bar kerafo
frequency table	ifrikhwensi theyibhile	frekhwensi theibole
flow diagram	iflowu dayagram	flow dayakeramo
flow diagrams	iiflowu dayagram	namba laene
expanded notation	ekspandedi noteyishini	ekspanded notheishene
place value	ipleyisi velyu	pleisi velyu
equivalent fraction	ikhwivalenti frekshini	diekhwivalente frakshene
number line	umgca wamanani	namba laene

Table 4 shows that both languages rely heavily on English-based word combinations. Most terms are adapted by changing their spelling and pronunciation to fit isiXhosa and Sesotho, rather than by translating their meanings. Concepts such as bar graph, frequency table, flow diagram, expanded notation, place value, and equivalent fraction therefore appear as close versions of the English forms in both languages, for example, ibha grafu / bar kerafo and ipleyisi velyu / pleisi velyu.

At the same time, there are a few differences between the languages. The term number line shows clearer localisation in isiXhosa, where it appears as *umgca wamanani*, a meaning-based indigenous expression. In contrast, Sesotho uses

namba laene, which is borrowed from English. A similar pattern is seen with 'flow diagrams', where Sesotho alternates between borrowed forms, *flow dayakeramo,* and *namba laene*. This shows some variation in how certain concepts are named and used.

4.3 Discussion of Findings

This section presents the study's findings in relation to the research questions, which explored how mathematical vocabulary is adapted in the Grade 4 isiXhosa and Sesotho MTBBE workbooks. The study considered that the limited availability of established mathematical terms in these languages may influence learners' understanding of mathematical concepts and the broader use of African languages in educational contexts. It examines how current adaptation practices may support or present challenges for learner comprehension and the development of isiXhosa and Sesotho for academic purposes.

The discussion is based on findings generated through both manual examination and computational corpus analysis of the workbooks. These complementary approaches allowed for a detailed identification of vocabulary items that may pose comprehension difficulties, an assessment of the linguistic choices and adaptation strategies employed, and an exploration of the potential contribution of these choices to language development.

By integrating quantitative data, such as term frequency and distribution, with qualitative observations of context and usage, this discussion provides a comprehensive understanding of how terminology choices in the workbooks align with the objectives of MTBBE. It also highlights implications for improving educational resources and supporting the ongoing intellectualisation of isiXhosa and Sesotho as languages of teaching and learning.

4.3.1 RQ1: How have mathematical vocabulary items been adapted in the MTBBE Grade 4 Mathematics workbooks for isiXhosa and Sesotho?

This section addresses Research Question 1 by examining how mathematical vocabulary has been adapted in the Grade 4 isiXhosa and Sesotho MTBBE Mathematics workbooks. It presents the adaptation strategies identified through the corpus and document analyses and compares the approaches used across the two language versions.

The findings indicate that mathematical vocabulary in the MTBBE Grade 4 isiXhosa and Sesotho workbooks is predominantly adapted through English borrowing rather than through the development of original Sesotho and isiXhosa terminology. In both languages, English terms are mainly adapted in spelling and pronunciation, so they fit the sound patterns and noun-class rules of isiXhosa and Sesotho. This echoes what the literature describes as a widespread reliance on borrowing in African language terminology development, particularly in technical subjects (Mabela & Ditsele, 2024). As they explain, borrowing and transliteration are often used when direct equivalents do not exist, leading to surface-level modifications that adjust pronunciation and morphology but do not localise meaning.

This pattern is particularly evident in high-frequency workbook terms such as *khalityhuleyitha/khaltjhuleitha* (calculate) and *frekshini/frakshene* (fraction) which are largely direct transliterations of English. While these terms appear across multiple topics, they are primarily reshaped to fit the phonological rules and noun-class systems of isiXhosa and Sesotho, reflecting the adaptation strategies described in the literature (Mabela & Ditsele, 2024; Bassnett, 2013; Milton, 2009). Such adaptations remain heavily dependent on English semantics, offering limited opportunities for learners to connect mathematical concepts to existing indigenous vocabulary. Consequently, this reliance on transliteration constrains the development of language-specific ways of expressing mathematical ideas and limits the intellectualisation of isiXhosa and Sesotho in Mathematics, a concern highlighted by Khumalo (2017) and

Kaschula and Maseko (2014), who argue that surface borrowing does not advance the cognitive or academic functions of African languages.

Furthermore, measurement terms such as *ilitha (litre), imililitha* (militre), and *iikhilogrem* (kilogram) show similar tendencies. These items are adapted in terms of pronunciation and grammar and do not necessarily contribute to expanding mathematical registers in these languages. This highlights how English continues to dominate technical fields and shape the terminology available to learners, even within mother tongueenvironments. This reflects the broader challenge noted by Sapire & Roberts (2023),–that the absence of standardised Mathematics terminology leads teachers and textbook developers to rely on ad-hoc borrowing, which hinders conceptual clarity. Collocations such as ‘place value’ and ‘expanded notation’ (*ipleyisi velyu / pleisi velyu; ekspandedi noteyishini / ekspanded notheishene*) provide further evidence that even more complex mathematical concepts are conveyed through borrowed phrasing rather than terms developed in isiXhosa or Sesotho. This highlights what Essien et al. (2023) identified as a persistent issue: translations become longer and more linguistically marked, often deviating from natural language usage.

Overall, the adaptation strategies employed in the workbooks prioritise learners' familiarity with English terminology rather than the systematic development of mathematical registers in isiXhosa and Sesotho. While borrowing may enhance accessibility for learners with prior exposure to English, it can disadvantage those with limited contact with the language. This reliance on English-derived terminology is theoretically problematic because it conflicts with the fundamental principles MTBBE, which seek to establish conceptual understanding through learners' first language before introducing equivalent concepts in an additional language. Cummins' (1979) interdependence hypothesis argues that the development of CALP in a second language is dependent on a well-developed foundation in the first language. Academic concepts acquired through the mother tongue can subsequently transfer across languages, enabling learners to engage more effectively with English-medium instruction in later grades. When instructional materials instead depend heavily

on English-derived terminology, learners are required to draw on English academic knowledge that they may not yet possess. Rather than supporting the transfer of conceptual understanding from the home language to English, such an approach risks reversing the intended direction of language development by expecting learners to rely on English linguistic resources to access concepts that should be introduced through isiXhosa or Sesotho.

This finding also aligns with Benson's (2004) argument that the effectiveness of MTBBE depends on the availability of well-developed terminology capable of expressing academic concepts in the home language. Where African-language educational resources rely predominantly on borrowed or minimally adapted English terms, opportunities to strengthen indigenous academic vocabularies are reduced. As a result, isiXhosa and Sesotho function less as independent languages of learning and teaching and more as vehicles for English terminology. This limits the broader goals of MTBBE, which extend beyond improving immediate comprehension to include the development of African languages as fully functional languages of scholarship capable of supporting sustained learning across the curriculum.

4.3.2 RQ2: Which specific mathematical vocabulary items in the isiXhosa and Sesotho workbooks may pose comprehension challenges for Grade 4 learners, and why?

This section addresses Research Question 2 by analysing mathematical vocabulary items that may hinder learner comprehension in the Grade 4 isiXhosa and Sesotho MTBBE workbooks, with particular attention to the linguistic choices underlying these challenges. The analysis identified several linguistic characteristics that may contribute to learner comprehension difficulties, including lexical complexity, phonological structure, morphological layering, and limited familiarity with the adapted terminology.

Lexical complexity is one factor that may contribute to learner comprehension difficulties. This includes characteristics such as word length, low frequency of occurrence, unfamiliar vocabulary, and specialised mathematical terminology.

For example, terms such as *ekspandedi noteyishini* (expanded notation) and ipleyisi velyu (place value) in isiXhosa, and *ekspanded notheishene* and *pleisi velyu* in Sesotho are relatively long (approximately 9 letters per word) and phonologically complex. Similarly, terms related to tessellation and data handling, such as *ifrikhwensi theyibhile* (frequency table) in isiXhosa and *phikthokerafo* (pictograph) in Sesotho, are linguistically unfamiliar and may pose challenges for decoding because they are low-frequency, specialised mathematical terms that learners seldom encounter outside the classroom. Word frequency plays a significant role in lexical processing, with high-frequency words generally recognised and processed more quickly than low-frequency words (van Heuven ,Mandera, Keuleers, & Brysbaert, 2014). Because these mathematical terms are unlikely to form part of learners' everyday vocabulary, they may require greater cognitive effort to decode and interpret before learners can engage with the underlying mathematical concept. This additional processing demand may reduce the cognitive resources available for solving mathematical problems, particularly for Grade 4 learners who are still developing academic language proficiency and conceptual understanding of mathematical terminology.

Phonological complexity could also contribute to comprehension difficulties. Consonant clusters less common in isiXhosa and Sesotho, such as /fr/ in *ifrikhwensi* and /ph/ in *phikthokerafo*, make pronunciation and decoding challenging. Bassnett (2013) explains that transliteration preserves English sound patterns, which further compounds the difficulty even after adaptation. Sapire and Roberts (2023) as well as Khumalo (2017) and Mabela and Ditsele (2024) note that these lightly adapted English loans frequently mismatch the phonotactic norms of African languages, making them harder for learners to process.

Morphological layering presents another potential challenge. For example, *ikhwivalenti frekshini* (equivalent fraction) in isiXhosa and *diekhwivalente frakshene* in Sesotho combine borrowed English roots with noun-class prefixes and plural markers, creating long, multi-morphemic constructions. While

agglutination and morphological layering are natural in isiXhosa and Sesotho, the difficulty arises from the fact that the semantic core of these words is borrowed from English. Learners must simultaneously process a foreign root and a familiar grammatical frame, creating an increased the cognitive effort. It is the mixing of forms, rather than the morphology itself, that increases cognitive demand, a phenomenon described as conceptual opacity by Nkomo (2019). Mostert (2020) similarly notes that English-derived mathematical terms in African languages may be structurally integrated but conceptually disconnected, forcing learners to navigate unfamiliar content through familiar grammatical shells.

Overall, the vocabulary items that pose the greatest challenges are those that are long, low frequency, phonologically marked, and structurally layered. These patterns align with Essien et al. (2023), who highlight that African language mathematical terms often become syntactically heavy when derived from English rather than from indigenous conceptual structures. The morphological and phonological complexity of these terms, combined with their borrowed semantic roots, increases the cognitive load placed on learners, particularly for Grade 4 learners still developing Cognitive Academic Language Proficiency (CALP) (Cummins, 1980).

4.3.3 RQ3: What are the similarities and differences in the approaches to vocabulary adaptation within the isiXhosa and Sesotho workbooks?

A comparative analysis of the isiXhosa and Sesotho Grade 4 MTBBE Mathematics workbooks reveals both shared strategies and language-specific differences in the adaptation of mathematical vocabulary. A clear similarity is the consistent integration of adapted terminology, with both workbooks modifying mathematical terms to fit the phonological and morphological rules of each language. For example, isiXhosa uses *imililitha* for ‘millilitres’, while Sesotho uses *dimililithara*,” both derived from the same English root, with plural markers applied according to the respective noun-class systems. This suggests a shared reliance on borrowing combined with morphological accommodation, reflecting a common strategy of adapting English terminology rather than

developing new, language-internal forms (Mabela & Ditsele, 2024; Nkomo, 2019).

At the same time, the workbooks display meaningful differences that point to language-specific grammatical and phonological preferences. One notable difference lies in how mathematical operations are expressed. IsiXhosa predominantly uses nominal forms such as *udibaniso* (addition) and *uthabatho* (subtraction), while Sesotho tends to rely on verbal constructions, such as *ho eketsa* (to add) and *ho tlosa* (to subtract). This pattern suggests that each language draws on its preferred ways of organising meaning. isiXhosa appears to conceptualise mathematical processes as concepts, whereas Sesotho frames them more directly as actions.

Phonological adaptation also varies between the two workbooks. IsiXhosa often retains pronunciations closer to English, as in *grafu* for ‘graph’, while Sesotho applies more noticeable sound changes, such as *kerafo* for ‘graph’, to fit the language’s sound patterns. These differences do not suggest that one approach is better or more accurate than the other. Rather, they indicate how each language reshapes borrowed terms in ways that feel natural within its own sound system. As a result, the same English mathematical concept may look and sound different across the two workbooks, even though it refers to the same underlying idea.

These patterns suggest that while both languages follow a shared strategy of modifying English mathematical terms, the final form of the vocabulary is shaped by each language’s internal structure. Both isiXhosa and Sesotho make extensive use of English-based terminology adapted to their phonological and morphological systems, but differences in grammatical preferences such as noun versus verb usage, and in sound adaptation have led to distinct outcomes. The linguistic patterns observed reflect adaptation from an English version rather than original terminology development within each language. The frequent use of English-derived terminology, together with systematic phonological and morphological restructuring support that the mathematical

vocabulary follows a translation-and-adaptation model in both isiXhosa and Sesotho.

4.3.4 RQ4: To what extent do the linguistic choices in the vocabulary adaptation of the workbooks support the promotion and development of isiXhosa and Sesotho?

The linguistic choices in the workbooks show early progress in supporting academic language development. Indigenous verbs used in the workbooks such as *umgca wamanani* (number line) ,*thabatha* (subtract) demonstrate that fundamental mathematical operations can be expressed meaningfully in learners' home languages. These verbs also appear frequently in the workbooks, which highlights their functional role in classroom discourse and provides learners with repeated opportunities to internalise both the grammatical and conceptual structures of their languages. This suggests that, at least for core operations, the workbooks effectively leverage learners' linguistic backgrounds to support comprehension and participation in academic Mathematics.

The overall adaptation strategy in the MTBBE workbooks relies heavily on English-based adaptations, which dominate much of the technical vocabulary. Many mathematical concepts are carried over from English and modified only superficially through adjusted spelling, pronunciation, or the addition of vowels and noun-class markers. Although these adaptations make the terms appear to conform to isiXhosa or Sesotho linguistic norms on the surface, the meaning is not generated from within the African languages themselves. Instead, the adapted forms remain semantically dependent on English, offering limited support for genuine understanding in the mother tongue (Khumalo, 2017).

While South Africa's MTBBE model is mother-tongue-based rather than a full mother tongueeducation system, this does not reduce the need for meaningful conceptual access in learners' home languages. MTBBE is intended not merely to use the mother tongue as a medium of instruction, but to enable it to function as a cognitive tool for engaging with new academic concepts.

When key mathematical terms are mostly phonological borrowings with very little localisation, they remain unclear to learners who do not already know the English originals. As a result, the mother tongue becomes only a superficial carrier of English concepts rather than a language that genuinely supports understanding and conceptual development.

This is especially important because learning in the vernacular is meant to make new concepts easier to grasp by using familiar vocabulary, allowing learners to connect ideas to what they already know (Cummins,1979) and Benson (2004). However, many of the adapted mathematical terms are neither common nor naturally occurring in isiXhosa or Sesotho. As a result, they do not provide the familiarity and conceptual grounding that vernacular instruction is intended to offer. Instead of supporting comprehension, these terms introduce unfamiliar forms that act more like disguised English, limiting the very benefits that MTBBE is designed to deliver.

Therefore, while current adaptation practices provide basic access to mathematical vocabulary, they fall short of supporting the deeper linguistic and cognitive development that MTBBE aims to promote. Phonological adjustment and transliteration alone cannot drive the intellectualisation of isiXhosa and Sesotho. Achieving this requires deliberate terminology development and creating terms that are culturally grounded and consistently used across educational contexts. Without such intentional work, African languages will remain dependent on English for technical expression, limiting their growth as academic mediums.

4.3.5 RQ5: What insights can be gained from the adaptation of vocabulary in the isiXhosa and Sesotho workbooks, and how can these inform the development of future MTBBE materials?

The analysis of vocabulary adaptation in the Grade 4 isiXhosa and Sesotho MTBBE Mathematics workbooks provides important insights into how mathematical terminology is currently developed and its implications for future

materials. The findings indicate that adaptation is predominantly achieved through borrowing and transliteration from English, with relatively limited development of terms that are conceptually grounded in isiXhosa and Sesotho. This reliance on English-based terms means that learners often need prior English knowledge to understand technical vocabulary, limiting their ability to access mathematical concepts fully through their home language.

While borrowing is a legitimate strategy within multilingual education, its dominance highlights the need for deliberate corpus and terminology development (Cooper,1989: Khumalo,2017). These scholars collectively argue that African languages cannot develop academically through surface-level phonological borrowing alone; instead, they require structured expansion that is conceptually rooted in the language. Similarly, standardisation efforts are essential if isiXhosa and Sesotho are to function effectively as languages of Mathematics. Strengthening isiXhosa and Sesotho as functional languages of Mathematics requires that adapted terms not only follow grammatical rules, such as prefixes and noun-class markers, but are also rooted in the home language. Systematic reinforcement of these terms across contexts can help learners internalise concepts, build understanding and develop confidence in using African languages as effective mediums for Mathematics.

Additionally, the National Literacy Strategy (Department of Basic Education, 2024) stresses that all educational materials must be grounded in the typological and structural characteristics of African languages. This means that terminology should be developed in ways that reflect the grammatical systems, phonology, and semantic patterns of the languages themselves, rather than merely modifying English forms. Aligning materials with the typology of isiXhosa and Sesotho would not only strengthen comprehension but also affirm these languages as capable mediums for academic reasoning. Overall, the insights from this study suggest that future MTBBE materials should move beyond simply reproducing English-based adaptations and actively develop and support terminology in learners' home languages. This approach would strengthen African languages as fully functional mediums of learning, giving

learners access to mathematical concepts in their mother tongue. By doing so, learners can better understand and engage with the content. This may help address the challenges they often face in schools where instruction in English limits comprehension and participation, as highlighted by the research in this study.

CHAPTER 5: CONCLUSION

This study examined how mathematical vocabulary is adapted in the Grade 4 isiXhosa and Sesotho MTBBE Mathematics workbooks, focusing on the linguistic strategies used, the potential challenges these strategies present for learner comprehension, and the implications for the academic development of African languages. Guided by a mixed-methods corpus-based approach, the study analysed term frequencies, KWIC patterns, collocations, and linguistic adaptations while interpreting these results through established literature on mother tongue education, language planning, and terminology development.

5.1 Summary of Major Findings

The findings of this study reveal a consistent pattern in how mathematical terminology is constructed within the Grade 4 isiXhosa and Sesotho MTBBE workbooks. Across both languages, the dominant strategy remains the adaptation of English terms through borrowing and phonological reshaping. While these adapted forms conform to the phonological and noun-class systems of isiXhosa and Sesotho, they remain semantically tethered to English. This mirrors long-standing observations in the literature that African-language terminology development in technical subjects is still heavily dependent on English linguistic structures rather than originating from internal lexical resources (Mabela & Ditsele, 2024; Nkomo, 2019). As a result, the development of independent mathematical registers in isiXhosa and Sesotho remains limited.

The reliance on transliterated English terms also explains why certain mathematical items emerged as particularly demanding for Grade 4 learners. Terms such as *ekspandedi noteyishini*, *ifrikhwensi theyibhile*, and *diekhwivalente frakshene* are characterised by their length, phonological complexity, and low frequency in everyday usage. These features make them especially challenging for learners who are still acquiring CALP, reinforcing the concerns raised by researchers such as Mostert (2020) and Essien et al. (2023). This highlights how heavy borrowing, when not accompanied by

conceptual localisation, often produces words that may pose comprehensibility challenges for learners.

Although both languages employ borrowing as their primary strategy, how borrowed terms are integrated differs subtly between the two. IsiXhosa tends to reshape English-derived vocabulary to align with its phonological patterns, while Sesotho incorporates these terms using systematic morphological marking, particularly through noun-class prefixes such as *di-*. These differences reflect each language's grammar rather than deliberate terminology development strategies. Nevertheless, the underlying reliance on English roots remains consistent, leaving little room for the conceptual indigenisation that African language scholars argue is essential for true intellectualisation.

The findings also demonstrate that while the workbooks incorporate certain indigenous verbs such as *udibaniso*, *uthabatha*, *ho eketsa*, and *ho tlosa*, which effectively anchor basic operations within familiar linguistic structures, these strengths are not characteristic of the technical vocabulary more broadly. In the more specialised domains of measurement, geometry, data handling, and fractions, borrowing remains overwhelmingly dominant. This pattern suggests partial support for language development within MTBBE: learners encounter some concepts expressed meaningfully in their mother tongue, but most of the technical terminology continues to reproduce English conceptual frames. This echoes the caution raised by Khumalo (2017) and Kaschula & Maseko (2014), who argue that borrowing, while sometimes necessary, cannot by itself drive the intellectualisation of African languages.

The results pointed to several insights relevant to the future refinement of MTBBE materials. The continued dependence on English-based adaptations indicates a need for coordinated and systematic terminology development that draws more deliberately on the linguistic and conceptual resources of isiXhosa and Sesotho. Additionally, the findings highlight the importance of aligning language practices in educational materials with the typological structures of African languages, as emphasised in the National Literacy Strategy (DBE,

2024). Finally, the successful implementation of MTBBE depends not only on the quality of materials but also on the linguistic confidence of teachers. Explicit support through glossaries, pronunciation guides, and professional development is crucial to ensure that adapted terms are introduced consistently and effectively in the classroom (Ntaka & Gustafsson, 2024; Guzula, as cited in University of Cape Town, 2025).

5.2 Contributions of the Study

This study makes several significant contributions across the domains of African language development, MTBBE implementation, corpus-based linguistic research, and policy refinement. Together, these contributions advance both the theoretical and practical understanding of how African languages can be strengthened as academic mediums within South Africa's multilingual education system.

5.2.1 Contribution to African Language Development

Firstly, the study contributes to African language development by providing empirical evidence of how English borrowing currently shapes the mathematical registers of isiXhosa and Sesotho in MTBBE materials. Whereas policy documents such as the Constitution (1996), LiEP (1997), and the National Literacy Strategy (DBE, 2024) emphasise the need to elevate the status and function of African languages, this study demonstrates how the existing linguistic practices in educational materials remain heavily reliant on English-derived forms.

The analysis highlights the areas in which borrowing has become the default adaptation strategy and reveals where purposeful terminology coinage is urgently required if isiXhosa and Sesotho are to develop independent and conceptually robust mathematical registers. In doing so, the study responds to long-standing calls by scholars such as Alexander (1998), Khumalo (2017), and Maseko and Kaschula (2014), who argue that the intellectualisation of African languages depends on expanding their technical vocabularies through

systematic, locally grounded linguistic development, not simply adapting English terms.

5.2.2 Contribution to the Implementation of MTBBE

Secondly, the study contributes to the ongoing implementation of MTBBE in South Africa. While policy frameworks signal a strong political commitment to extending home-language education beyond Grade 3, the success of MTBBE ultimately relies on the linguistic accessibility of the resources that support it. By examining how mathematical terms are adapted and how learners might encounter difficulty with the most complex and low-frequency items, this study provides practical insight into the extent to which current materials facilitate or hinder learners' comprehension. The findings demonstrated specific vocabulary gaps, particularly in domains such as measurement, fractions, and data handling, that must be addressed if MTBBE is to deliver on its promise of improving conceptual understanding and reducing the cognitive load associated with English-medium instruction. In this way, the study supports the national push toward equitable education and reinforces MTBBE's goals of strengthening conceptual access through the home language.

5.2.3 Contribution to Linguistic and Corpus Research

Thirdly, this study contributes to ongoing research on African language corpora by applying corpus-based methods in an educational context. Using a specialised corpus drawn from isiXhosa, Sesotho, and English MTBBE Mathematics workbooks, it illustrates one approach to analysing vocabulary adaptation in multilingual settings. While the corpus is small and focused, it provides structured linguistic data that can complement existing resources and support further research in terminology development for African languages.

5.2.4 Contributes to Policy and Curriculum Development

The findings offer evidence-based insights relevant to the Department of Basic Education, PanSALB, the National Language Service, curriculum advisors, and textbook developers. By identifying inconsistencies in terminology adaptation, revealing the linguistic challenges embedded within current materials, and

highlighting where indigenous linguistic resources are underutilised, the study provides guidance that can support more coherent terminology planning and quality assurance processes. Moreover, by aligning its recommendations with broader national initiatives, such as the expansion of MTBBE and the National Literacy Strategy's emphasis on the typological realities of African languages, the study positions itself as a practical resource for policymakers seeking to strengthen the linguistic foundations of MTBBE. Through these contributions, the research supports efforts to build a more inclusive, linguistically responsive education system that affirms the academic value and potential of African languages.

5.3 Limitations of the Study and Recommendations for Further Research

Although this study contributes valuable insights into vocabulary adaptation in the isiXhosa and Sesotho Grade 4 Mathematics workbooks used in MTBBE, several limitations should be recognised to ensure that its findings are interpreted within the appropriate context. These limitations also point to opportunities for future research.

5.3.1 Limited Scope of Data

The study focused on the Grade 4 Mathematics workbooks in isiXhosa and Sesotho, using the English version as the base text for comparison. These materials represent only one subject and one grade level. Therefore, the findings may not fully reflect vocabulary adaptation practices in other subjects, grade levels, or African languages used within the South African education system. The linguistic patterns identified may differ in subjects with different conceptual demands or in languages with distinct morphological structures. In addition, the analysis was limited to the official DBE workbooks and did not include supplementary resources such as teacher guides or informal classroom materials. Because the workbooks represent only one component of the broader MTBBE resource ecosystem, the study captures only part of the linguistic environment encountered by learners.

Furthermore, the corpus analysed in this study is relatively small, which limits the extent to which the findings can be generalised beyond the selected materials. Although the smaller corpus enabled a detailed examination of specific terms and adaptation strategies, it reduced the range of linguistic variation available for comparison, including alternative translation strategies, different terminology choices for the same mathematical concepts, and variation in the morphological and phonological adaptation of borrowed terms. Consequently, less frequent vocabulary patterns or alternative adaptation strategies may not have been captured. The findings therefore reflect the linguistic characteristics of the analysed texts rather than broader patterns that may exist across multiple grades, subjects, or MTBBE materials.

Future research could address these limitations by expanding the corpus to include additional grades, subjects and other African languages. A larger and more diverse corpus would enable comparative analyses across different educational contexts and provide a more comprehensive understanding of vocabulary adaptation practices within MTBBE. Such research could also incorporate supplementary teaching and learning materials, including teacher guides and classroom resources, to capture a broader representation of the linguistic environment supporting multilingual education.

5.3.2 Lack of Classroom-Based Evidence

The study did not include learner performance data, teacher interviews, classroom observations, or evidence of how the workbooks are used in practice. Consequently, conclusions regarding potential comprehension challenges are based solely on the linguistic analysis of vocabulary adaptation rather than on direct evidence of learners' understanding or classroom interaction. While the study identifies vocabulary that may present conceptual challenges, it cannot determine how learners interpret adapted terminology, how teachers explain unfamiliar concepts, or how effectively the workbooks support teaching and learning in authentic classroom settings.

Future research should complement corpus-based analyses with empirical classroom investigations. Studies involving learner assessments, classroom

observations, teacher interviews, and learner focus groups could provide valuable evidence of how adapted mathematical terminology is understood, taught, and applied in practice. Such research would help determine whether borrowed, translated, or newly coined terms best support conceptual understanding and could further explore the pedagogical strategies teachers employ to introduce and reinforce mathematical vocabulary within MTBBE classrooms.

5.4 Implications for Practice

The recommendations presented below are intended to respond to the specific challenges identified in this study and to inform the ongoing implementation of MTBBE in South Africa. The focus is therefore on realistic, incremental improvements that are aligned with existing language and education structures.

This study suggests several targeted implications for strengthening the implementation of MTBBE Mathematics materials in South Africa. First, there is a need for greater standardisation of mathematical terminology used in isiXhosa and Sesotho workbooks. Centralised term banks and consistent spelling conventions would reduce duplication and variation, thereby supporting clearer learner comprehension.

Secondly, terminology development should move beyond the widespread phonological adaptation of English terms towards the deliberate creation of semantically transparent and culturally meaningful equivalents, particularly for abstract mathematical concepts. Such an approach would better support learners' conceptual understanding in the home language.

Thirdly, teachers require focused support to work effectively with MTBBE materials. This includes access to terminology glossaries, pronunciation guides, and exemplary lesson resources that are directly aligned with the workbooks, as well as professional development that strengthens confidence in using adapted and newly coined terms.

Finally, consistency across MTBBE learner and teacher materials is essential. Aligning terminology and orthographic conventions, supported by quality assurance processes during material development, would help ensure uniform and coherent use of mathematical language. While these measures cannot address all challenges facing MTBBE, they represent practical, achievable steps toward strengthening the role of African languages as effective mediums for Mathematics teaching and learning.

These implications show that improving MTBBE is not achieved through a single solution, but through ongoing, coordinated efforts in terminology development, teacher support, material design, and policy alignment over time.

5.5 Conclusion

This study has demonstrated that while MTBBE represents an important step toward equitable education, its success depends on robust linguistic work that extends beyond translating English terms into African languages. The Grade 4 isiXhosa and Sesotho workbooks show progress, particularly in the use of indigenous verbs for basic operations, yet they also reveal heavy reliance on English-based adaptations that restrict conceptual accessibility and limit the intellectualisation of African languages.

If MTBBE is to fulfil its promise, improving comprehension, strengthening learning outcomes, and affirming African languages as full academic languages, then terminology development must move beyond phonological borrowing. Deliberate, coordinated, and linguistically grounded efforts are required to ensure that African languages evolve into languages of Mathematics, Science, and modern knowledge. Ultimately, this study affirms that language development is educational development. Strengthening isiXhosa and Sesotho as academic languages is not only a linguistic task but a pedagogical and social justice necessity which is essential for building a more equitable and linguistically empowered education system in South Africa.

REFERENCES

Alexander, N. (1998). The political economy of the harmonisation of the Nguni and the Sotho languages. Lexikos, 8(1), 269–275. https://doi.org/10.5788/8-1-957

Afolayan, A. (1984). *The English language in Nigerian education as an agent of proper multilingual and multicultural development*. *Journal of Multilingual and Multicultural Development, 5*(1), 27–34.

Almeida, F. (2018). Strategies to perform a mixed methods study. European Journal of Education Studies,*5*(1),137–151.. http://dx.doi.org/10.5281/zenodo.1406214

August-Mowers, C. M. (2025). The slowly turning wheels on Mother Tongue-Based Bilingual Education (MTBBE) finally stopped. South African Journal of Higher Education, 39(3), 16–36. https://doi.org/10.20853/39-3-7348

Bamgbose, A. (1976). *Mother tongue education: The West African experience*. UNESCO Press.

Benson, C. (2004). The importance of mother tongue-based schooling for educational quality. Background paper for the Education for All Global Monitoring Report 2005. UNESCO.

Bassnett, S. (2013). Translation studies (4th ed.). Routledge. https://doi.org/10.4324/9780203488232

Benoit, K., Obeng, A., Nulty, P., & Matsuo, A. (2025). readtext: Read text files into R for text analysis (Version 0.99.40) [R package]. https://CRAN.R-project.org/package=readtext

Benoit, K., Watanabe, K., Wang, H., Nulty, P., Obeng, A., Müller, S., & Matsuo, A. (2018). quanteda: An R package for the quantitative analysis of textual data. Journal of Open Source Software, 3(30), 774. https://doi.org/10.21105/joss.00774

Chimhundu, H. (2002). Adoption and adaptation in Shona. ALLEX Project, University of Zimbabwe.

Chumbow, B. S. (2013). Mother tongue-based multilingual education. In H. McIlwraith (Ed.), Multilingual education in Africa (pp. 37–55). British Council.

Coetzer, T., Livingston, C., & Barnard, E. (2023). Eleven Grade 1 teachers' understandings of mathematical language in a South African context. Reading & Writing, 14(1), a409. https://doi.org/10.4102/rw.v14i1.409

Coombs, H. (2022). Case study research: Single or multiple [White paper]. Southern Utah University. https://doi.org/10.5281/zenodo.7604301

Cooper, R. L. (1989). Language planning and social change. Cambridge University Press.

Cropley, A. (2023). Qualitative research methods: A practice-oriented introduction. Editura Intaglio.

Creswell, J. W. (2009). Research design: Qualitative, quantitative, and mixed methods approaches (3rd ed.). SAGE Publications

Cummins, J. (1979). Linguistic interdependence and the educational development of bilingual children. Bilingual Education Paper Series, 3(2), 27–38.

Cummins, J. (1980). The cross-lingual dimensions of language proficiency: implications for bilingual education and the optimal age issue. TESOL Quarterly, 14(2), 175–187.

Dagalea, A. J. L., Peralta, S. B., & Abocejo, F. T. (2022). Evaluation of the mother tongue-based multilingual education program in the Philippines. Budapest International Research and Critics in Linguistics and Education Journal, 5(4), 422–431. https://doi.org/10.33258/birle.v5i4.7269

deMarrais, K., Roulston, K., & Copple, J. (2024). Qualitative research design and methods: An introduction. Myers Education Press.

Department of Arts and Culture. (2013). Multilingual mathematics dictionary: Grade R–6 (2nd ed.). Department of Arts and Culture.

Demuth, K. (1992). Acquisition of Sesotho. In D. Slobin (Ed.), The crosslinguistic study of language acquisition (Vol. 3, pp. 557–638). Lawrence Erlbaum Associates.

Department of Basic Education. (2011). Curriculum and assessment policy statement (CAPS): Mathematics grades 4–6. government printing works.

Department of Basic Education. (2013). The incremental introduction of African languages: Draft policy. https://www.education.gov.za/Portals/0/Documents/Policies/IIAL%20Policy%20September%202013%20(3).pdf

Department of Basic Education. (2024a). South African 2023 Trends in International Mathematics and Science Study (TIMSS) highlights report. Department of Basic Education. https://www.education.gov.za/Portals/0/Documents/Reports/2024/TIMSS%202024.pdf

Department of Basic Education. (2023a). PIRLS 2021: South African preliminary highlights report. Department of Basic Education. https://www.education.gov.za/Portals/0/Documents/Reports/2023/PIRLS%202021_Highlights%20Reports.pd

Department of Basic Education. (2024b). Mother-tongue-based bilingual education. https://www.education.gov.za/ArchivedDocuments/ArchivedArticles/Mother-tongue-based-Bilingual-Education-0224.aspx

Department of Basic Education. (2023c). South African national literacy strategy and plan 2024–2030. Department of Basic Education. https://www.education.gov.za/Portals/0/Documents/Publications/2025/South%20African%20National%20Literacy%20Strategy%20and%20Plan%202024-2030.pdf

Department of Basic Education. (n.d.). Languages: Frequently asked questions. https://www.thutong.doe.gov.za/Languages/FAQ

Department of Education. (1997). Language in education policy. https://www.education.gov.za/Portals/0/Documents/Policies/GET/LanguageEducationPolicy1997.pdf

Department of Basic Education. (2024d). SEACMEQ V South African technical report: A study of the conditions of schooling and the quality of education. Department of Basic Education.https://www.education.gov.za/Portals/0/Documents/Reports/2024/SEACMEQ%20V.pdf?ver=2024-12-03-170622-000

Department of Basic Education. (2023b). Workbooks (Rainbow workbooks for learners). https://www.education.gov.za/Curriculum/Workbooks/tabid/574/Default.aspx

Djite, P. H. (2011). The language differences: Language and development in the Greater Mekong Sub-Region.Multilingual Matters.

Essien, A. A., Sapire, I., & Taylor, N. (2023). Landscape analysis of the role of language in early grades mathematics. JET Education Services. https://www.jet.org.za/resources

Ferguson, G. (2013). The language of instruction issue. In H. McIlwraith (Ed.), Multilingual education in Africa (pp. 17–20). British Council.

Fesi, L., & Mncube, V. (2021). Challenges of English as a first additional language: Fourth grade reading teachers' perspectives. South African Journal of Education, 41(3), 1–11. https://doi.org/10.15700/saje.v41n3a1849

Flowerdew, L. (2004). English specialized corpora. In U. Connor & T. Upton (Eds.), Discourse in the professions (pp. 11–33). John Benjamins.

Flowerdew, L. (2012). Corpus-based discourse analysis. In R. Wodak & M. Meyer (Eds.), Methods of critical discourse studies (2nd ed., pp. 174–188). Routledge.

Genesee, F. (2004). What do we know about bilingual education for majority language students? In T. K. Bhatia & W. C. Ritchie (Eds.), The handbook of bilingualism (pp. 547–576). Blackwell Publishing.

Gophe, M. (2025, February 17). A step towards multilingualism and equity. UCT News. https://www.news.uct.ac.za/article/-2025-02-17-a-step-towards-multilingualism

Graham, M. A., Kruger, G. M., & van Ryneveld, L. (2024). Developing a novel model for ICT integration in South African education: Insights from TIMSS. Education Sciences, 14(8), 865. https://doi.org/10.3390/educsci14080865

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), Handbook of qualitative research (pp. 105–117). Sage.

Hancock, D. R., & Algozzine, B. (2017). Doing case study research (3rd ed.). Teachers College Press.

Huddleston, R., & Pullum, G. K. (2002). The Cambridge grammar of the English language. Cambridge University Press.

Hunston, S. (2002). Corpora in applied linguistics. Cambridge University Press.

International Association for the Evaluation of Educational Achievement. (n.d.). PIRLS. https://www.iea.nl/studies/iea/pirls

International Association for the Evaluation of Educational Achievement. (n.d.). TIMSS National Reports – South Africa. https://www.timss-sa.org

International Association for the Evaluation of Educational Achievement. (2024). TIMSS 2023: South Africa. https://timss2023.org/wp-content/uploads/2024/10/South-Africa.pdf

Ipara, I., & Mbori, B. (2009). *The role of Kiswahili in enhancing science and technology*. *The Journal of Pan African Studies, 2*(8), 139–150.

Kamwendo, G. H. (2013). Language in education in South Sudan. In H. McIlwraith (Ed.), Multilingual education in Africa (pp. 103–107). British Council.

Karikari, A., Kumi, E. O., Achiaa, E. A., & Adu, J. (2022). The impact of using mother tongue as instructional language in teaching and learning of mathematics in rural primary schools (A case study of four selected schools in Sefwi Akontombra District, Ghana). International Journal of Novel Research in Education and Learning, 9(1), 26–38

Kaschula, R. H., & Maseko, P. (2014). Researching intellectualisation. In R. H. Kaschula, P. Maseko, & H. Ekkehard Wolff (Eds.), Multilingualism and intercultural communication: A South African perspective (pp. 19–33). Wits University Press.

Khumalo, L. (2017). Intellectualization through terminology development. Lexikos, 27(1), 252–264. https://doi.org/10.5788/27-1-1402

Kivunja, C., & Kuyini, A. B. (2017). Understanding and applying research paradigms in educational contexts. International Journal of Higher Education, 6(5), 26–41. https://doi.org/10.5430/ijhe.v6n5p26

Kuhn, T. S. (1996). The structure of scientific revolutions (3rd ed.). University of Chicago Press.

MacFarlane, D. (2003). Bantu education and its legacy. Wits University Press.

MacFarlane, M. (2024). Performance of L1 and L2 Grade 6 South African learners on an assessment of core academic language skills. Per Linguam, 40(1), 75–92. https://doi.org/10.5785/40-1-1084

Maepa, S., Linden, M., Blose, O., & Moretsi, M. (2024). Literature review of academic work related to language standardisation. PanSALB.

Makalela, L. (2015). New directions in language policy and planning in South Africa. University of Pretoria Press.

Makalela, L. (2022). Not eleven languages: Translanguaging and South African multilingualism in concert. De Gruyter Mouton.

Manning, C. D., & Schütze, H. (1999). Foundations of statistical natural language processing. MIT Press.

Mandende, I. P., Ramuedzisi, L. S., & van Huyssteen, L. (2019). Terminology development. South African Journal of African Languages, 39(3), 263–272. https://doi.org/10.1080/02572117.2019.1672322

Matsinhe, S. F. (2013). African languages in Africa's quest for development. In H. McIlwraith (Ed.), Multilingual education in Africa (pp. 23–33). British Council.

Mabela, M. L., & Ditsele, T. (2024). Exploring intellectualisation of indigenous languages. Literator, 45(1), a1980.https://doi.org/10.4102/lit.v45i1.1980

Mbude, N. N. (2019). IsiXhosa as the language of teaching and learning mathematics in Grade Six: Investigating the mother tongue based bilingual education mathematics pilot in the Eastern Cape Province, South Africa (Doctoral dissertation, Rhodes University). Rhodes University Research Repository. http://hdl.handle.net/10962/143262

Mbude-Mehana, N. (2024, February 28). Mother tongue-based bilingual education (MTBBE) [Presentation]. Department of Basic Education, Pretoria, South Africa.

Mbude-Mehana, N. (2024). Mother tongue power: Literacy and bilingual education (Tuesdays in the Trenches presentation). National Schools Safety and Curriculum Evaluation Centre (NASCEE). https://nascee.org.za/tuesdays-in-the-trenches-presentations-2024/dr-naledi-mbude-mehana-mother-tongue-power.pdf

McLachlan, K., & Essien, A. A. (2022). Language in mathematics teaching. Pythagoras, 43(1), a669. https://doi.org/10.4102/pythagoras.v43i1.669

Mhlolo, M. K. (2025). Excellence for some before equity for all: Re-examining the national strategy for mathematics education through the capability approach theory. South African Journal of Education, 45(2), 1–11. https://doi.org/10.15700/saje.v45n2a2423

Milton, J. (2009). Translation and adaptation studies. Translation Research Projects, 2, 51–58.

Magocha, M., Mutasa, D. E., & Rammala, J. R. (2019). Mother-tongue education in South Africa: A highly contested terrain of the 21st century. *South African Journal of African Languages, 39*(3), 253–262. https://doi.org/10.1080/02572117.2019.1672321

Mostert, I. E. (2020). Number and comparison in early grade mathematics: Learning from isiXhosa and English canonical texts (Doctoral dissertation, University of Johannesburg). https://hdl.handle.net/10210/482934

Mostert, I., & Roberts, N. (2022). Diversity of mathematical expression: The language of comparison in English and isiXhosa early grade mathematics texts. Research in Mathematics Education, 24(1), 3–23. https://doi.org/10.1080/14794802.2020.1821757

Motshekga, A. (2023, July 27). Minister Angie Motshekga: Language Policy Conference. Republic of South Africa. https://www.gov.za/news/speeches/minister-angie-motshekga-language-policy-conference-27-jul-2023

Ngubane, S. P., & Ngwenya, E. T. (2025). Implementing mother tongue based bilingual education through translanguaging in multilingual classrooms: A systematic review. International Journal of Learning, Teaching and

Educational Research, 24(6), 741–757. https://doi.org/10.26803/ijlter.24.6.34

Nkomo, D. (2019). Theoretical and practical reflections on specialized lexicography in African languages. Lexikos, 29(1), 96–124. https://doi.org/10.5788/29-1-1514

Mbekwa, M., Nomlomo, V. (2013). Voices from the Classroom. In: Napier, D.B., Majhanovich, S. (eds) Education, Dominance and Identity. Comparative and International Education, vol 1. SensePublishers, Rotterdam. https://doi.org/10.1007/978-94-6209-125-2_9

Ntaka, P., & Gustafsson, M. (2024). How well have teacher supply and demand been aligned in recent years? Looking below the aggregates at the specialisation of teachers. Research on Socio-Economic Policy (ReSEP).

Nugraha, S. I. (2019). The language-in-education policy in South Africa: A gap between policy and efficacy. In Proceedings of the Eleventh Conference on Applied Linguistics (CONAPLIN 2018) (Advances in Social Science, Education and Humanities Research, Vol. 254). Atlantis Press. https://doi.org/10.2991/conaplin-18.2019.321

Okoye, F. I. (2012). The use of languages in mainstream Grade 4 schools in KwaZulu-Natal: Implications for policy development (Master's dissertation, University of KwaZulu-Natal). http://hdl.handle.net/10413/8832

Omodan, B. I. (2024). Research paradigms and their methodological alignment in social sciences. Routledge.

Pan South African Language Board. (n.d.). PanSALB – Pan South African Language Board. https://www.pansalb.org

Pan South African Language Board. (2018). PanSALB language policy (Version 4). https://www.pansalb.org/wp-content/uploads/PanSALB-approved-Language-Policy.pdf

Pan South African Language Board. (2025). Annual report 2023/2024. Pan South African Language Board.

Pedersen, T. L. (2020). patchwork: The composer of plots [R package]. https://CRAN.R-project.org/package=patchwork

Perez, N. B. (2019). Comparative study of MTB-MLE programs. American Journal of Humanities and Social Sciences Research, 3(6), 47–55.

R Core Team. (2025). R: A language and environment for statistical computing. https://www.R-project.org/

Republic of South Africa. (1996). *Constitution of the Republic of South Africa, 1996*. South African Government

Republic of South Africa. (1997). Language in education policy. https://www.education.gov.za/Portals/0/Documents/Policies/GET/LanguageEducationPolicy1997.pdf

Sapire, I., & Roberts, G. (2023). The status of the language of learning and teaching (LoLT) in schools: A quantitative overview: 2008–2016. Department of Basic Education.

Silge, J., & Robinson, D. (2016). tidytext: Text mining in R. Journal of Open Source Software, 1(3), 37. https://doi.org/10.21105/joss.00037

Spaull, N. (2023). PIRLS 2021 overview of key findings. https://nascee.org.za/resources/nascee-resources/pirls-2021-main-findings-16-may-2023-docx.pdf

Stefanowitsch, A. (2020). Corpus linguistics: A guide to the methodology. Language Science Press.

Tshotsho, B. P. (2013). Mother tongue debate. International Journal of Humanities and Social Science, 3(13), 39–44.

UNESCO. (2003). Education in a multilingual world. UNESCO.

University of Cape Town. (2025, February 17). *A step towards multilingualism and equity in South African education*. https://www.news.uct.ac.za/news/audio/-article/2025-02-17-a-step-towards-multilingualism-and-equity-in-south-african-education

van Heuven, W., Mandera, P., Keuleers, E., & Brysbaert, M. (2014). Subtlex-UK: A new and improved word frequency database for British English. Quarterly Journal of Experimental Psychology, 67(6), 1176–1190.

Van Staden, S., Bosker, R., & Bergbauer, A. (2016). Differences in achievement between home language and language of learning in South Africa: Evidence from prePIRLS 2011. South African Journal of Childhood Education, 6(1), a441. http://dx.doi.org/10.4102/sajce.v6i1.441

Visser, M. (2008). Definiteness and specificity in the isiXhosa determiner phrase. South African Journal of African Languages, 28(1), 11–28.

Vosiljonov, A. (2022). Basic principles of corpus linguistics. Academicia Globe, 3(2), 173–175.

Walliman, N. (2022). Research methods: The basics. Routledge.

Wickham, H. (2016). ggplot2: Elegant graphics for data analysis. Springer.

Wickham, H., Hester, J., & Bryan, J. (2025). readr: Read rectangular text data [R package]. https://CRAN.R-project.org/package=readr

Zougris, K. (2025). Origins, styles, and applications of text analytics in social science research. Encyclopedia, 5(2), 70. https://doi.org/10.3390/encyclopedia5020070

ANNEXURE A

Department of Basic Education Gatekeeper Approval Letter

basic education
Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

Private Bag X895, Pretoria, 0001, Sol Plaatjie House, 222 Struben Street, Pretoria, 0002, South Africa
Tel.: (012) 357 3000, Fax: (012) 323 0601, www.education.gov.za

Ref no: 00075/2025/1
Enquiries: Dr S Taylor
Tel: (012) 357-4156
Email: taylor.s@dbe.gov.za

Ms L Malemela
86 Itsanang Street
Mahube Valley
PRETORIA
0122

By e-mail: 62550373@mylife.unisa.ac.za

Dear Ms Malemela

RESPONSE TO A REQUEST FOR PERMISSION TO USE DEPARTMENT OF BASIC EDUCATION (DBE) LEARNER WORKBOOKS FOR RESEARCH PURPOSES - STUDENT NUMBER : 62550373

The Department of Basic Education (DBE) received your request to use the DBE learner workbooks for your research titled *"Mother Tongue-Based Bilingual Education in South Africa: An Analysis of Vocabulary Adaptation in Grade 4 Mathematics Workbooks."*

The request is approved on condition that the researcher adheres to the conditions set in the research protocol and to the ethical conduct of using research information.

We wish you all the best with the research.

Yours sincerely

MR HM MWELI
DIRECTOR-GENERAL
DATE: 23 APRIL 2025

ANNEXURE B

Ethics approval letter

College of Human Sciences_CREC

NHREC Registration # : (Rec-240816-052)
Ref #: 7318
Name: Ms Lehlogonolo Malemela
Student #: 62550373

Date: 02/09/2025

Dear: Ms Lehlogonolo Malemela

Decision: Ethics Approval from 02 September 2025 to 01 September 2026

Researcher: Ms Lehlogonolo Malemela

86 Itsanang Street Mahube Valley Mamelodi

Pretoria

62550373@mylife.unisa.ac.za 0678401738

Supervisor: Ms Mikaela Daries mikaeladaries@gmail.com

Mother Tongue-Based Bilingual Education in South Africa: An Analysis of Vocabulary Adaptation in Grade 4 Mathematics Workbooks

Qualification: Master of Arts in Linguistics (GEN)

Thank you for the application for research ethics approval by the College of Human Sciences_CREC for the above-mentioned research study. Ethics approval is granted for **one year**.

The **negligible-risk application** was **reviewed** by the College of Human Sciences CREC on **02 September 2025** in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising during the undertaking of the research study that may affect the ethical integrity of the study, including those involving research participants, third parties, or juristic persons, must be reported in writing to the College of Human Sciences_CREC without delay.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that may affect study-related risks to research participants, juristic or third persons, must be reported in writing to the College of Human Sciences_CREC, accompanied by a progress report.

5. The researcher will ensure that the research study complies with all applicable national legislation, professional codes of conduct, institutional guidelines, and scientific standards relevant to the specific field of study. Where applicable, adherence to the following South African legislation is essential: the Protection of Personal Information Act (No. 4 of 2013), the Children's Act (No. 38 of 2005), and the National Health Act (No. 61 of 2003)

6. Future use of this research data is permitted only in de-identified form and only for secondary research with objectives similar to those of the original study. Any secondary use involving identifiable human data will require additional ethics clearance.

7. No fieldwork activities may continue beyond the stated expiry date (**01 September 2026**). A completed Research Ethics Progress Report must be submitted as an application for renewal and is subject to approval by the Research Ethics Committee. A Close-Out Report must be submitted upon completion of the research study.

8. The College of Human Sciences_CREC may require the submission of regular progress reports on an [annual] basis, in alignment with Section 7.2 of the Unisa Policy on Research Ethics (2024).

Additional Conditions

1. Disclosure of data to third parties is prohibited without explicit consent from the research participants and Unisa.
2. Research data must be stored in compliance with the university's research data management policy for a period of up to 15 years.
3. When publishing the results, the researcher must take appropriate precautions to safeguard the confidentiality and privacy of the research participants, juristic persons, third parties, and the university, in accordance with institutional policies and ethical standards.
4. Adherence to the National Statement on Ethical Research and Publication Practices, specifically Principle 7 on Social Awareness, must be ensured. This principle states: 'Researchers and institutions must be sensitive to the potential impact of their research on society, marginal groups, or individuals, and must consider these when weighing the benefits of the research against any harmful effects, with a view to minimising or avoiding the latter where possible.' The University of South Africa (Unisa) accepts no liability for any failure to comply with this principle.

Note

The reference number 7318 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Kind regards,



Prof J K Malesa
Chair of College of Human Sciences_CREC
E-mail: maleskj@unisa.ac.za



Professor Omwoyo Bosire Onyancha
Executive Dean / By delegation from the Executive Dean of College of Human Sciences_CREC
E-mail: onyanob@unisa.ac.za

ANNEXURE C

Eastern Cape Provincial Education Correspondence

RE: Request for research information

ML

Malemela, Lehlogonolo

To 'Lindelwa Sibawu'

01/31/2026

From: Lindelwa Sibawu <Lindelwa.Sibawu@ecdoe.gov.za>
Sent: Saturday, 31 January, 2026 13:04
To: Malemela, Lehlogonolo <Malemela.L@dbe.gov.za>
Subject: RE: Request for research information

Good afternoon Lehlogonolo

I trust that you are doing well. Eastern Cape Department of Education (ECDoE) is implementing two transformation pragrmmes, Mother Tongue Based Bilingual Education (MTBBE) and Incremental Introduction of African Languages (IIAL) through Education Language Policy (ELP) Directorate. The directorate is responsible for the provisioning of Learning and Teaching Support Materials for the schools. The Department of Basic Education (DBE) is providing the provinces with Mathematics and Natural Sciences & Technology Workbooks which are in English version. As the province, the ELP Directorate versioned (translated) those English workbooks into isiXhosa and Sesotho and other publishers they ask the directorate to provide them with versioners they can use to version their textbooks into isiXhosa and Sesotho.

Hoping that I have answered your question.

Kind regards

Lindelwa Sibawu
Chief Education Specialist: Education Language Policy Directorate
Easter Cape Department of Education
Zwelitsha – King William's Town

ANNEXURE D

Complete word list

English	isiXhosa	Sesotho
Capacity	Ikhaphasithi	Khaphasithi
Litre(s)	Ilitha / Ilitha	Dilithara
Operations and number concepts		
Calculate	Khalityhuleyitha	Khaltjhuleitha
Fraction(s)	Ifrekshini / Iifrekshini –	Frakshene
Number patterns and sequences		
Diagram	Iflowu dayagram	Flow dayakeramo
Data Handling		
Data	Idatha	Datha
Geometry		
Triangle	Itrayengile	Traenkele
Circle	Isekile	Sekele
Other Mathematical Concepts		
Operation	Ophareyshini	Ophareishene
Digit(s)	Iidijithi	Dijithi