Language use in the learning and teaching of early grade mathematics in the context of multilingualism

A thesis submitted to the Faculty of Humanities, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Doctor of Philosophy.

Ingrid M Sapire
Student Number: 8166164
Supervisors: Prof Yael Shalem and Prof Anthony A Essien
University of the Witwatersrand, 2021

Abstract

Studies on the teaching and learning of mathematics in multilingual classrooms argue that language is central to the learning of mathematical concepts but that teachers who focus on mathematical register rather than on concepts could inhibit learners' opportunities to develop conceptual understanding. Teaching is mediated through language and thus language use in multilingual contexts is critical. In South Africa, a problem has arisen, that although the Language in Education Policy (LiEP) supports multilingualism, the Curriculum and Assessment Policy Statement's (CAPS) interpretation of the policy provides for monolingual education, albeit in all 11 official languages. The research reported on in this thesis investigated language use by Grade 3 and Grade 4 teachers and learners in multilingual mathematics classes in Gauteng. This study interrogates the question of the language of learning and teaching (LoLT) through focusing on the relationship between variation and standardisation of language use in multilingual early grade mathematics classes. To unpack the drivers of language use, I drew on the theory of multilingualism in mathematics education and on the concept of 'language ideology' from sociolinguistic literature. This enabled me to investigate mixed language use (translanguaging or code-switching) in mathematics classes and the factors influencing it.

The mathematical curriculum topic of patterns formed the content context for the investigation. The research design was that of a descriptive study based on a three-part survey, focus group discussions, and classroom observations. Three of the eleven official languages in South Africa were chosen: IsiZulu (an Nguni language), Setswana (a Sesotho language) and English (the dominant language used in schools and the official LoLT in all schools from Grade 4 onwards in the system). The research was carried out in a sample of 20 schools in three districts in a Province in South Africa (with LoLT IsiZulu, Setswana and English).

Findings from the three data sources (survey, focus group and observation) showed variation in language use and perceptions about language use, with speakers drawing on IsiZulu, Setswana, English and other languages in different ways. Perception data (survey and focus group discussions) showed a tendency towards pure language use and a preference for the use of English when teaching mathematics. Evidence of this was strong in the written explanations on the survey but in the observations, slightly more mixed language use was evident. The pressure of policy (favouring the use of the LoLT to the exclusion of other languages) is clearly felt by teachers, who comply even when they think that mixing languages is supportive of learner understanding. These findings contribute to the question of whether and if so, how, teachers can utilise their full language repertoire and encourage learners to do so as well. The findings show that there are conflicting language ideologies that drive policy and policy implementation – the evidence shows that policy exhibits an embodied monoglossic ideology while both monoglossic and heteroglossic ideologies are embodied and articulated by teachers. The findings also speak to the language standardisation debate in relation to mathematical register in that teachers expressed the need for standardised language in the teaching of mathematics because they are aware that some terms do not exist in the home languages in which they teach.

Key terms

Early grade mathematics, language use, mathematical register, language ideology, multilingualism, mixed language, translanguaging, code-switching.

Declaration

I declare that this research project is my own work, except as indicated in the acknowledgements, the text and the references, written under the supervision of Prof Yael Shalem and Prof Anthony Essien. It is being submitted in fulfilment of the requirement for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination in any other university.

Ingrid Sapire

3rd day of October, 2021

Acknowledgements

I acknowledge with gratitude the funding provided by the *FirstRand Empowerment Foundation* (Grant 036806). The funding was allocated to the project *Researching Multilingualism in Foundation Phase Mathematics*. Data from three of the project activities provided the source of the data for this PhD.

I will never forget the two wonderful years spent working on the RMFPM project with my student team – Dineo Makoro, Michael Louw, Benny Mojela, Sylvester Molokoane, Thompho Rambuda and Ntombikayise Zulu. Thank you for your dedication and for the interest you showed in the work. Thank you Kgethi for your support in setting up the project and the team. I could not have done this without you.

Sincere thanks go to all the teachers and learners who participated in the study. May the insights shared and learned contribute towards thinking about change in the system.

Thank you to my supervisors, Yael Shalem and Tony Essien who took me on, believed in me and got me to this point.

Special thanks of course go to my family – Peter, Sam and Romy – without whom I would not be who I am nor could I do the things I do. Thank you.

Those who know me will know that I have been fortunate to have a life which has been a journey full of the joy of shared learning and I hope that the journey will just go on.

PUBLICATIONS ARISING FROM THIS STUDY

Sapire, I. & Essien, A. (2021). Multiple monolingualism versus multilingualism? Early grade Mathematics teachers' and students" language use in multilingual classes in South Africa. In A. Essien and A. Msimanga (Eds.), *Multilingual Education Yearbook 2021: Policy and practice in STEM multilingual contexts*. Springer Nature: Switzerland.

LIST OF TABLES

LIST OF FIGURES

[1] The ANA was last written in 2012. Hence this data was the last national data reported on for Grades 1-3.

GLOSSARY OF TERMS

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

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

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

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

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

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

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

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

Translanguaging Pedagogy: Translanguaging pedagogy is a teaching strategy (referred to in the literature) which is seen as proactive and planned and calls for the use of the language repertoire of the speakers in a class. A translanguaging pedagogy allows for all types of language use – translanguaging, code-switching and pure language use.

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

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

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

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

Language mixing: In this study when I use the term language mixing, I am referring to pluralist or mixed language use.

Single LoLT school: Refers to a school that uses only one language (medium of instruction or LoLT) for all learners in all grades.

Multiple LoLT school: Refers to schools which have chosen more than one LoLT, based on their learner population. In provinces like Gauteng schools may have up to 5 LoLT although this is not common. Teaching takes place in each of the LoLT of the school. In multiple LoLT schools classes are separated according to language – there is one class per LoLT in each grade in the school.

LIST OF ACRONYMS

ANA	Annual National Assessment
CAPS	Curriculum and Assessment Policy Statement
DAC	Department of Arts and Culture
DBE	Department of Basic Education
EMIS	Education Management Information System
FET	Further Education and Training (Grades 10-12)
FP	Foundation Phase (Grades R-3)
GET	General Education and Training (Grades R-9)
IP	Intermediate Phase (Grades 4-6)
LiEP	Language in Education Policy
LoLT	Language of Learning and Teaching
PanSALB	Pan-South African Language Board
PIRLS	Progress in International Reading Literacy
RMFPM	Researching Multilingualism in FP Mathematics

Chapter 1 Introduction

1.1 Background and introduction

Learning and language are inextricably bound together. Education is critical for the development of the 21^{st} century goals and mathematics and language are often presented as the two core learning areas needed for the educational development of young learners. The language(s) used in school education in South Africa more broadly, but also in relation to the teaching of mathematics, is the focus of conversations in both professional circles and in public debate – because language is political (Clarkson, 2016; Mohohlwane, 2020; Phakeng, 2017). Pointing to the sad reality in South African classrooms, Albertyn and Guzula say, "Painfully, our country's children are often positioned as deficient English monolinguals rather than resourceful bilingual learners" (Daily Maverick, 2020). The debate as to which language(s) should be used for the teaching of mathematics is ongoing. A fairly recent longitudinal quantitative study by Taylor and von Fintel (2016) showed that learning in the home language in the Foundation Phase (Grades R-3) has a positive effect on achievement in the Intermediate Phase (Grades 4-6), particularly for language learning but also for mathematics. More and more, studies are showing the value of multilingualism not only for language learning but for learning across the curriculum (Albertyn & Guzula, 2020).

Recent studies (and media releases) published on the Progress in International Reading Literacy Study (PIRLS) data have shown the dire situation in the country with regard to language learning (Spaull, 2015 & 2016a). Similar findings have also been published in relation to mathematics outcomes (e.g. DBE, 2014; Spaull & Kotze, 2015).

In my study I focus on language use in mathematics learning. I am embarking on this study after many years of involvement in mathematics teacher education at the primary school level. More recently (since 2012), my focus has been in the early grades. My reading and experience have shown me that teaching mathematics in the early grades should enable learners to make abstractions based on concrete experiences which embody the concepts being taught. There are several pedagogical strategies that are used to allow learners with a range of different learning styles to grasp that which is being taught. Importantly, teaching in the early grades requires the support of materials. These materials are predominantly in the form of concrete manipulatives to support the teaching of mathematical concepts. Pedagogically these concrete materials are mediated in order to enable appropriate generalisation of concepts by learners, based on their experience of working with the manipulatives. Learners are guided by their teachers, talking and listening as they learn new mathematical concepts. Although not all mediation is language based, most learning, thoughts and ideas, ultimately are expressed using language. The teaching of mathematics, from the outset, is thus intertwined with the teaching and use of language.

The teaching of Mathematics is also supported by print materials – these constitute written language support alongside the manipulatives being used. In terms of written learning support material for curriculum implementation, schools are provided with the Curriculum Assessment Policy Statement (CAPS) for the teachers, and (annually), the DBE workbooks for the learners, according to their choice of LoLT (DBE, 2015). The CAPS policy document determines the guidelines for mathematics content coverage, but it is also intended to set the standard for the mathematical register in each of the official languages, since development mathematical language of all of the official languages is still on-going. Here lies one aspect of the problem: issues arise because of the on-going development (or lack thereof) of all the official languages which are not always openly acknowledged although teachers often refer to them (Sapire, 2018a) and researchers have pointed to the need for development of the mathematics registers in the indigenous languages (Mohohlwane, 2020; Ouane & Glanz, 2010; Schäfer, 2010). There has not been a systematic investigation across all the official South African languages or a write up of the mathematical terminology required for all the content areas, starting from the early grades, which could support effective language development of the official languages even though teaching in all of the official languages is endorsed and supported by policy.

In line with curriculum policy, the teaching of Mathematics in the Foundation Phase (Grades R-3) is carried out in the home language[2] of learners in most schools in South Africa (Sapire & Roberts, 2017). The first post-apartheid Language in Education Policy (LiEP) (DBE, 1997) promotes the development of all eleven South African official languages and, ostensibly, multilingualism. In accordance with this policy, the Department of Basic Education (DBE)

[2] The LiEP uses "home language" to refer to the preferred spoken language of an individual. In the South African context, particularly in urban settings, the reality is that learners may not have only one preferred language. In this study the expression home language is used (in line with the policy documents) while it is noted that the expression "main language" might better express the language spoken most often by an individual. I use the terminology home language when writing about a speaker's main language so that my writing speaks more directly to policy makers.

supports multilingual education through the provision of education for Foundation Phase (FP) learners in all eleven official languages of South Africa. [3] Schools are expected to negotiate the choice of the Language of Learning and teaching (LoLT) with parents to determine the appropriate LoLT, according to the learner population of the school. Current policy implementation thus results in the selection of a LoLT by a school, which teachers and learners are then expected to use exclusively in all their spoken and written interactions. If a school has sufficiently large learner numbers, they may opt for more than one LoLT, but in this case each different LoLT is accommodated in separate class. If learner numbers do not warrant separate classes the "best fit" LoLT (or in many cases English) is chosen, resulting in some learners being taught in a language which is not necessarily their home language. Despite the prevalence of multilingual classes, Makoe and McKinney argue that "the South African LiEP is silent on the possibilities of using more than one named language in the classroom simultaneously" (2014, p. 661). What this means is that, according to official policy (which is strictly monitored by district officials), teaching in FP mathematics classes is essentially carried out in one language, even if the learner population of the classes might be diverse in terms of language and other spoken languages may be present. Here lies another aspect of the problem: although there is a spread across all eleven official languages nationally in FP classes, current policy interpretation and implementation, specifically the way in which LoLT is selected and learning material are produced, officially imposes education in one language only. Hence in spite of a policy which supports early grade education in all official languages of South Africa, not all learners are being taught in a language of their choice.

A further complexity in relation to LoLT selection is that there is a widely held belief on the part of parents (who are represented on the School Governing Body committees that make the LoLT choice for the schools) that English is the best language for the teaching of mathematics, from the start. This choice has been called going "straight-for-English" (Badenhorst & van der Merwe, 2016; Dixon & Peake, 2008; Mohohlwane, 2020) and there is evidence, albeit slight, from EMIS (Education Management Information System) data that some schools are moving in this direction (Sapire & Roberts, 2017). The straight-for-English choice is made by parents (and School Governing Bodies) primarily because of a belief in the power of English as a social resource (Setati, 2008) and it needs to be made because of the LoLT policy which endorses one

[3] South African Sign Language (SASL) is now included in the list of official South African languages and is also provided for in some schools.

LoLT per class (Dixon & Peake, 2008) even though it might be a flawed choice. Makoe and McKinney (2014) lament that, "As was the case in the past, post-apartheid policies continue to advance and invest in monoglot ideologies that legitimise and give authority to standard English language at the expense of pluralism and diversity" (p. 669). Makoe and McKinney place the struggle for multilingualism into the realm of ideology. *Language ideologies* (from an ethnographic perspective) expose how the beliefs of speakers are rooted in the social and cultural systems to which they belong, which in turn explains that these systems can beget such beliefs (Silverstein, 2018). I will discuss language ideologies further in the theoretical framework (Chapter 3) of this study.

The shift to home language as LoLT was implemented assuming that conditions were in place for monolingual classes, according to a chosen LoLT, where all learners could be taught in their home language. This assumption is flawed firstly because it requires fully developed, standardised languages in order to be implemented successfully and secondly in reality the LoLT of the school and home languages of teachers and learners do not always coincide, resulting in a further aspect of the problem. There are two reasons for this, the first as already explained, is that a learner might attend a school where the learner's home language is a minority language. The second, more prevalent in urban (and peri-urban) contexts, is that many South African learners (and teachers) use more than one language when they speak to communicate that which they want to say. A single LoLT, to be used exclusively in the teaching of a class, does not make provision for this kind of flexible language use. By *language use,* I mean the words, phrases, symbols or diagrams chosen by speakers to express themselves – it encapsulates the full range of words, phrases, symbols or diagrams used when speaking or writing, including things such as the use of multiple spoken or written languages and formal or informal expressions when speaking or writing mathematically.[4] Language use is the focus of my study in order to shed light on the various aspects of the problem of language use in the teaching of mathematics in the early grades.

In this study I investigated language use in early grade multilingual mathematics classes, with a focus on the teaching of number patterns, in schools with IsiZulu, Setswana and English LoLT, the reasons for which will be explained in detail in the methodology section of the study

[4] Although, as I discuss in the literature review, the language of mathematics (register) could also include gestures, I do not include these in my study.

(Chapter 4). Language use varies – with some speakers tending towards inflexible, monolingual language use and others favouring flexible, multilingual language use. This will be discussed in more detail in the literature review of the study (Chapter 2), but a brief outline of these language use choices is included here as an introduction, since these are core ideas which were investigated in my study.

Inflexible language use is also referred to as purist language use. Purist language use does not reflect variation, since by definition, a purist practice excludes the possibility of variation. Flexible language use, also known as pluralist language use, exhibits variation since there are different ways in which speakers may use these flexible practices. In linguistics and other fields where language use is researched the terms code-switching and translanguaging (amongst others) are used to describe pluralist language use (García & Baetens Beardsmore, 2009). In the context of this study I use the term mixed language use to refer to a speaker using more than one language when speaking – and when I refer to mixed language use it may refer to code-switching or translanguaging or a combination of code-switching and translanguaging. The terms language mixing/mixed language have been used in association with code-switching since the 1980s and more recently with translanguaging (Barwell, 2016; Grosjean, 2008).

In mathematics education research, the term code-switching has been in use longer than the term translanguaging. Both terms originated in the field of linguistics. In the 1940s and 1950s code-switching was regarded by some as an inferior use of language but since the 1980s it has been regarded as a normal, functional use of language by bilinguals (Gumperz, 1982) in that it enables them to draw on other languages they know when learning in a language that is not their home language. The term translanguaging has been used more recently to describe multiple language use practices. It originated in Wales in the 1980s and is said to be a translation of the Welsh word *trawsieithu* coined by Cen Williams when he and his colleagues were researching strategies of using both Welsh and English in a single lesson in a classroom setting. While code-switching is seen as external function where speakers of more than one language switch between their languages (1982, p.59) to express themselves, translanguaging is seen as an internal strategy by which speakers use all their linguistic resources to communicate (García & Baetens Beardsmore, 2009; García & Wei, 2014; Williams, 1980). There is not full agreement on whether or not code-switching is part of or separate from translanguaging. For the purposes of this study, I regarded both code-switching and translanguaging as pluralist language use even though in code-switching there is a recognition of the "code". I regarded code to mean a named language. This aligns with the position taken by Wei (2017) that translanguaging "does not deny the existence of named languages, but stresses that languages are historically, politically, and ideologically defined entities" (p. 27).

Recognition of pluralist language use as a valid form of language use in South African classrooms is recognition of the multilingual and multicultural body of learners populating schools, especially in urban areas of South Africa. In South Africa, where there are eleven official languages, the question is not necessarily "which language" but possibly "what repertoire of languages" (meaning that a mix of languages at the disposal of the speaker may be used) would best enable young learners to learn their mathematics? The answer to this question, in part, needs to engage with the power relations and the ideological basis of language use (McKinney, 2017; McKinney, Carrim, Marshall & Layton, 2015), since there are times in multilingual contexts when choices about language use are political and could be controlled by power relations (Setati, 2008). There is a need to investigate language use in early grade mathematics in multilingual contexts in order to describe this language use and to what extent it could facilitate or obstruct the learning of mathematics.

1.2 Problem statement

In the early grades, learners are learning foundational mathematical concepts at the same time as they are learning how to read and write. Learners' language proficiency is being developed and learners need to become fluent in the use of the language of learning and teaching as well as in mathematical language. Mathematical language includes phrases, words, symbols and diagrams needed to express mathematical concepts. In multilingual classrooms, two or more different languages may be used flexibly as teachers and learners use their full language repertoire to "speak mathematics". The language repertoire is the full set of language resources available to a speaker. This consists of several languages (two or more), which may be known partially or fully by the speaker. There is very little published research (both in South Africa and internationally) that reports on multilingualism in the early grades (Essien, 2018). The possibility (or in many cases reality) of multilingual language use practices in the early grades needs to be investigated.

Multilingual classrooms present contexts in which complexity of language use could be used to foster (or alternatively might interfere with) the learning of mathematics. In the early grades, learners' language use is in the process of being developed, building on their existing knowledge of language. The words that they are learning, which combine into phrases and sentences used to express conceptual ideas, come from the language base of the language in which they are learning. There is potential for confusion about language use in young learners emanating from two potential sources. Firstly, uncertainty could be caused by a technical focus on mathematical register rather than on concepts in the early grades, particularly in the presence of variations or inconsistencies in the existing mathematical register as a result of inadequate language development and standardisation (Mohohlwane, 2020). Teachers who focus on mathematical register rather than on concepts could inhibit learners' opportunities to develop conceptual understanding together with language use (Morgan, 2005). Secondly, the relationship between mathematics as a language and the language of learning and teaching in mathematics classrooms could create tension, particularly since some choices about language use might be ideological rather than educational. Teachers who unthinkingly (or purposefully) insist on a use of language which is "code" driven rather than "learning" focused could also distract learners from the core conceptual learning that should be the focus of mathematics classes (Chitera, 2010; Essien 2018). A flexible use of language in multilingual classes, which could foster the learning of mathematics, requires deep knowledge of the language base(s) necessary for the learning of mathematics (Barwell, 2018, Planas, 2018). I contend that it also requires that teachers are able (and allowed) to sanction and monitor the flexibility of language use in order to prioritise the learning of mathematics above all in a mathematics class. I contend that too little or too much flexibility could be problematic – teachers have to find the right combination between purist and pluralist language use which depends on many issues including policy, teachers' knowledge of the topic and the language, the availability or not of the mathematical terms in the indigenous languages (standardisation), authority relations and the class composition.

Studies on the learning of mathematics in multilingual classroom contexts (e.g. Adler, 1998, 2001; Moschkovich, 1999, 2010; Setati, 2008, 2012) argue that language is central to the learning of mathematics but that in mathematics classes, the focus should be on the learning of the mathematical concepts – that in a mathematics class, language should be a tool used to enable mathematical conceptual learning (Setati, 2008). Adler highlights the dilemma of mathematics teachers in secondary schools – caught in a bind where they have to teach both mathematics and language (Adler, 1998). Teachers in the early grades find themselves facing the same dilemma, intensified by issues of language development (are the languages sufficiently standardised/is such standardisation needed) and policy issues around LoLT, both of which are impacted on by ideologies. In my study I focused on early grade mathematics, drawing on research carried out at various levels in the school system (since more research to date has been carried out in higher grades), in order to shed light on the pros and cons of multilingualism in the early grade context. I thus embarked on the study, guided by the following main research question: *What factors drive the language use of multilingual Grade 3 and Grade 4 mathematics teachers and learners on the topic of patterns?*

1.3 Context of the study within a research project

This study was part of a larger research project carried out in 2017 and 2018 that was designed to investigate multilingualism in early grade mathematics. Data gathering and reporting for the project took place over a period of two years, to allow for substantive reporting and to provide a basis for further research into teaching mathematics in the early grades in multilingual contexts. I was the leader of the project, Researching Multilingualism in FP Mathematics (RMFPM) but I worked with a multilingual research team because of the nature of the study. The multilingual research team comprised six students all of whom had mathematics as a subject in their degrees and all of whom had an interest in primary education. Two of the students were post-graduate students of applied mathematics and the other four students were undergraduate BSc (3) and BComm (1) students. The project aimed to produce reports that would be presented to and could be heard by policy makers at the Department of Basic Education (DBE) and thus inform them on the current situation in South African schools. This was with a view to informing further policy making decisions particularly with respect to language policy.

There were five project tasks. The first task of the project involved a quantitative analysis of *Educational Management Information System* (EMIS*)* data that was carried out in order to determine the distribution of LoLT and home language in South African schools. EMIS data from the Annual Schools Survey (ASS) was used to profile South African classes (across the entire school system). The report found that the trends for the period 2008 to 2016 "indicate that there has been a continued growth in the number of learners studying in their home language in the FP but that this shift has not been as marked as the change reported on in the 2010 report where changes from 1998 to 2007 were presented" (Sapire & Roberts, 2017, p. 41). According to the report slightly more learners are now being taught in their home language:

"approximately 18% of [FP] learners in the system (this percentage is down from 20% in 2007) are not being taught in their home language" (ibid, p. 41). Figure 1.1 gives an indication of the spread of LoLT in Grade 3 classes in South Africa.

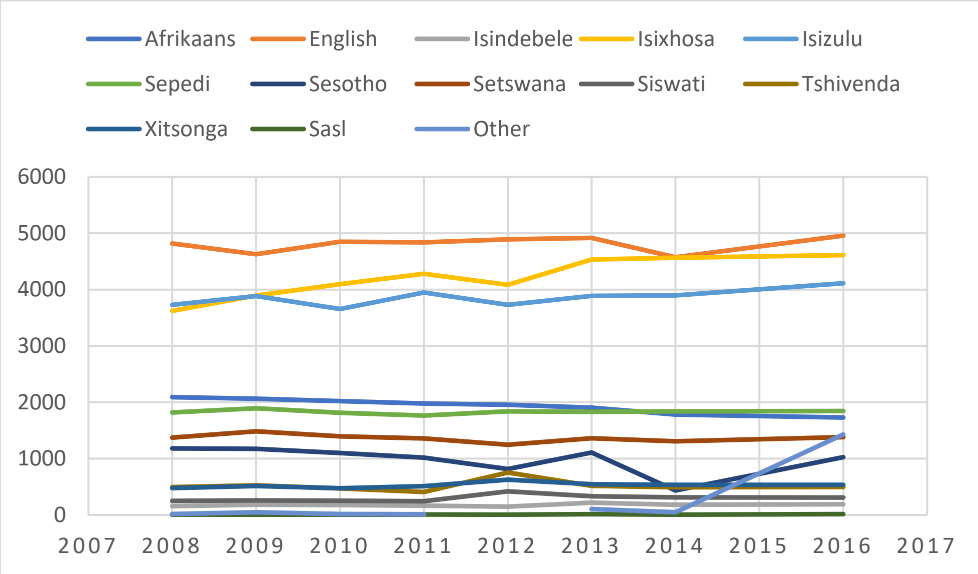


Figure 1.1: Number of schools by LoLT in Grade 3: 2008 to 2016 *(Source: DBE: 2008 to 2016 Annual School Survey)*

As it can be seen in Figure 1.1, the highest numbers of schools are found offering English, IsiXhosa and IsiZulu as LoLT which aligns to a certain extent with the population statistics for language (similar trends were shown for Grades 1 and 2), but again exceeding the population proportions in respect of English by quite a large degree. In Grade 3 the number of schools that offer English as LoLT outnumber schools with other LoLT for the entire period 2008 to 2016. (Sapire & Roberts, 2017, p. 47) In Grade 4 this picture changes completely as English becomes the LoLT in the majority of schools.

The quantitative analysis carried out in my study sought to determine correlations, in Grade 3 and Grade 4 between the teachers' home language and the LoLT of the school; the learners' home language and the LoLT of school and the teachers' and learners' home language. In the FP, policy assumes alignment between learner home language and LoLT and, based on this, between teacher and learner home language. But EMIS data could not be used to calculate these correlations since the data were not captured at the level of the learner (Sapire & Roberts, 2017). [5] The national statistics do not always represent the situation in particular provinces, or schools, as accurately as would be hoped (Sapire, 2017b) [6], hence the project aimed to gather data that could be used to present the situation in Gauteng early grade classrooms more accurately.

In order to present the context of multilingualism in early grade mathematics in a more nuanced way (with a focus on language use), the other four project tasks were carried out in schools. The tasks were designed and executed to investigate language use specifically in early grade mathematics teaching. The school-based tasks were carried out in a sample of 20 schools across three districts in Gauteng, in Grade 3 and Grade 4 classes. To contain the scope of the project, the languages focused on were IsiZulu, Setswana and English. This provided an entry point to the relationship between the dominant mathematical language (English) and the other South African official languages and allowed a lens on the power relations present in language use. A further containment of the scope involved the choice of the curriculum strand of Patterns[7] as the mathematical focus of the study at Grade 3 and Grade 4 level. The mathematical topic of patterns was a pragmatic choice (to restrict the content scope of the study), but it does arise as an area of difficulty in national assessment statistics (ANA 2013, 2014). It is also a topic that links closely to the curriculum strand of Number, Operations and Relations[8] and thus allowed ample opportunities for investigation and observation. Project tasks 2, 3, 4 and 5 are now described.

The second project task investigated variation in language use in printed materials. The task focused language use in four sets of documents – the Curriculum and Assessment Policy Statement (CAPS), the Department of Basic Education (DBE) workbooks, the Annual National Assessment (ANA) and a commercially published textbook (Platinum Mathematics) on the official list of materials for schools in South Africa. The analysis of materials (which included official publications and a commercially produced publication) gave insight into language use in a static written form. In this static set of published documents (at Grade 3 and Grade 4 level) there was evidence of embodied language ideologies. The third project task involved a survey

[5] From 2016 EMIS data will be digitally captured and learner level data should become available.
[6] In rural areas the statistics are closer to reality, in urban areas, schools are far more multilingual than the national statistics show. This is more often spoken about anecdotally but there is evidence to suggest the anecdotal reports are correct (e.g. Sapire, 2017b).
[7] *Patterns, Functions and Algebra* is the second content strand in the CAPS and comprises number and geometric patterns.
[8] *Number, Operations and Relations* is the first and largest content strand in the CAPS.

of FP officials, Grade 3 and Grade 4 teachers and Grade 3 and Grade 4 learners. The survey was designed to gather accurate and up to date data in order to map the current situation in a sample of classes in the Gauteng province in relation to language use in schools. The survey was also designed to gather data on mathematical language use through a questionnaire and translation activities. The fourth project task involved focus group discussions aimed to investigate Grade 3 and Grade 4 teachers' perceptions of the role and status of language in early grade mathematics classrooms and their preferences with regard to language use. The fifth (and final) project task involved observation in Grade 3 and Grade 4 classes in order to investigate the language use of teachers and learners when they interact in the classroom, on the topic of patterns.

A large amount of data was collected for the project tasks over the two years. I used three of these datasets (survey, focus group discussions and classroom observations) in my study. Hence certain sample sizes (Section 4.5) are fairly large. All of the project data collection, capture and analysis was carried out by the team of fieldworkers under my direction using tools developed by myself and hence I had a hand in all project activities and outputs that have been taken further in this PhD study. The data gathered for the project reporting enabled me to describe language use in multilingual Grade 3 and 4 mathematics classes based on national EMIS data, written text analysis, teacher focus group discussions and classroom observations. The way in which I took up the work of the project (looking more closely at the drivers of language use) and took it further in my PhD is discussed in detail in the methodology chapter (Chapter 4).

I will now discuss the aim of my PhD study.

1.4 The aim of the study

The aim of this study is to investigate language use in multilingual early grade mathematics classes. This study thus interrogates the question of LoLT and the language of instruction for mathematics through focusing on language use in multilingual early grade mathematics classes in a sample of Gauteng schools. In the course of the investigation I realised that a tension exists between variation and standardisation in language use and I looked more closely at teachers' language use and what they perceive as good language use. Firstly, I observed tension in relation to variation when teachers discussed issues arising from using pure or mixed language to teach mathematics. Secondly, I observed tension in relation to standardisation when teachers mentioned a lack of standardisation of certain mathematical terminology in the indigenous languages. It also became clear to me that language use cannot be understood fully without considering the way in which language ideology informs language use and so I drew on the sociolinguistic field of language ideologies to further unpack the drivers of language use in multilingual contexts.

In order to achieve this aim, I first systematically described the language use of Grade 3 and 4 teachers and learners. This has not been done to date in South Africa by other researchers in the way in which I have done it in my study. I carried out quantitative analysis of data using a reasonably large sample (62 teachers and 2891 learners) and qualitative analysis using a subset of the data. In my analysis of the data I investigated whether language ideologies or other factors influence patterns of language use and if so, how they influence the learning and teaching of mathematics. Secondly, I further investigated language use in order to address the language standardisation debate – specifically to investigate anecdotal evidence that there is a lack of standardisation of mathematical terminology for use in mathematics teaching in the early grades. The question of whether standardisation of languages should be a goal is contested and language ideologies inform discussion around this question and so in this study I bring to light evidence that could be used to inform the debate.

The distinction between LoLT and language of instruction is important for a study that investigates language use in multilingual mathematics classes. I make the distinction here in order to question the application of a LoLT in terms of the actual language use that plays out (language of instruction) in the classroom. If LoLT is to be narrowly applied to the exclusion of other languages whose purpose does this serve? And what is the value? If mathematics benefits from code-switching and translanguaging, then a single LoLT is not an appropriate choice, if as a result purist language use is promoted. If mixed language practices are allowed in schools, then is the selection of a LoLT as big an issue? The application of a majority LoLT would seem like a sensible thing, used flexibly to support learning in more than one language for the whole class which has a diverse learner population, where the language repertoires of the learners may lead to mixed language use. This study attempted to clarify the issues raised in the questions asked in this paragraph by using the data to paint the picture of language use in the sample schools in order to show more clearly how the LiEP is not serving the purpose it set out to serve, which was to promote multilingualism in a multilingual South Africa.

As it has been explained, my study examines language use in the context of Grade 3 and 4 mathematics learning and teaching about Patterns. As such, it could not and did not look into all of the issues which could be investigated in relation to the learning and teaching of mathematics in the early grades. For example it was not possible for me to investigate the effect of language on mathematical achievement outcomes of learners in the early grades (since I did not carry out pre/post-tests), general pedagogical issues in early grade mathematics (since this project did not involve an intervention) or the bridging between the Foundation and Intermediate phases – specifically the effect of language on the decrease of learners' performance in Grade 4 mathematics (since no learner testing was carried out as part of the project). All of these issues warrant further investigation which are beyond the scope of the present study.

I now discuss the research questions that framed the study.

1.5 Research Questions

Mathematics education needs to keep the focus on mathematics (the goal of mathematics teaching is mathematics learning) but this cannot be done without language. As Durkin (1991, p. 3) argues, "Mathematics education begins and proceeds in language, it advances or stumbles because of language, and its outcomes are often assessed in language".

This study will investigate the following sub-questions in relation to the overarching question: *What factors drive the language use of multilingual Grade 3 and Grade 4 mathematics teachers and learners on the topic of patterns?*

Sub-questions:

1. What is the relationship between the LoLT and home language of the teachers and learners?
2. What variation in language use is evident when teachers and learners write and speak mathematics?
3. What are teachers' perceptions of the "best practice" in relation to language use in mathematics teaching?
4. What are teachers' perceptions of the language standardisation debate in relation to mathematical register of patterns?

The first sub-question probes the relationship between the teachers' and learners' home language and the languages they are obliged to teach and learn in as a result of the chosen LoLT of the schools they find themselves in. Answering this question gives insight into the context of the study and of the broader multilingual context in South African schools. The second sub-question probes teachers' and learners' language use when they speak or write mathematically. It also probes the ways in which teachers and learners move between languages of expression when using the mathematical language related to the topic of number patterns. Knowledge of and flexibility in the use of terminology is essential for it to be possible for a speaker to use this terminology in active expression (spoken or written). In answering this question, I will look at the how, when and why of teachers' and learners' language use when they speak or write mathematically. How and when do they move between languages of expression and why do they do this (what are the drivers). The third sub-question probes teachers' perceptions about language use in early grade mathematics teaching. Answering this question gives insight not only into teachers' perceptions but also enables analysis of the alignment between their perceptions of and actual language use. This question probes teachers' perceptions about the pros and cons of the idea of variation in language use. The fourth sub-question brings to the fore perceptions expressed by teachers on the standardisation of mathematical register and will be used to inform the discussion on the language standardisation debate. The four sub-questions frame the findings that will be used to inform a discussion on language use and the language standardisation debate.

In conclusion to this introductory chapter, I explain the rationale for the study.

1.6 Rationale

There are several factors impacting on learner achievement, all of which warrant attention and investigation, but the one that this study focused on was the language of learning and teaching. The longitudinal quantitative study by Taylor and von Fintel (2016) referred to in the introduction was based on a large dataset constructed by "merging information from the Department of Basic Education's Annual Surveys of Schools (ASS) from 2007 to 2011 with the Annual National Assessments (ANA) data for 2012" (p. 9). The results were understandably stronger for language learning than for mathematics (p. 14) but for both areas, this robust study found that, "after controlling for school fixed effects, there is a … disadvantage to receiving instruction in English rather than the home language of the child" (p.

19). This finding confirms a large body of qualitative research reported on prior to this date (e.g. Brock-Utne, 2007, Heugh, 2005; Ouane & Glanz, 2011) that it is preferable to learn school subject matter in the home language in the early years. This is still a pure language approach and in my study, I looked at all language use (pure and mixed) since language diversity is the norm in South African classrooms.

The language policy for South African schools recognises this diversity and has made provision to cater for it but the reality in FP classrooms is that mathematics learning is still not taking place ideally, an observation that can legitimately be made based on learner achievement. Although it has been noted that the ANA results are not statistically robust and cannot be used for comparisons, they do give some idea of the learner performance over the years during which they were administered. As it can be seen in Figure 1.2, the overall ANA results for mathematics in the FP are higher than those from Grade 4 onwards. The Grade 3 marks increased from 41% in 2012 to 56 % in 2014 (an increase of 15%) but the Grade 4 marks remained unchanged (a constant 37%) and hence the drop in results from Grade 3 to Grade 4 increased from 4% in 2012 to 19% in 2014. (Data Source: Report on the Annual National Assessment of 2014 Grades 1 to 6 & 9 p. 9).

GRADE	MATHEMATICS AVERAGE PERCENTAGE MARK		
	2012	2013	2014
1	68	60	68
2	57	59	62
3	41	53	56
4	37	37	37
5	30	33	37
6	27	39	43
9	13	14	11

Figure 1.2: Summary Table for Mathematics in 2012, 2013 and 2014 (ANA)[9]

The drop in achievement shown in Figure 1.2 in Grade 4 must in some way be related to learning (or lack thereof) carried through from the FP and language may be one of the factors contributing to the Grade 3 to Grade 4 drop in outcomes since in Grade 4 the LoLT for all learners learning in a language other than English (or Afrikaans) suddenly changes. Bertram, Christiansen, & Makurdi (2015) found that Foundation Phase teachers' low subject content and

[9] The ANA was last written in 2012. Hence this data was the last national data reported on for Grades 1-3.

pedagogic content knowledge is responsible for poor performance in mathematics. The proposed research does not intend to investigate learner achievement *per se* but rather to delve more deeply into language use in the early grades, in order to shed light on factors such as policy, research and ideology which drive the language use in multilingual classrooms.

Although the LiEP and related CAPS policy specifications do create the possibility for learners to be educated in their home language in the FP, as explained in the background to this study, this is still not the experience of many learners. In a recent tabled report of the Portfolio Committee on Basic Education (24 May 2016), a speaker, giving “An Overview of South Africa’s Schooling System”, was noted to have said that, “The experience was that the use of mother-tongue within the schooling system continued to be a challenge in our schooling system, especially learners of African descent. Their languages were being marginalised by the schooling system” (Item 5. Prof L. Lalendle). This marginalisation (in spite of policy directives and provision) might prevail because of a growing view among the parent population in South Africa that their children should learn English, and in English. As Taylor notes, **“**English is widely perceived to be the language of upward mobility and this leads to a preference for instruction in English from as early as possible” (2013, p. 3). In spite of this perception, the updated EMIS report produced by the RMFPM project found an increase in the overall number of learners studying in their home language in FP schools in the country in 2017 (Sapire & Roberts, 2017, p. 41). This finding is contradicted by the project survey which found very low alignment between the home language of learners and the LoLT of the schools at which they were enrolled (Sapire, 2017b, p. 28). It should be noted that the project was carried out in urban Gauteng schools where greater linguistic diversity may be found than in some other provinces or in more rural contexts. However, the misalignment between learner home language and LoLT points to a possible need for the use of more than one language in a classroom when mathematics is being taught, particularly if one considers a mix between indigenous languages and English. Purist and pluralist language use were discussed in the introduction. Arguments exist in favour of both purist and pluralist language use in learning.

A purist approach (use of one language only) assumes that teachers and learners will operate effectively when only one language is used in a classroom. Given the complexity of the average South African classroom, where generally more than one spoken language is present, purist language use may give rise to difficulties. The pluralist approach, which allows for a combination of languages to be used to serve the purpose of expression, is argued to be preferable given our context in line with the claim that translanguaging is a useful practice in the context of multilingual teaching (García & Wei, 2014, Lewis, Jones & Baker, 2012, Makalela, 2015a, 2015b, 2019; Otheguy, García, & Reid, 2015). A pluralist approach (mixed language – translanguaging or code-switching) does not prescribe one standard rule for how different languages should be used, but rather upholds the belief that users of language(s) should be given freedom to use language(s) meaningfully in a way that enables expression and transfer of ideas (García & Wei, 2014). The pluralist approach claims that teachers and learners will be able to operate effectively when more than one language is used for learning and teaching. This claim was investigated in my study.

Whether teaching strategies apply purist or pluralist language use (or both), the mathematical register used to give expression to ideas needs to be there. The purist approach assumes that the language to be used has a fully developed standardised lexicon with definitions which are accepted and will be understood by all speakers of the language. Pluralist approaches vary. Some draw on translanguaging, which is a planned teaching strategy (Lewis, Jones & Baker, 2012a, 2012b) that can be implemented in multilingual classes to enact a variety of language use. The existence and development of dictionaries could be seen to be aligned with a purist use of language yet many examples of translanguaging practices mention the use of dictionaries to assist in the movement from one language to another (e.g. Makalela, 2015a, 2015b).

Problems in relation to standardisation of specialised mathematical register have been raised in the South African context and need to be further investigated. For example, a limited evaluation of the Gauteng Primary Literacy and Mathematics Strategy (GPLMS) FP mathematics materials was carried out in the fourth term of 2014. The draft evaluation noted that the inadequacy of the lexicon of mathematical register for use in mathematics teaching leads to problems not only in translation but also in communication and agreement between teachers of the same content (Essien, Venkat, Takane, & Tshesane, 2014). The evaluation also pointed to a "proliferation of multilingual dictionaries in the country … [with] different groups of people [coining] different words for the same concepts" (ibid, p.30). Research into the development of the Maori mathematical register in New Zealand revealed that there are both positive and negative considerations to be taken into account when developing a common mathematical register (Barton, Fairhall & Trinick, 1998; Trinick, Meaney, & Fairhall, 2014). The idea of a core mathematical register raises questions which do not have simple answers and this study hopes to shed some light on these questions through an analysis of variation in language use in the teaching of multilingual Grade 3 and 4 mathematics. [10]

I would argue that allowing freedom of expression (and determining the boundaries of the freedom) in mathematics classes is probably more difficult than insisting on the use of one pure language but that in multilingual contexts a purist use of language is virtually impossible. A study that could shed light on tensions in relation to purist and pluralist language use (between or within these views) in mathematics learning and teaching could yield valuable insight. Findings from the study could be used to inform early grade mathematics policy considerations in relation to home language development in South Africa and in support of early grade mathematics teachers and learners.

1.7 Chapter outline

The thesis is written up in the following sequence of chapters.

1. Introduction
   This chapter introduces and gives the background to the study and include the rationale for undertaking the research in the context of early grade mathematics classes in South Africa.

2. Literature review
   Here a write-up of the literature upon which this study builds is provided. Three broad areas in the literature were identified: early grade mathematics teaching and curriculum; mathematical register and standardisation; and teaching mathematics in multilingual classes.

3. Theoretical framework
   In this chapter I draw on another field of study, language ideologies, in order to develop the analytical framework for my study. In this chapter my conceptual framework is presented.

[10] The RMFPM project also carried out an analysis of variation of language use in existing teacher and learner support material.

4. Methodology

   Here an outline and justification of the research design, instruments, data collection, sample and data analysis are given. In this chapter my analytical framework is presented. I also summarise the way in which I provided for trustworthiness and ethical considerations in the study.

5. Findings – The multilingual context

   In the first findings chapter data from the survey is used to give a detailed picture of the multilingual context of the study. This is done to provide a springboard for the discussion on language use and variation.

6. Findings – Variation in language use

   The next set of findings that I present relates to teachers' and learners' language use and teachers' perceptions of language use. Two of the datasets (survey and lesson observations) were used to analyse the active language use of the teachers and learners and two of the data sets (survey and focus group discussions) were used to analyse the teachers' perceptions about language use.

7. Findings – The language standardisation debate

   The final set of findings that I present relates to the language standardisation debate and teachers' perceptions of the language standardisation debate. I once again use key findings to structure the chapter and data from the three data sources that informed my study (survey, focus group discussions and observations) are used.

8. Discussion

   This chapter is framed by three questions which I answer drawing on the findings from the study in order to show what emerged from the data in relation to the drivers of language use in the multilingual context in which I worked.

9. Conclusions and recommendations

   In conclusion, implications emerging from the findings and recommendations that could be put forward based upon these are given.

1.8 Conclusion

As stated in my introduction, there is a need to investigate language use in early grade mathematics in multilingual contexts in order to describe this language use and to find out the extent to which it could facilitate or obstruct the learning of mathematics. In this chapter I established the background to the study, the problem statement and gave some details on the context of the study. Having established the context, I wrote up the study aim – to carry out the investigation of language use, identified in the problem statement. I explained that I would do this through focusing on language use in multilingual early grade mathematics classes in a sample of Gauteng schools. My research questions followed – carefully drawn up to guide the investigation. I then defined the scope of what I would do – examine language use in the context of Grade 3 and 4 learning and teaching about mathematical patterns. Since my overarching question is broad, it was necessary to restrict the scope of the study, to prevent it from becoming too large and unmanageable. In the rationale I expanded on the context and potential usefulness of the study. In the lest section I provided a chapter outline of the study.

The next chapter presents my review of the literature relevant to the study.

Chapter 2: Literature review

2.1 Introduction

The literature which informs this study comes from the areas of early grade mathematics teaching, mathematical register and language use in multilingual mathematics classes. A strand which crosses all three of these areas is that of policy, since policy informs curriculum, that which is to be taught and how it is to be taught. In addition to giving guidelines for the mathematical content to be covered in the early grades, the national policy (CAPS) stipulates language use in mathematics classrooms and in support of this has attempted to standardise the mathematical register across all of the official languages. Thus in each of the review sections below some policy implications are raised.

Policy makers internationally make different choices in response to multilingualism – either the dominant language is chosen as the language of learning and teaching or more than one language is given legal status for teaching in mathematics classes (Awobuluyi, 2013; Kaphesi, 2003; Nhongo, 2013). Examples of the effects of the different language policy choices can be found. Singapore is often spoken of as a country which has turned around its educational outcomes: here English was chosen as the language of instruction in spite of it not being the home language of the majority of learners in the country. The value of English unilingual instruction is often given as one of the drivers of the improvement of learner achievement outcomes in the country (Vasagar, 2016). In contrast to this, there are studies that show the value of using more than one language when mathematics is being taught – and many show the benefits which can be gained from this approach (e.g. Adler, 1998, 1999, 2001; Bose & Choudhury, 2009; Setati, 1998a, 1998b; Setati & Adler, 2000).

The first section of the literature review looks more broadly at the teaching and curriculum of early grade mathematics. This is included to give a theoretical background to the context and policy implications for the context of the study – early grade mathematics. In the first part of this section more general ideas about teaching mathematics in the early grades are discussed and then ideas specific to the teaching of patterns in the early grades are discussed.

2.2 Early grade mathematics teaching and curriculum

In the early grades, learners are moving from the pre-operational to the concrete operational stage of development (Piaget, 1957) and mathematics teaching for learners at this stage needs to be planned so that it enables them to learn abstract ideas based on concrete experiences. Further, in accordance with general educational theory (Bruner, 1966; Piaget, 1957; Vygotsky, 1978), learners should be given opportunities to develop their mathematical knowledge through being incrementally exposed to a developmentally appropriate curriculum where the different components of the curriculum complement each other and work together. These ideas are reflected in the CAPS preamble and embedded in the curriculum design (DBE, 2011). Research has shown that there are several principles for learning and teaching in early grade mathematics (Anthony & Walshaw, 2009; Hoadley, 2012). Firstly, lesson activities should allow the development of abstractions by enabling learners to make connections between concrete and semi-concrete representations and the concepts which they embody (e.g. Askew, 2012, 2016). Secondly, several pedagogical strategies can be used to allow learners with a range of different learning styles to grasp that which is being taught (e.g. Cai, Kaiser, Perry & Wong, 2009). Thirdly, teachers should expose learners to different activities which are well sequenced and together allow them to experience a mathematically rich environment that allows them to develop practical mathematical skills in a range of contexts (e.g. Anthony & Walshaw, 2009; Askew, 2012, 2016). Fourthly, learners should be enabled to explore mathematical concepts and language and learn to communicate in a range of mathematical contexts for a variety of purposes and audiences (e.g. Barwell, 2005b; Morgan, 2005; Mostert, 2019). Three of these four principles rely on language. The fourth is all about language. Thus although concrete experiences are central to learning at this stage, language is at the heart of this learning, since at this stage learners are developing academic literacy (Madiba, 2013).

To date, there great deal of research on language use in early grade classes both locally and internationally and in mathematics education. While curriculum policy in multilingual contexts has been more widely written about, there is less research that has been published in the area of curriculum policy in relation to language use in the teaching of mathematics in these contexts. There is very little research on learning materials used in multilingual contexts, teaching in these contexts or on what approaches to language use are held by key stake holders and teachers in these contexts. All learning and teaching activities are guided by the curriculum which is a policy document that was developed based on international and national curriculum expectations (Alexander, 1989, 2004; Plüddemann, 2002, 2015).

The CAPS is the result of three rounds of curriculum development and revision in South Africa. It is a sound, well sequenced and structured curriculum which promotes appropriate mathematical learning and activities for the phase although I contend that it could benefit from certain amendments, some of which are already under discussion at a national level (DBE, 2017).

Research on curriculum implementation suggests that teachers are not all able to interpret and implement the curriculum effectively (Beukes, 2008; Chetty 2012; Chetty & Mpewu, 2008; Gauteng Department of Education, 2011; Magwa, 2013; Venkat, Adler, Rollnick, Setati, & Vhurumuku, 2009). Research carried out by Venkat and Naidoo (2012) based on data from LoLT English FP classes, reports findings in relation to teachers' and learners' proficiency in the use of language to express their ideas and to communicate mathematically. They analysed transcripts interactions from Grade 2 classrooms (LoLT English) to look for levels of coherence in explanations given by teachers. They observed that, "[t]alk had to carry the major burden for the communication of meaning and given both the ambiguity and disconnection within this aspect of pedagogy, opportunities for broadening access to learning beyond those who already appeared able to complete the task were severely restricted" (2012, pp. 29-30). They thus found severely impaired possibilities for connected learning of ideas in these FP mathematics classes.

The CAPS states that mathematics is a "human activity that involves observing, representing and investigating patterns" (DBE, 2011, p. 8). The mathematical topic of patterns is one that presents possibilities for learners to reason mathematically while they make conjectures about rules that they identify for given patterns. This is spoken about in both local and international literature on the teaching of mathematics (e.g. Chikiwa, Westaway, & Graven, 2019; Suh & Seshaiyer, 2015). Rittle-Johnson, Zippert and Boice (2018) state that, "Current evidence suggests that repeating patterning skills are linked to improved *numeracy* knowledge in early elementary school. (p. 30). The topic of patterns thus provides teachers with a teaching context where learning from the content area of number can be extended and used to develop learners' mathematical conceptual knowledge. Fundamentally the teaching of patterns deepens learners' number sense, the core conceptual teaching needed in the early grades (Chikiwa, Westaway, & Graven, 2019; Clements & Sarama, 2014; Rittle-Johnson, Fyfe, Hofer, & Farran, 2016).

An important part of learning in any mathematical content area is the development of the language of expression – also referred to as mathematical register. Mathematical register is the focus of the second section of my review of the literature. The broader literature on mathematical register is discussed first, since it establishes the importance of the notion of register which is core in any research on language use. The specific register required for the teaching of patterns in the early grades is then discussed.

2.3 Mathematical register and standardisation

Language plays a key role in the learning and teaching of mathematics (Trinick, Meaney, & Fairhall, 2014). The full mathematical register is made up of terms, phrases, symbols, diagrams and gestures that enable a speaker to express a mathematical idea. When language is used to express mathematical ideas, it is serving a particular function which the linguist Halliday (1978) refers to using the linguistic notion of register. The term "addition" could mean an extension to an existing building, but in mathematics it refers to the operation (add) which combines two numbers to find the sum of those numbers. The symbol "–" can be used to separate two written phrases which relate to each other, but in mathematics, it means "subtract" or "find the difference between" the two numbers between which it is written. Terms such as addition/add and subtraction/subtract form part of the mathematical register which is built up from early grades. Building on Halliday's notion of register, Setati explains that mathematical register refers to a set of meanings that belong to the language of mathematics and by way of definitions, express mathematical meaning, when used for mathematical purposes (Setati, 2002). Definitions generally relate to particular terms, which can be listed and can be identified as "core mathematical register".

It is generally accepted that mathematical language is more than words (Barwell, Barton & Setati, 2009; Barwell, Leung, Morgan & Street, 2005); it includes using and refining the use of words to talk about mathematical ideas (Barwell, 2005a, 2012; Barton, Fairhall & Trinick, 1998; Morgan, 2005; Moschkovich, 2002; Roberts, 1998; Setati, 2002; Trinick, Meaney, & Fairhall, 2014). Studies on the development of mathematical register argue that the development of the register *per se* does not necessarily translate into improved learning in mathematics and it might even lead to other complications regarding language use (Barton, Fairhall & Trinick, 1998; Roberts, 1998; Trinick, Meaney, & Fairhall, 2014). These studies show that even when the mathematical register was fully developed, as it was for the Maori language in New Zealand (Barton, Fairhall & Trinick, 1998; Roberts, 1998) and Chichewa in Malawi (Kaphesi, 2002), learners' understanding of mathematics did not suddenly and vastly improve because the mathematical register existed. The learning and teaching of mathematics go beyond the existence of a well formulated lexicon but the way in which language is used while the mathematics is being taught (together with other aspects of a good early grade mathematics lesson as discussed in 5.1) plays an important role.

Researchers such as Barwell, Barton and Setati (2009) and Barwell, Leung, Morgan and Street (2005) draw a distinction between knowing words and using words. This distinction is important in the context of my study since I will be investigating what words are used in IsiZulu, Setswana and in English to speak about mathematical patterns in the early grades, and the ways they are used. Differences in language as it is used by learners, teachers and the support material which they receive, might reveal variation in language use which could be problematic and cause confusion. This confusion could relate to a lack of standardisation of the mathematical register or broader standardisation of languages. Webb (in Lafon & Webb, 2008) discusses "the crucial notion of "fully-fledged standard languages": South African languages do have recognized standard varieties but these lack broad acceptance within the various sectors of their respective speaker communities, and this constitutes a serious impediment to their use as language of learning and teaching" (p. 3).

The key source of terminology used in the preparation of materials for South African schools in all of the official languages is the Department of Arts and Culture (DAC) dictionary: "The *Mathematics Dictionary Grade 1 to Grade 6* is a multilingual, unidirectional term list containing about 1000 entries (DAC, 2008, p.15)". Point four in the explanatory notes of the latest edition of the DAC dictionary states that, "The aim of this list is to make a contribution towards mother-tongue education for all speech communities in SA and it therefore does not include complex Mathematics terminology (DAC, 2008, p. 15)". As one of the primary sources for translators of educational materials, this is a major restriction on what the dictionary is able to provide. Although the dictionary does include synonyms, they are few. The DAC list is extremely limited with generally one-word options (per language), as illustrated in Figure 2.1, a snapshot of the DAC entry for the term *subtract*.

subtract v. <symbol ->

Afrikaans	**aftrek**
IsiZulu	**susa**
IsiZulu	**khipha**
IsiXhosa	**thabatha**
SiSwati	**khokha**
SiSwati	**susa**
SiSwati	**khipha**
IsiNdebele	**khupha**
Setswana	**ntsha**
Setswana	**tlosa**
Setswana	**tlosa**
Sepedi	**ntšha**
Sesotho	**tlosa**
Tshivenḓa	**-ṱusa**
Tshivenḓa	**u ṱusa**
Xitsonga	**susa**

subtraction n. <symbol ->

Afrikaans	**aftrekking**
IsiZulu	**ukususa**
IsiXhosa	**ukuthabatha**
SiSwati	**kususa**
SiSwati	**kukhipha**
SiSwati	**kukhokha**
IsiNdebele	**ukukhupha**
Setswana	**tloso**
Setswana	**ntsho**
Sepedi	**tlošo**
Sepedi	**ntšho**
Sesotho	**ho tlosa**
Tshivenḓa	**muṱuso**
Tshivenḓa	**u ṱusa**
Xitsonga	**nsuso**

subtraction calculation

Afrikaans	**aftrekberekening**
IsiZulu	**ukubala ngokususa**
IsiXhosa	**uthabatho**
IsiXhosa	**ukuthabatha**
SiSwati	**kubala ngekususa**
SiSwati	**kubala ngekukhipha**
IsiNdebele	**umbalokhupha**
Setswana	**palelotloso**
Setswana	**palelontšho**
Sepedi	**palelo ya go tšha**
Sesotho	**tshebetso ya ho tlosa**
Tshivenḓa	**murekanyo wa muṱuso**
Tshivenḓa	**u vhalela ha muṱuso**
Xitsonga	**nkhakhuleto wa nsuso**

Figure 2.1 Extract from the DAC dictionary

In the example of word lists shown in Figure 2.1, it can be seen that synonyms (and some parts of speech) are provided for the term subtract, subtraction and subtraction calculation. The IsiZulu versions provide two synonyms for the term subtract (susa and khipa) but this is not followed through into the following two entries. The Setswana versions also provide two synonyms (ntsha and tlosa)[11] which are followed through into the following two entries. Researchers such as Mafela (2010) refer to the issue of dialect representation in their work. In languages where there are multiple dialects the lists of synonyms are extensive and they are not represented adequately. This is a flaw not only of the DAC dictionary but of other indigenous language dictionaries (Mafela, 2010). Synonyms are one of the sources of variation in language use (in all languages) and this has bearing on variations in the mathematical register as well.

Variation in the form of synonyms is part of the full range of mathematical language. For example, in English, the word “numeral” is another word for “number symbol”. It would not be incorrect to use both of these ways of referring to the symbol “2”. Finding out what words are used and how many different ways there are for naming mathematical terms does not represent the full picture. The way in which words are used also forms an integral part of mathematical language. In this regard, Morgan (2005) questions the traditional role of definitions in mathematics which she says results in their being “highly valued in high stakes mathematics discourses” (p. 105, 2005) but which distracts from their potential to contribute to mathematical learning through debate. In agreement with other authors, she argues that

[11] There is a third entry for Setswana, but this appears to be a typographical error.

mathematical language is more than a specialised mathematical register and proposes that the role of definitions in mathematics needs to be challenged – that they need to be seen to have value rather according to what they can facilitate and the kind of activity that they can promote (Barwell, 2005a, Leung, 2005; Morgan, 2005). Morgan talks about the "generative or creative aspects of mathematical definition" (2005, p. 114) and claims that this aspect of definitions can play out in the primary school, by citing as an example the deep and valuable debate that can be sparked by the discussion of whether or not a rectangle is a square.

In the broader context of schooling in South Africa, learners' confusion might result from a general lack of understanding because of poorly developed prior knowledge and/or poor teaching. I will be investigating both mathematical register and language use and whether or not any disadvantage could stem from this. In my study, where the focus will be on variation (and in some respects) consistency of language use, I need to remain aware that achieving a standardised definition of mathematical terms may be necessary but not sufficient for the learning of mathematics.

The CAPS document states that "Mathematics is a language that makes use of symbols and notations for describing numerical, geometric and graphical relationships" (DBE, 2011, p. 8). As a policy document, the Foundation Phase CAPS sets out to do more than record the mathematical curriculum requirements for Grades R-3, it also sets out to provide the standard for the teaching of mathematics in all eleven official languages of South Africa. Linguistically, it is set up to inform the standardisation of mathematical terminology to be used when queries arise as to what mathematical register should be used. [12] In conversations about language use whenever there is uncertainty about the translation of the mathematical register into any of the eleven official languages, teachers and department officials will refer to the CAPS as the source of the appropriate translations. Yet, on the inside cover of the CAPS document there is a disclaimer that reads:

> There may also be vernacular inconsistencies in the language documents at Home-, First and Second Additional Language levels which have been translated in the various

[12] In conversations with district officials about translation queries when working on learning materials in three large teacher support and development projects (provincial and national) in which I have been involved in South Africa, I am told to "refer to the CAPS". This has happened on many occasions and when I follow up on the queries with professional translators registered (or not, as registration is not required) with the South African Institute for Translators (SATI), they concur with this stance. The DAC dictionary is another source to which I am referred. It is a very limited document with lists of single word translation options some of which are challenged when they are used in the school context.

> African Languages. Please note that the content of the documents translated and versioned in the African Languages are correct as they are based on the English generic language documents at all three language levels to be implemented in all four school phases. (DBE, 2011)

The CAPS curricular expectations in terms of mathematics teaching might be sound (and according to the disclaimer "correct in the English generic version") but a question relating to language is raised, by the DBE itself, in connection with the "vernacular inconsistencies" in the curriculum document. Yet no rigorous academic study has been carried out to investigate these inconsistences or how they might impact learning in the early grades.

I argue that in addition to teachers' content knowledge and broad pedagogical expertise, the quality of their interpretation of the curriculum and its implementation in the classroom is compounded by the relationship between the language of mathematics and the language of learning and teaching in mathematics classrooms. Much of the conceptual mathematics learning in the early grades becomes the mathematical register of later mathematics. Although the main thrust of early grade pedagogy is towards teaching through the use of concrete materials and semi-concrete representations (Askew, 2016), language binds all of this teaching together. Teachers use language to mediate the connections between the different representations and the abstract ideas which they embody which at times may create difficulties if the necessary language is not well developed (Robertson & Graven, 2018). CAPS sequences the content to be taught and offers multilingual support (in monolingual texts) in relation to policy requirements but Venkat and Naidoo's study mentioned previously (2012) raises the issue of poor communication and use of language in early grade mathematics lessons. These all relate to issues linked to the effective and efficient use of mathematical register.

The register that forms the focus of this study is that of patterns. In terms of this discussion, the mathematical terminology of patterns includes some terms and phrases that are well defined and generally known. There are also some terms that are more technical and that could be the source of confusion as a result of lack of familiarity or possibly poor standardisation of the register. In this study, I might come across multilingual contexts where certain mathematical terms may exist in one language but not in another or where terms exist, but they are not familiar to young learners. Setati (1998a) refers to this issue, saying, "[direct translation] is not always possible in mathematics, because some of the maths words are either not available in

Tswana or not readily used". In 2017 Guzula encountered the same problem (words for which terms did not exist or terms that exist but are not well known by children) when translating a text about scientific concepts into isiXhosa (Moore, 2017). Patterns as a mathematical content topic draws on the core terminology of number (such as the number names and operations) which is generally used and known but it also draws on some more specific terminology that enables speaking about the patterns themselves. The more specific pattern terminology (such as number or geometric patterns, sequences, terms, next term) is less commonly used. I noticed a dearth of research literature on the topic of standardisation of mathematical register in the South African context. This study yields findings which could inform the language standardisation debate. This research is critical if we are to inform the debate around the following strong position (either to challenge or confirm it) stated by Webb (Lafon & Webb, 2008, p. 15):

> in so far as communication in school classrooms is in an African language, such communication should be in the standard form of the language, and not in an urban vernacular. Learners' linguistic skills in the standard variety of their primary languages must also be developed in content subjects, i.e. across-the-curriculum.

In multilingual contexts there is at times a tendency to focus on the lack of standardised mathematical register in certain languages, indicating buy-in to the "high stakes" notion of definition and overemphasising the role of the development of mathematical register to the detriment of mathematical conceptual development (Kaphesi, 2002; Barton, Fairhall & Trinick, 1998; Barwell, 2005b, 2012). According to Morgan (2005), giving definitions and teaching mathematical register does not preclude the possibility of meaningful tasks but a lack of mathematical register does preclude the possibility of meaningful discussion, because without knowledge of the appropriate terms, one cannot say what one wants to say. Mathematical terms are part of the mathematical register. Even if they do not constitute the register in full and should not be overemphasised in terms of importance, they are necessary for fluent communication (Barton, 2008; Jorgenson, 2018; Pimm, 1981, 1991). However, from a pluralist perspective, learners might be able to engage in mathematical debates and discussions in order to learn the concepts being discussed by using words from across more than one language, obviating the need to have every mathematical term equally defined in all languages. Teachers and learners in these contexts might choose to use languages in a more fluid or flexible way to say what they want to say.

The final section of the literature review presents the research on teaching in multilingual classes.

2.4 Teaching mathematics in multilingual classes

Barwell (2007), cites Franceschini (1998), saying “Multilingualism is no longer an extraordinary case – approximately half of the world’s population use more than one language in their everyday life”. It is thus important that we understand how mathematics learning plays out in multilingual contexts. Whatever the language of expression might be, spoken language needs to be used in such a way that learners are able to express their thoughts as clearly as possible, while they grapple with the mathematical concepts that they are learning. Language use should not interfere with the learners’ ability to speak about what they are doing and make conceptual generalisations. In multilingual contexts research has shown that learners do like to draw on more than one language in classroom discussion when they learn mathematics.

There has been a fair amount of research in multilingual mathematics classes that reports on the practice of code-switching (e.g. Adler, 1998, 1999, 2001; Aineamani, 2018; Bose & Choudhury, 2009; Bunyi, 1997; Chikiwa, & Schäfer, 2016; Essien, 2010, 2013, 2018; Kaphesi, 2002; Langa, 2006; Moschkovich, 2002; Mukucha, 2012; Poo & Venkat, 2021; Setati, 2002, 2008; Wildsmith-Cromarty & Gordon, 2009). Code-switching (an alternation between two or more languages of expression) is seen as useful for both teachers and learners when mathematics is being taught in multilingual contexts. There is a growing body of research into the role of language and the use of translanguaging in mathematics learning, more so internationally (e.g. Castro, 2015; Creese & Blackledge, 2010; Mejía Colindres, 2015; Prediger et al., 2019; Sorto, Mejía & Wilson, 2014). In South Africa most researchers still use code-switching to refer to flexible language use practices in mathematics classes. Translanguaging can be defined as “integration of language practices in the person of the learner” (García & Wei, 2014, p. 80) involving a “shift within bilingual instruction from teaching two separate autonomous linguistic systems to a more flexible set of arrangements” (Cummins, 2015, slide 15). Flexibility is a core requirement for translanguaging in a mathematics class, but for this to be possible, transferability between languages is a necessity (Canagarajah, 2011). This means that, for both teachers and learners, knowledge of the mathematical register in more than one language is a necessity and the ability to draw on those different language resources flexibly is essential.

The power and value of multilingualism is gaining recognition internationally (Wolff, 2018) and searching for ways in which to fully utilise language as a resource is an ongoing task – translanguaging is seen as key to this endeavour. Researchers claim that translanguaging is a useful practice in the context of multilingual teaching, especially (but not exclusively) in the context of language learning (García & Wei, 2014, Lewis, Jones & Baker, 2012, Makalela, 2015a, 2015b, 2019; Otheguy, García, & Reid, 2015). This has implications for the teaching of mathematics in the early grades. Recently in the South African context, Mostert (2019) and Poo &Venkat (2021) have written about the value of using the linguistic structure of number names in indigenous languages in the teaching of number concept. Makalela argues that "research on classroom and programme and practices has revealed a myriad of benefits that show the need for translanguaging policy in multilingual contexts" (2014, p. 92). These benefits include language development, but also cognitive development, since some researchers have shown that brain function is strengthened in learners who draw on two languages simultaneously. Many authors speak to the cognitive benefits of translanguaging for learners of all ages (e.g. Bialystok 2006; Chin & Wigglesworth, 2007; Kovács & Mehler, 2009). For example, Castro (2015) suggests that "translanguaging is one way in which [learners can] support their working memory" (p. 64). In addition to this, Castro's study that explored language use in mathematics lessons in multilingual spaces in a rural community in the Midwest USA found that the school worked at systemising translanguaging as part of their bilingual programme and that this impacted on learner engagement as it was experienced as a "pedagogy of care" (Castro, 2015). The benefits of translanguaging in multilingual contexts rest on the ability of teachers in these contexts to facilitate learning in more than one language. This is possible for some but not all teachers, which is what this study intends to investigate further.

In multilingual contexts, particularly where certain languages may be dominated by others, there could be a debate about the "correct" mathematical register and there could also be slippages in translation between languages. In translation, the multiple meaning of words needs to be monitored with care. The words which have special meanings in mathematics in English might not carry over to other languages in the same way, where different words or phrases may have been established to convey the specialised mathematical meanings. In spoken language, there might even be a tendency to use the words from one language while speaking another (translanguaging). It is argued that connections across different languages between meanings of terms which make up the mathematical register can be made in print material through the use of multi-bi-lingual presentation of the material (Botes & Mji, 2010; Owen-Smith, 2012).

One of the main claims in the literature is that connections need to be made between all of the languages spoken by a learner. This is emphasised by Genessee in an article entitled "The Home Language: An English Language Learner's Most Valuable Resource". A support mechanism that could be developed to assist teachers in multilingual classes is bilingual materials.

In the literature presented above, the benefits of mixed language use have been the focus. There are challenges and issues that may arise in multilingual contexts when mixed language is used. Canagarajah (2011) points out some of the misconceptions that have arisen in relation to translanguaging. The first is that some authors have created an impression that it is a new practice while Canagarajah argues there is "evidence that translanguaging has been practiced in pre-colonial communities and in rural contexts" (p. 3). He also cautions against the creation of a new binary – monolingualism/multilingualism, arguing that such a binary tends to distort "the integrated nature of multilingual competence and communication" (p. 3) saying that "[e]ven the so-called "monolinguals" shuttle between codes, registers and discourses" (p. 4). According to Vaish (2019) the main challenges are created by superdiversity of the language context and the hegemony of English which results in a preference for English even when it is not the home language. He proposes the use of translanguaging pedagogy to address this domination of languages. Ticheloven, Blom, Leseman & McMonagle (2019) have written about pedagogical challenges that arise in multilingual contexts, listing seven distinct pedagogical challenges concerning a translanguaging pedagogy that emerged from the focus group discussion analysis: (1) Side effects; (2) Goal formulation; (3) Learning the language of schooling; (4) English and other semiotic resources; (5) Affective functions; (6) Effort; and (7) Confusion (p. 8). They argue that awareness of the challenges can enable further research on "how systematic and purposeful translanguaging can become part of a multilingual school culture" (p. 19). Any analysis of the pros of translanguaging needs to be carried out with an awareness of the cons.

2.5 Conclusion

Emerging from the literature in mathematics education in multilingual contexts is a strong claim that learners need to acquire literacy skills not just for everyday language but for the language of mathematics. These "languages" intersect and yet are different. There has been a considerable amount of research done on the development of mathematical register (e.g. Barton, Fairhall & Trinick, 1998; Barwell, Leung, Morgan & Street, 2005; Morgan, 2005; Roberts, 1998). The terms, drawings and symbols used to communicate mathematically make up the mathematical register that is needed for communication in a mathematics class. There are great expectations of teachers' use of language to mediate learning and learners' ability to engage and interact, using language, but these are not always met in reality. Research has been carried out in the higher grades that reports on language use in mathematics lessons (e.g. Adler, 1998, 1999, 2001; Moschkovich, 2011; Setati, 2012; Setati, Molefe & Langa, 2008). Findings from all of these studies point to the usefulness of a learners' home language in mathematics lessons, used as a resource in conjunction with the LoLT, where the LoLT is not the learners' home language (Planas & Setati-Phakeng, 2014).

As my review shows, many studies on language acquisition are set in multilingual contexts as this is fast becoming the norm in the world especially in highly populated large cities and particularly those situated near to borders between countries where different languages are spoken (Cloud, Genesee & Hamayan, 2009). These studies suggest that in multilingual contexts, where bilingualism is recognised and valued, ongoing inter-relationship between languages will facilitate the learning of mathematics. García identifies this relationship as moving away from a monoglossic orientation towards bilingualism that views languages as separate and whole entities, towards a heteroglossic one that views languages as interrelated (García, & Baetens Beardsmore, 2009, p. 7).[13] This is in line with Makalela's suggestion that it is important to move from fixity to fluidity in language use, with a focus rather on what people do with language than what the language looks like (Makalela, 2016).

My reading has also shown me that tension prevails in relation to choices to be made in relation to language use in the early grades. The dominant voice in the literature of learning and teaching in multilingual contexts at present is in favour of multilingualism and drawing on

[13] These terms are developed in Section 3.2.2.

multilingual resources (e.g. García & Wei, 2014; Makalela, 2019). As discussed, Canagarajah (2011) warns against certain misconceptions about the concept of translanguaging that might blur research in the field, one of them being the romanticisation of the practice, arguing that "[i]t is not surprising that scholarship on translanguaging makes multilingual communication appear more diverse, dynamic and democratic than "monolingual" competence" (p. 3). In addition to this, there are challenges and issues that arise in some contexts that mitigate the use of translanguaging (Vaish, 2019) and the way in which it can be used effectively in early grade mathematics classrooms has yet to be established. There are challenges and issues that arise when translanguaging pedagogies are used which require further investigation (Ticheloven, Blom, Leseman & McMonagle, 2019). As Setati argued many years ago (1998b), recommending code-switching is not straightforward and unproblematic and the limited use of code-switching can lead to blockage of learner access to mathematics and its communication.

In the South African context, drawing on multilingual resources is a necessity, especially in urban schools and so in my study I hope to build upon existing research to find out more about language use in this context with an awareness of the challenges and issues in relation to multilingualism and with a view to doing further research on how to optimise language use in the context.

The next chapter presents the theoretical framework of the study.

Chapter 3: Theoretical framework

3.1 Introduction

In South Africa the tension around language use in education is tangible, particularly in the early grade years, since this is where policy addresses the issue of home language education. [14] Learners begin to acquire academic language in these years, building on what they have learned in early childhood. My literature review has shown that mathematics researchers on language argue that learners should study in their home language, supported by code-switching or translanguaging. As discussed in the background, introduction and rationale of this study, the choice of LoLT at schools is not always made in favour of the majority home language of the learner population for a number of reasons and more so in urban areas. There are schools where the majority of learners do not speak one homogeneous language and there are schools that favour English as the LoLT even when there is a more homogeneous learner population language other than English. The favouring of English may be because of the pressure experienced as a result of the curriculum switch to English as LoLT from Grade 4 onwards in the schooling system or it could be based on a popular belief that teaching mathematics in English is preferable. The choice of LoLT is thus influenced by factors other than learner population home language preferences. The tension around the selection of the LoLT is not just a South African phenomenon. As alluded to in the following quotation, the value of including some languages in educational settings is sometimes questioned:

> Languages may be excluded from education because they are not thought to be suitably adapted to deal with the content of educational programmes, reflecting ideologies that some languages are less suited to the expression of modernity than others. This argument has often been used to exclude vernacular languages from educational settings in preference to exogenous languages, often of colonial origin. (Liddicoat & Taylor-Leech, 2015, p. 2)

[14] In Grade 4, the first year of the IP (the second of three phases in the General Education and Training (GET) schooling sector, the LoLT changes to English for the majority of learners in South Africa (or Afrikaans, for a minority). This is the current reality. It is not within the scope of this study to investigate the issues that arise as a result of this switch but this study raises the question as to the value of a narrow definition of LoLT (one chosen language of instruction per class) and extending the investigation of a narrow definition of the LoLT into the IP would be pertinent.

This claim brings me to the question of ideology and its influence on the choice of language of learning and teaching and as I will show, on language use too. Policy makers in South Africa are influenced by the same pressures as policy makers in other post-colonial countries and although the South African language policy has attempted to address the hegemony of English, this process has not yet fully worked itself out. Thus, although this study is situated in the field of multilingualism in mathematics education, which has been expanded upon in my literature review, the theoretical framework that I chose draws on the theory of language ideology. This will enable me to bring in the power play that is on-going in relation to policy and practice of language use in South African schools. This does not mean that the language policy is merely ideological or that there is not educational reasoning behind it. It is however important to acknowledge the place of ideology in policy, teachers' practices and teachers' perceptions. My study goals align with the argument put forward by Makoe and McKinney that, "without an understanding of the language ideologies informing both policy and practices, we will not be able to shift practices in South African classrooms so that learners' full linguistic repertoires can be legitimately used as resources for learning" (2014, p. 659).

In this chapter, I briefly discuss some of the literature of language ideology in order to give background to and substantiate the way in which language ideologies will be used in my analytical framework. In Section 3.2 I discuss language ideologies, language use in relation to language ideologies and the two main language ideologies that inform language use. I also reflect on the question *Is all language use ideological?* In this reflection, I look at the differences and similarities between the conception of ideology in the social sciences in general and the way it is used in the literature of language ideology. In line with my main question, in Section 3.3, I give a brief overview of what I perceived as the relationship between language ideology, policy, research and practice to explain my theoretical approach to my main focus – language use. This chapter addresses only the third of my three main concepts (ideology, policy and research) because the others have been addressed already. FP mathematics policy was addressed in 2.1 and 2.2 and research on language and mathematics teaching was addressed in 2.3. and 2.4. The main claims of each of these three concepts are presented in my conceptual framework (Table 3.1).

3.2 Language ideology

Ideology, according to the Merriam-Webster dictionary in the broader sense, refers to the "manner or the content of thinking characteristic of an individual, group, or culture" or "a systematic body of concepts especially about human life or culture" (Merriam-Webster, n.d.). Ideology is a term that was coined in the 18th century by the French writer A. L. C. Destutt de Tracy who proposed it as a term to designate the "science of ideas," (Merriam-Webster, n.d.) and it was soon absorbed into the English language. The term ideology has been used in the political and sociological domains, but the Russian philosopher Bakhtin highlighted the ideological nature of language, saying that "verbal discourse is a social phenomenon" (1981, p. 269). Costa (2016, p. 39) quotes from Bakhtin and Medvedev of the Bakhtin Circle (1991), to explain how according to their philosophy, language mediates the construction of ideology:

> Nor do philosophical views, beliefs, or even shifting ideological moods exist within man, in his head or in his "soul". They become ideological reality only by being realized in words, actions, clothing, manners, and organizations of people and things – in a word: in some definite semiotic material. Through this material they become a practical part of the reality surrounding man.

The idea of language ideology was pioneered in the early 1990's by Kathryn Woolard, Paul Kroskrity and Bambi Schieffelin, a group of scholars from the fields of linguistics, anthropology and sociology. The first major text they produced was published in 1998, entitled *Language Ideologies: Practice and Theory*. They built on Silverstein's (1979) writing on linguistic ideology. The thrust of their work was that a focus on language ideology enables a connection between linguistic and social theory (Schieffelin, Woolard & Kroskrity, 1998). Woolard writes in her conclusion to the introductory chapter to this book, that the ideology concept "allows us to relate the microculture of communicative action to political economic considerations of power and social inequality" (p. 27). In a more recent publication, Woolard (2021), grapples with the complexity of defining and exemplifying language ideology. She summarises it as an analytic move made by linguistic anthropologists, saying that, adding to the dictum of British sociologist of language, Bernstein that "between language and speech, there is social structure" (p. 1), linguistic anthropology added, "and between language and social structure, there is language ideology" (p. 2). The group of scholars who pioneered and have continued to work in this field were thus interested in the ideological dimension of language use and its relationship to cultural history, ethnohistory and linguistic structure. Makoe and McKinney, writing about linguistic ideologies in multilingual South African suburban schools explain that "language ideologies provide the link between social structures and power relations and language use at the micro level" (2014, p. 659). Interpreting this in the current South African multilingual early grade mathematics context, I posit that learners in our schools are being educated in a cultural context at a particular point in time (post-colonial, post-apartheid South Africa), where language use in classrooms (the "micro level") in this context is also influenced by the ideologies of the players in the system – policymakers and policy ("social structures") – and the power relations at play in this context.

Kroskrity has defined language ideologies as "beliefs, or feelings, about languages as used in their social worlds" (2004, p. 498). In South Africa, the work of McKinney has placed questions about language education and policy in the ideological domain and highlighted the need for greater awareness of this connection on the part of policy makers and teachers alike if language use in classrooms is to better serve the needs of learners (McKinney, 2017).

Costa (2016) writes about ideology and scientific dissemination. She bases the discourse analysis that she carried out on the text in a selection of scientific journals on the idea that "the concrete utterance appears in the work of the [Bakhtin] Circle as a privileged *locus* of constitution of ideology" (2016, p. 41).[15] This means that speech (spoken or written) embodies or represents an ideological stance and can be analysed to expose this stance. I take up this idea and in this study of language use I take the "concrete utterance" (spoken or written) as my unit of analysis. I will expand on the study of language use in relation to ideology in my study in Sections 3.2.1 and 3.2.2.

3.2.1 Language use in relation to ideology: embodied or articulated ideologies

Language use lies on a continuum between multilingualism and monolingualism. The multilingual context and literature relating to teaching mathematics in multilingual contexts has been discussed in my literature review (Section 2.4). Multilingual language use may take on more than one form (these will be exemplified in my analytical framework), but monolingual language use takes on one form – the use of only one recognised language (which

[15] I discuss Bakhtin's work in relation to this study more fully in Section 3.2.2.

will also be exemplified in my analytical framework). Language use can be understood in relation to language ideologies whether the users of language are aware of their choices or not, because language ideologies may be articulated or embodied (Kroskrity, 2004).

Articulated ideologies are made evident when speakers are questioned about their language use choices, and they give explicit reasons for these choices. The explanations they give express their articulated ideology with regard to language use. For example, a teacher who is questioned about the way in which she has given a particular explanation during a lesson, who is able to give reasons for why she used code-switching, is expressing an articulated ideology. Whether her decision is ideologically based or not is a different question[16] but the main point is that when a speaker expresses a choice and reasons for this choice, they articulate the ideology that they follow. They may be aware or unaware of what they are saying. If they do not have reasons for their choice one could say that they are not aware of what they are saying. If the reasons are not explained on educational or policy grounds, they are considered to make a choice ideologically.

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

Examples of language ideologies can be found in spoken mathematical expressions, of which speakers may be aware or unaware. This awareness is inferred according to *choices* made by speakers. An example of an embodied ideology of which the speaker is aware is found when a teacher explains a concept to a multilingual class and chooses to give a definition in both the home language of the majority of the learners as well as in English, first in one language and

[16] If a teacher says that she follows the policy and the school principal is very strict she shows compliance to her/his authority but she may have a different view on that decision. So the policy is pushing a perspective with which the principal is not prepared to negotiate with the teacher and as a result that teacher acts ideologically and not rationally – she is not autonomous to make a rational justified decision.

then in another. In this example the teacher is showing an awareness of the codes being used and chooses to switch from one to the other. Another example of an embodied ideology, but one of which a teacher is unaware, is found when a teacher, without thinking about it, translanguages while explaining a concept to her class, *fluidly* using language as a resource and drawing on her full language repertoire to do so.

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

Drawing on the theory of language ideological enquiries thus enabled me to examine language use and shed light on the language ideologies of policy makers, materials developers and teachers. The two language ideologies which I identified from the literature that are useful in my study and that form part of my theoretical framework are monoglossic and heteroglossic ideologies[17]. I discuss these in the next section.

3.2.2 Language ideologies: monoglossic or heteroglossic

Language ideologies vary and they are linked to a speaker's (or writer's) orientation towards language. García has linked monoglossia (and on the other side of the spectrum, heteroglossia) to ideology. She does this by speaking about the ways in which language is conceptualised. Monoglossic ideologies treat languages as bounded autonomous systems without regard for

[17] There are many language ideologies but for the purpose of my study of language use in the multilingual mathematics context, monoglossic and heteroglossic ideologies were the most appropriate.

the actual language use of speakers, while heteroglossic ideologies recognise multiple language use practices in interrelationships (García, 2009). A monoglossic ideology is linked to a purist view of language which upholds that one, pure language can be used to express oneself meaningfully and that only pure language should be used when speaking or writing. A heteroglossic ideology is linked to a pluralist view of language which upholds that speakers who have a language repertoire of more than one language are able, and should be allowed, to draw on multiple languages when they speak. A heteroglossic ideology acknowledges linguistic diversity. Society does not always recognise or value the existence of speakers drawing on multiple language resources, which is partly what underlies the existence of these two opposing language ideologies.

Silverstein (2018) refers to what he calls a monoglot ideology, which rests on the belief that a society is monolingual, in denial of the presence of linguistic diversity and multilingual practices. Evidence of this is alluded to in South Africa by McKinney, Carrim, Marshall & Layton (2015) who have identified "monoglossic conceptions of language that inform language in education policy, planning, curricula and teaching, whether monolingual or multilingual, [with] profoundly inhibiting effects on children's participation in classrooms and ultimately their access to quality education" (p. 104). They refer to the anomaly of monoglossic ideologies which underpin "multilingual" approaches (p. 105). As Heugh (2014) notes, this is the general trend in developing countries previously controlled by colonial powers. This limiting effect of a monoglossic ideology influences the way in which policy makers envision language use.

The linguist Bakhtin introduced the term heteroglossia to describe the existence of multiple voices within one spoken utterance (Bakhtin, 1981). The tensions, conflicts, and multiple voices at play when language is used in multilingual contexts can be considered in the light of heteroglossia as expressed in the following quote (Bakhtin, 1981, pp. 271–272, in Barwell, 2014, p. 913):

> At any given moment of its evolution, language is stratified not only into linguistic dialects in the strict sense of the word […] but also […] into languages that are socio-ideological: languages of social groups, ""professional"" and ""generic"" languages, languages of generations and so forth.

This quote introduces the idea that the multiple voices which are present in an utterance are differentiated according to linguistic codes but also that they are socio-ideological – that they are expressions of different ideologies. I draw on Barwell's interpretation of this Bakhtinian theory in my contextualisation of heteroglossia to the South African classroom. Barwell uses Bakhtin's idea of heteroglossia when he writes about language use in multilingual mathematics classes. He states that the "various tensions arising for teachers and learners in multilingual mathematics classrooms can all be traced to the nature of language itself" (Barwell, 2014, p. 920). He identifies two ideas about language in these contexts (unitary language and heteroglossia) which create tension. These two ideas apply in the South African context. The idea of unitary language speaks to the language that is imposed by policy (which language is spoken, or LoLT, a unitary language). The idea of heteroglossia speaks to the multiple languages, drawn on as resources by the diverse teacher and learner population present in the multilingual context. The presence of these two opposing ideas about language leads to tension (which is essentially evidence of an ideological struggle) in multilingual classes.

Barwell explains the ideological struggle present in multilingual classes by drawing on Bakhtin's characterisation of centripetal and centrifugal forces which are present in any utterance (Bakhtin, 1981). These forces help to explain the tensions driving language use. According to Barwell, "centripetal forces represent the drive for standardisation; centrifugal forces arise from the inherent diversity of language practices" (2014, p. 911). The centripetal forces are thus the forces that drive monoglossic ideologies (they push for unitary language or purist language use) while the centrifugal forces are the forces that drive heteroglossic ideologies (they push for mixed language or pluralist language use). In my analysis I will bear in mind these forces when I analyse the ways in which ideology drives language use in multilingual contexts.

McKinney writing about what counts as language in South Africa suggests that "[h]eteroglossia thus provides a multifaceted lens for analysing the complexity of instances of language use within a micro and macro socio-political context" (2015, p. 109). In my study I investigated "the complexity of instances of language use" by foregrounding particular tensions that exist in early grade mathematics as a result of language policy and language use in this context.

3.2.3 Is all language use ideological?

When I began my study, I was of the view that not all language use is ideological and that, particularly in a mathematics class, professional choices could be made based on pedagogy and not ideology. Thinking of examples of language ideology influencing language use was not difficult: for example, the action on the part of officials monitoring curriculum compliance, prohibiting the use of English terminology in a Setswana LoLT mathematics class. In contrast to this, I initially considered that the example of a choice of language use which is not influenced by ideology, could be seen in the professional choices. I considered that these choices could be based on research and experience, made by teachers in relation to language use for mathematics teaching when developing the mathematical register of learners. But after collecting and analysing my data, I realised that "pedagogical choices" are all ideologically based since they generally relate to choosing which language to use to speak mathematically, and this is linked to language ideology. However, although I contend that all language use is thus seen as having an ideological basis (which I classified in my study as monoglossic or heteroglossic, according to pure or mixed language use), other drivers can still be identified. Identifying the ideology driving language use does not exclude the nuance of other "drivers", such as policy or research about multilingualism in mathematics education and mathematics education. These drivers, in turn, have implications for factors such as teachers' professional judgement, experience and authority relationships.

This aligns with the theory – going right back to the philosopher Bakhtin for whom, as already mentioned in the introduction to this chapter, verbal discourse is a social phenomenon. All language use is ideological, it cannot be abstracted and removed from its context and there is no verbal utterance that is not ideological, or according to the definitions of Bakhtin, "every word/discourse betrays the ideology of its speaker … every speaker is an ideologue and every utterance an ideologeme" (1981, p. 429). Language use is contextually bound.

Wortham (2001) writing about the use of language ideology in educational research, states that "language ideology has particular power as an analytic tool, because such ideologies *both* contribute to larger social belief systems *and* allow individuals to construe particular instances of discourse" (p. 9, emphasis in original). More recently, in the South African context, although in language education not mathematics education, McKinney draws on language ideologies in her research, finding that, "[t]he ways in which people value languages and speakers differently and frequently position each other differentially in relation to the ways in which they use language and the kinds of language they use is largely informed by their beliefs about language" (McKinney, 2017). The context of my study, as explained earlier, is one where the language policy is sending mixed messages – in favour of both pure and mixed language use. Thus, tension around language use, broadly, but also in mathematics education, informed my choice of a theoretical framework from outside of mathematics education.

While I was reading, the range of issues and ideas which pointed to the influence of language ideologies motivated me to do this study in order to look more closely at language use in the early grade mathematics context. I recognised a need to investigate and record more systematically, ways in which language ideologies may influence language use (and thinking about language use) in the multilingual early grade mathematics context. In Section 3.3 I present a schematic representation of the drivers of language use – ideology, policy and research – in the way I finally conceived this after completing the research.

3.3 Language ideology, policy, research and practice

I developed my theoretical framework, drawing on the concept of language ideologies to enable me to distinguish between educationally relevant reasons and ideological reasons for language use in the classroom. At the outset of my study, I created a table of the way in which issues from policy, research and teaching practice interact with and are influenced by language ideologies. The table summarised some of the ideas and issues that I identified upfront while drawing up the proposal for my study and with which I continued grappling while writing it up. I reworked this table several times during the process of writing up this study and it now encapsulates my theoretical framework – including my changed perspective on the role and place of ideology, policy and research. I still identify three drivers of language use but with a greater awareness that ideology is a driver that also influences the other drivers.

The table I drew up is not comprehensive, but it maps (for some key ideas), the interplay between ideology (embodied or articulated), research, policy, language use and standardisation in the multilingual classroom. The table not only summarises some key ideas but also gives a visual demonstration of the way in which ideology can be seen as a force which influences policy and research. In addition to this, all three (ideology, research and policy) have a bearing on language use in classrooms in multilingual contexts although not necessarily in equal measures. At the same time, the constraining force of standardisation pushes up from the ground, influencing language use and creating tension in the system.

The items listed under language ideologies in the top left cell of the table set out some of the ideas in relation to language ideology and language use in early grade mathematics. The items listed under research in the top right cell of the table are some key findings from the research (local and international) on language use in mathematics education in multilingual contexts. The items listed under policy in the table (top central cell) are some elements I identified in terms of policy in the South African early grade mathematics arena. Policy and research are seen to have influence on language use in practice, but before that, there may be an interplay between them, and they will have been influenced by ideology. The items listed in the bottom cell of the table relate to standardisation – some of the questions raised by and linked to the standardisation debate which have yet to be resolved. I identified standardisation as the constraining factor – also influencing language use, at times by constraining it, but at other times (through its absence) driving creativity.

I finally named Table 3.1 (next page) *Drivers of language use: language ideology, research and policy* to portray my theoretical framework.

Table 3.1: Drivers of language use: language ideology, research and policy

Language ideologies (articulated or embodied)

- Social language use – all languages have equal right to be used. Education drawing on full language repertoire affirms the dignity and the rights of the individual.
- Heteroglossic: Pluralist language use promotes multiculturalism.
- Heteroglossic: Pluralist use of language is the right of the speaker.

- Social language use – dominant languages are the language of the powerful. Education in dominant languages will give learners the best opportunity to get ahead in life.
- Monoglossic: Purist use of language will preserve culture.
- Monoglossic: Pluralist language undermines culture.
- Monoglossic: Purist use of language is the right of the speaker.

Research on multilingualism in mathematics education (authority)

- Language plays a key role in mathematics education. (e.g. Trinick, Meaney, & Fairhall, 2014).
- Language is a resource in multilingual classrooms (e.g. Adler, 2001; Setati, 2012); language proficiency is essential (e.g. Barwell, 2018; Planas 2018).
- Language can interfere with but can also be supportive of the learning of mathematics (e.g. Chitera, 2011; Essien 2018).
- Teachers are able to use mixed language to mediate the teaching of mathematics optimally (e.g. Jorgenson, 2018; Mukucha, 2012).
- Teachers use home language to mediate the teaching of mathematics which can have positive effects on learning outcomes (e.g. Langa, 2006; Taylor & von Fintel, 2016).
- Language is political (Clarkson, 2016; Phakeng, 2017; Mohohlwane, 2020)
- Well-designed resources can support learning in multilingual contexts (Aineamani, 2018)

Policy (authority)

- Grades R-3: School language policy – monolingual separation of learners in classes preferred.
- Grades R-3: School language policy – teaching should be in the home language of the learner.
- Grade 4: School language policy – English.
- Materials: Monolingual policy documents, textbooks and workbooks.

Practice: Language use

- Types of language use – monolingual (pure) and multilingual (mixed – code-switching or translanguaging)
- Tension between push towards standardised language use and reality of variation of language use in context.

Standardisation

- The standardisation debate – needed or not needed?
- Teachers' and learners' language proficiency – full register necessary for conversation in mathematics classrooms?
- Lexicon: standard for terminology – well enough developed?
- Invention of terms – whose responsibility?

As it can be seen in the schematic representation in Table 3.1 there are links between the three drivers – language ideology, research (on multilingualism in mathematics education) and policy – and practice, in the context of multilingual early grade mathematics. The drivers influence each other and language use, resulting in variation. But pushing up against variation in use, is standardisation. This results in tension in the system.

Research related to mathematics education (as presented in Chapter 2) addresses many issues that arise from and inform the study of language use, but it also raises questions about what works in multilingual contexts. The nature of language as a resource is one: language as a resource implies that a speaker is allowed to draw on his/her language repertoire, which may consist of non-standard terms. Speakers may also prefer to use an informal rather than formal register and flexibility of language use is endorsed by the research. The benefits of allowing learners to use a flexible mix of languages and even to use non-standard language that they invent for themselves has also been shown to have a positive influence on and maximise learning in these contexts. The policy context in South Africa needs to take this research into account.

The issue confronting a monolingual policy choice is that an emphasis on the ideological dimension of languages has resulted in the conception of "standard" as a matter of ideology rather than fact (Woolard, 1998). Policy issues that I raised in the introduction and rationale of my study are relevant – the standardisation of language assumed by policy (inferred from the drive for pure language use in the home language) is evidence of this ideological choice in South Africa. The curriculum interpretation of the multilingual language policy has resulted in a system of multiple monolingualism, where teaching in the (assumed) home language of learners has been established and monolingual materials are provided. In my study I investigated the validity of this assumption.

This being said, in mathematics there is an educational justification for standardisation of terminology, because of the conceptual nature of mathematical content and the need for a shared language that can be used for speaking about this content which also needs to be considered. In the context of mathematics learning and teaching – how flexible (or rigid) should language use be to enable mathematics learning most effectively? These ideas need to be investigated, since recent research into translanguaging in multilingual classrooms has shown the importance of proficiency in a language in order for effective learning in that language (Barwell, 2018; Planas 2018).

3.4 Conclusion

Language ideologies impact on the way in which speakers use language in any given context at times with an awareness but at other times, without such awareness (Kroskrity, 2004) because they may be articulated or embodied. Because of the power relations at play with regard to language use in the context of mathematics teaching (e.g. Setati, 2008), I used the theory of language ideologies to shed light on language use in my data. The language ideology of the powerful players in the system, embodied in policy, drives a particular language use. Opposing this, a speaker's language ideology can motivate (and empower) an alternative language use, in spite of the dictates of policy. Research can shed light on and inform best practice, but it is also influenced by ideology. When recognised and explored, language ideologies expose connections between the beliefs speakers have about language and the larger social and cultural systems of which they are a part, illustrating how these beliefs are informed by and rooted in these systems (Schieffelin, Woolard & Kroskrity, 1998). Language ideologies provided the critical lens that I used to analyse the data collected for this study of language use in the learning and teaching of mathematics in multilingual contexts in Grade 3 and 4 classes.

The next chapter presents the methodology of the study.

Chapter 4 Methodology

4.1 Introduction

Cai, Morris, Hohensee, Hwang, Robison, and Hiebert (2017) state that, "[o]ne of the most robust findings of education research is that students learn best that which they have the opportunity to learn" (p. 233). I argue that knowledge of language creates an opportunity to learn mathematics since language is a tool in the mathematics class (e.g. Barwell, 2018; Planas, 2018; Setati, 2012). This study, by investigating language use gives insight into language used in (and necessary for) the learning and teaching of mathematics. The study thus builds on the knowledge of language needs for learning and teaching and hence provides means to opening doors that create opportunities to learn. Without the necessary language, and a productive approach to language use, there cannot be any meaningful learning.

The research design of the study is that of a descriptive study (McMillan & Schumacher, 2006) based on three data sources – a survey, focus group discussions and classroom observations. The study is descriptive as it gives insight into language use although it does not answer questions about the effects of particular language use as there was no pre- and post-test component to this study. In this PhD study I drew on the RMFPM project reports (as discussed in Section 1.3 of the introductory chapter). [18] For the purposes of my PhD I undertook further data analysis (which is explained in this chapter). In this further analysis, I also considered the data from a language ideological perspective which was not done for project reporting purposes.

In this chapter, further research design elements and the methodology of the study are discussed. The design elements are discussed first (Sections 4.2 and 4.3) after which detail about the methods of data collection, the tools that were used, the sample and the data analysis are discussed (Sections 4.4, 4.5 and 4.6). The ways in which trustworthiness was maximised for this study and the ethical considerations of this study are also discussed (Sections 4.7 and 4.8). First the mathematical focus of the study is described.

[18] The project reports gave overall descriptors of the data and some analysis of language use, some of which are referred to in this study.

4.2 Mathematical content focus

The mathematical topic selected from the mathematics curriculum for the study is Patterns. This topic specific choice was made in order to contain the scope of the data collected for analysis by limiting the content focus. Patterns is the second CAPS topic for early grade mathematics. The full topic name is Patterns, Functions and Algebra, and it is made up of two subtopics, 2.1 Geometric Patterns and 2.2 Number Patterns. It is a relatively small topic with a clear focus but, as with much mathematical content, it does have links to other topics, notably space and shape (for geometric patterns) and number and operations (for number patterns). A further design element was the language focus of the study, which is explained next.

4.3 Language focus

As a further containment of the scope of the study it was also language specific. Any of the official languages of South Africa could have been chosen for the study, but I chose to focus on IsiZulu, Setswana and English. IsiZulu and Setswana represent the two main language groupings of the indigenous languages in South Africa – the Nguni languages (IsiZulu) and the Sesotho languages (Setswana).

Detail on the data collection methods and tools, sample and data analysis now follow, starting with the data collection methods and tools.

4.4 Data collection methods and tools

My study draws on three data sources as has already been discussed (Section 1.3). The three sources all drew on different methodologies which were chosen in order to allow multiple perspectives on language use. The descriptions of the three data sources and justification of choices made within each of the data collection activities is given below.

The survey method and tools are discussed first in Section 4.4.1.

4.4.1 Survey: Data collection method and tools

I chose to carry out a survey that I could use to inform subsequent stages in the research and data collection since a survey allows for large scale data collection that is more likely to yield information that represents the reality of the school context in which I set out to investigate language use. I carried out the survey data collection with the support of the research team. We went to the schools in pairs – I went with one of the student team members to the schools. [19] The survey was carried out in the third term of 2017 using teacher and learner questionnaires which both consisted of three sections (for exemplars see *Appendix 4.1* and *4.2*). The aim and contents of each of the survey sections are discussed separately in the following paragraphs.

The first section of the survey questionnaire collected data on the language background of the participants. This section consisted of some closed and some open-ended questions. The teacher questionnaire contained more background questions than the learner questionnaire. The aim of this section of the instrument was to collect information on the official LoLT of the participating schools, the home languages spoken by the survey participants and some perception data on the part of the teacher participants about their language use. In this section of the instrument the LoLT of the school was recorded, the teachers and learners were asked to name their main spoken language (home language) and the additional languages they speak. Teachers also had to note the different languages they use (or have used) to teach mathematics and to expand on and explain this use of language. The biographical information provided background information which I could use to set the stage for the language ideological enquiry. The perception data on language use was also used to inform the development of the focus group discussion schedule.

The second section of the survey questionnaire collected data on language use of the participants in a specific mathematical task. The aim of this section of the instrument was two-fold – to collect data on the use of the mathematical register of patterns and on active language use when giving mathematical explanations. In this section of the instrument there was a set of three questions about number patterns and participants were asked to give explanations for

[19] In this way the student team members were able to participate in and support the activity – which allowed for their professional development while at the same time enabling the project data collection to be carried out. I was supported in this activity by a senior Wits staff member since my sample consisted of 20 schools and I was unable to go to all of the 20 schools personally within the time available for data collection. I personally went to at least one third of the schools in all of the data collection activities.

their answers. Firstly, since the mathematical content of the questions related to patterns, I could collect data on the use of mathematical register of patterns. Secondly, since the questions were given in a bilingual format (IsiZulu/English and Setswana/English) and participants were told that they could respond using language freely in the way they preferred, I could collect data on language use in mathematical explanations. The format and administration of this section of the instrument suited the aims of the research. The questions were presented using a bilingual format and participants were told they could use any language when they gave their explanations. By not prescribing language use in the completion of the questionnaire, the choice of language use remained in the control of the individual when they gave answers and explanations to the mathematical questions in this section of the survey and thus the written responses yielded data on variation in mathematical language use.

The specification of content of the mathematics questions is briefly discussed next since it provides the context for the mathematical explanations and the analytical interpretation of the responses given by the teachers and learners. Examples of each question are provided in Figure 4.1 for reference in the discussion.

Questions 1 and 2 from the IsiZulu version of the questionnaire.

1. Fill in the missing number:/ Faka inombolo engekho:
   228, 230, 232, ________, 236

   Explain how you got your answer:
   Chaza ukuthi uyithole kanjani impendulo yakho

   ____

   ____

2. Extend the pattern:/ Khulisa leli phethini
   93, 96, 99, ______, ______, ______

   Explain how you got your answer:
   Chaza ukuthi uyithole kanjani impendulo yakho

   ____

   ____

Question 3 from the Setswana version of the questionnaire.

3. Underline the number that does not belong to the pattern.
   Thalela dipalo tse di sa weleng mo dipateroneng.
   3, 6, 11, 15, 18

   Explain how you got your answer:
   Tlhalosa go re o fitlhetse karabo ya gago jang:

   ____

   ____

Figure 4.1: Exemplar bilingual number patterns questions – Setswana and IsiZulu

Mathematically, the content of the questions can be described as follows:

The first question presents a sequence of 3-digit numbers with one number (contained between two other numbers in the sequence) missing. Learners had to "fill in the missing number". In terms of curriculum requirements:

- Grade 3 learners learn how to work with up to 3-digit numbers and so numerically this is at the highest level they should achieve in the Grade 3 year. This presents relatively high-level cognitive activity.
- The rule for the sequence is an increase of 2 between successive terms, which is easy to identify. This presents low level cognitive activity.
- The missing number is not positioned on the bridge between the ten's digits of the numerical sequence which also lowers the cognitive level of the question.

The second question presents a sequence of 2-digit numbers and the instruction to "extend" the pattern.

- Since the numbers in the sequence are 2-digit numbers this is conceptually more familiar territory for Grade 3 learners who should have achieved number concept of up to 2-digit numbers by the end of Grade 2. In terms of curriculum level, this is lower than the content of question 1.
- The rule for the sequence is an increase of 3 between successive terms, which is easy to identify. This presents low level cognitive activity.
- The numbers that need to be added to the sequence follow on after the first three terms of the given sequence of numbers. The last given number is 99 and thus the first of the three numbers that need to be added to the sequence not only bridges a ten but also moves into the 3-digit numbers. Bridging tens into hundreds calls on more highly developed number sense and heightens the cognitive level of the question.

The third question presents a sequence of five numbers, in numerical order, one of which does not "fit" with the general rule for the sequence. The question calls for the identification of the number which "does not belong" to the sequence.

- The numbers in the sequence are 1-digit and 2-digit numbers which represents very familiar conceptual content for Grade 3 learners. This content is at a Grade 1 level in terms of curriculum requirements for number.
- The rule for the sequence is an increase of 3 between successive terms (as in question 2), which is easy to identify. This presents low level cognitive activity.
- The identification of a number that "does not fit" in a given sequence of numbers is more complex as it involves recognition of a rule and reasoning using the rule to exclude a particular term in the sequence of numbers. This heightens the cognitive complexity of the question as alternative rules may be mistakenly identified (such as odd/even numbers) and applied.

The third section of the survey questionnaire collected further data on the mathematical register of patterns. The aim of this section of the instrument was to collect data that could give insight into teachers' and learners' knowledge of the mathematical register of patterns in their home language and English. This section of the instrument included a list of terms (and phrases) that half of the participants were asked to translate from an indigenous home language

(IsiZulu/Setswana) to English and the *vice versa* for the other half (for exemplars see *Appendix 4.1 and 4.2*). Thus there were four versions of the questionnaire which allowed for the four alternative directions of translation. Altogether there were thus eight different survey questionnaires – four teacher survey questionnaires and four learner survey questionnaires. I compiled the list for the translation activity from the full mathematical register list compiled by the project team (*Appendix 3*) based on an analysis of the curriculum and other Grade 3 and 4 materials . The terms/phrases chosen for the translation activity in the survey ranged in difficulty and familiarity. Some of the mathematical terms included on the list could be represented using symbols or drawings. This section of the questionnaire suited the aims of the research because it provided for open-ended translations in both directions between languages and hence it also yielded data showing variation in language use.

The focus group discussion method and tools are discussed next in Section 4.4.2.

4.4.2 Focus group discussions: Data collection method and tools

I chose to follow up on the survey findings with focus group discussions in order to give as many teachers as possible in each school the opportunity to talk at greater length about their language use in the context of teaching mathematics. The aim of the focus group discussions was to gather perception data on language policy and the language use of teachers. The focus group discussions were carried out in the first term of 2018 in the 20 project schools, in the same way as the survey, by paired research team members. The majority of teachers who participated in the focus group discussions had participated in the survey and thus for most this was to a certain extent a follow up discussion which might have contributed positively towards the data collection. The focus group discussions had a potential dual purpose. The first was to yield insight into teachers' views of and perceptions about language use. The second was to inform teachers' views on issues relating to language use in the teaching of mathematics in multilingual classes before the classroom observations were carried out (in the next round of data collection). The focus group discussions were carried out in English, but participants were encouraged to respond using multiple languages.

The focus group discussions were semi-structured. This discussion format was chosen so that some structure could assist the flow of the discussion while still allowing the opportunity for follow-up on responses to questions (Denzin & Lincoln, 2000). In an open discussion one can probe for the expansion of the responses that are given to questions (Cohen & Manion, 1980; Fraenkel & Wallen, 1990). As part of my data gathering for the descriptive study, I thus used both open-ended and closed questions (in the survey) which gave greater possibilities for analysis. “Open-ended questions allow for a greater variety of responses from participants but are difficult to analyze statistically because the data must be coded or reduced in some manner. Closed-ended questions are easy to analyze statistically, but they seriously limit the responses that participants can give” (Jackson, 2009, p. 89). The leader of the focus group discussion can expand on the responses given in the discussion when questions are open-ended by asking probing questions that follow the lead of given responses as they arise, in order to extend the range of responses as far as possible. This suited the aim of the research as it allowed participants to answer in detail and according to their interpretation of the questions. The contents of the focus group discussion schedule are discussed in the following paragraphs in more detail.

The focus group discussions were carried out guided by a schedule which included a list of questions that were used as open prompts (*Appendix 6*). This development of the schedule was guided by the categories from my analytical framework (Figure 4.2). The discussion schedule was planned to move from broader policy related questions to more individual practice related questions. The first three questions covered the policy background and teachers’ perceptions and experience of the policy.

1. Do you feel comfortable teaching in the LoLT of your school? Why/why not?
2. What is your view on the language policy for FP?
3. What do you think the LoLT for mathematics should be? (HL/English?)

The next question was designed to lead the teachers to speak about their language use prompted by their drive to explain mathematical ideas to learners while they teach. It was specifically more personal and related to classroom practice to draw the conversation away from the more policy-based discussions which would have been conducted so far.

4. What do you do when you see that the learners don’t understand what you are saying? (explain/use concrete material/other?)

The next three questions, questions 5, 6 and 7 moved towards a more focused discussion of language use, honing in on the language standardisation debate in relation to indigenous languages and mathematical register. Examples relating to the mathematical register, generally but also specifically on the topic of patterns, were raised by the leader of the focus group discussion to stimulate the participants' thinking about this idea if these did not come up naturally in the discussion. The word "terminology" was used in the focus group discussions since "mathematical register" is a more academic phrase that may have added confusion to the discussions.

5. What is your view on mathematical terminology for home language in your school? Are there preferable terms/"missing terms"? (the language standardisation debate)
6. Have you noticed language inconsistencies in textbooks/DBE workbook/CAPS?
7. Did your learners experience any problems with regard to terminology when the learners wrote the ANA? (specific examples/general).

The last two questions on the schedule brought up teachers' language use in their classes. The final question referred to the practice of translanguaging specifically in order to introduce the term and enable the move away from describing all mixed language use strategies as code-switching. Group leaders had to explain this term to participants in every group, contrasting it with code-switching since teachers had not heard of it before.

8. Do you feel any pressure to use English/home language when you teach maths? (why/who imposes/school/general explain)
9. How do you use translanguaging strategies in your teaching? (explain that this means flexible use of languages at the disposal of the learners and the teacher – freedom of expression involving multilingualism – similar to code-switching)

The introduction of the term translanguaging was done specifically in order to expand teachers' knowledge and awareness of language use strategies prior to the observation phase of data collection. This design choice was also made because it may have allowed for clearer expression of language ideologies on the part of the teachers.

Finally, the observation method and tools are discussed next in Section 4.4.3.

4.4.3 Observations: Data collection method and tools

I followed up on the survey and focus group discussion with classroom observations. The aim of the classroom observations was to gather data on the language use of teachers (and learners) in their classes – that is in the context of teaching (and learning) mathematics. Similarly to the previous data collection activities, two research team observers went to each school to do the data collection. All teachers who volunteered to participate in the observation activity were videoed (detail on the sample is discussed in the following section). Lessons were observed as part of the teachers' routine teaching so that as little disruption as possible was made for the teachers and learners involved in the study but also in an attempt to gather data which closely represents the daily classroom interactions between teachers and learners.

The observations took place in the second term of 2018. Teachers were asked to prepare lessons on the content area of number patterns. Teachers were told that they should teach and use language as they normally do when teaching and that there is no right or wrong way to do this. Thus the classroom observations gave teachers the opportunity to interact with learners as they normally do and, in this way, give insight into their (and their learners') language use in mathematics lessons. The survey and focus group discussion activities may have enhanced the observation data – if in any way they inspired teachers to use mixed languages more actively during the lesson observations or if they led to some of the teachers teaching with a more heightened awareness of issues around language use. The observation schedule is discussed in the following paragraphs in more detail.

The classroom observations were guided by the classroom observation schedule (*Appendix 7*). The pointers in the schedule referred to important aspects of the observations that needed to be recorded for analysis purposes. The schedule pointers can be separated into four basic groups. The first five items in the schedule made focused attention on the spoken language use during the observation.

1. What spoken teacher language use is observed? (LoLT/English/translanguaging)
2. What spoken learner language use is observed? (LoLT/English/translanguaging)
3. What engagements (spoken) are noted – teacher-learner and learner-learner?
4. What is the nature of the spoken interactions – mathematical/general?
5. Time segment analysis of languages used (spoken) by teachers and learners.

The next three items in the schedule made focused attention on the written language use during the observation.

6. What written teacher language use (e.g. lesson planning/board work/etc.) is observed? (LoLT/English/translanguaging)
7. What written learner language use (e.g. learner exercise books/board work/etc.) is observed? (LoLT/English/translanguaging)
8. Time segment analysis of languages used (written) by teachers and learners.

The next two items in the schedule made focused attention on the resources used during the observation.

9. What resources are used in the lesson by the teachers and learners?
10. What is the language present in the resources used in the lesson by the teachers and learners? (LoLT/English/both)

The final four items in the schedule made focused attention on the nature of the spoken language use during the observation.

11. How much time is spent on interactive conversation between teachers and learners?
12. Does the use of translanguaging (if present) appear planned/unplanned?
13. Does the use of translanguaging (if present) assist the flow of the lesson – how?
14. Other emerging patterns of language use in the teaching of mathematics.

The study thus used three different methodologies for data collection which yielded three large, diverse sets of data in order to enable triangulation of findings when the analysis was carried out.

The sample of the study and the three separate data collection activities that made up the study are discussed in more detail in Section 4.5 below.

4.5 Sample

The survey, focus group discussions and observations were all carried out in the same 20 schools which were located in three districts in Gauteng. The primary criterion for selection of schools for the study was school LoLT. I first contacted the head of FP mathematics at the Gauteng Department of Education to ask for advice on which districts to carry out the study in, in order to locate districts with several eligible schools (IsiZulu and Setswana LoLT) from which to choose my sample. Three districts were chosen after this consultation according to the spread of LoLT in the districts and their proximity to the University of the Witwatersrand. All schools with IsiZulu and Setswana LoLT were included in the list for sample selection in accordance with the language focus of the study (discussed in Section 4.3). After further consultation with the Gauteng Department of Education, some English LoLT schools (ex-Setswana or IsiZulu) were also included in the list. There are several such schools in the province which have changed to English as LoLT (from Setswana or IsiZulu) and some of the sample schools made this change over the two-year period of the study. Schools that satisfied the criteria were contacted telephonically in the second term of 2017 and asked if they would be prepared to participate on a voluntary basis in the study. Once 20 schools (spread fairly evenly across the three districts) had agreed to participate in the study the sample of schools was finalised. Ultimately, a further additional language, Sesotho, was represented as a LoLT in my sample, because some schools in the sample had dual LoLT (Setswana/Sesotho), which is permissible according to policy. This LoLT was not the focus of my investigation, by design, but it added to the diversity of my sample and richness of my findings as will be seen.

The sample was a purposive random sample. It was purposive in that the three districts selected with the support of the Gauteng province official who guided me in their selection were chosen to be those nearest to the university at which I am based, to limit the distances to the schools when I had to carry out field work. Within those three districts as discussed above I created a list of all schools with LoLT IsiZulu and Setswana, dual Setswana/Sesotho LoLT and English LoLT (but ex IsiZulu or Setswana LoLT). The English LoLT schools were put last on the list so that they would be contacted only once all active IsiZulu and Setswana LoLT schools had been contacted. The sample was random in that schools were called using the list one by one in the order on the list, starting from the top. Once the number of schools that satisfied the criteria for the study were chosen (20) the sample was complete, and no further schools were called. Consent was obtained from the office of each of the district directors for the three districts which were chosen for the study. The district officials responsible for the selected schools gave their consent and were supportive of the study in that they facilitated communication with the principals of the sample schools once the consent process began. The principals at each of the schools gave their consent for their schools to participate and the Grade

3 and 4 teachers and learners at the school to participate in the study. Finally, consents were obtained from all of the Grade 3 and 4 teachers, the learners and the parents of the learners who participated in the study.

The sample schools thus formed a subsample of schools with IsiZulu, Setswana and English LoLT in the province and were representative of this group of schools in the province.

The number of schools, teachers and learners varied slightly across the three data collection activities. Consent for each activity was sought and obtained before the activity was carried out. Specific information about the samples for the three research activities is given next, starting with the survey sample, since this varied slightly according to the activities.

4.5.1 Survey sample

The survey was the first data collection activity and was carried out after the first formal contact was made with the school. All 20 of the sample schools participated in the survey: two Grade 3 classes and two Grade 4 classes at each of the schools participated. Final arrangements were made with the school principals and admin staff and the surveys were carried out in the third term of 2017. Consent was obtained from all participants in the survey sample (teachers and learners). Consent was also obtained from the learners' parents. When they signed the consent, participants were told about (and consented to) all of the project tasks, although in 2017 the only task they participated in was the survey. The distribution of the participants in the survey sample according to grade and district is shown in Table 4.1.

Table 4.1: Language survey sample: number of teachers and learners by grade and district

	Grade 3		**Grade 4**		**TOTAL**	
	Teachers	Learners	Teachers	Learners	Teachers	Learners
District 1	14	658	11	621	25	1 279
District 2	11	415	6	319	17	734
District 3	12	456	8	422	20	878
Total	**37**	**1 529**	**25**	**1 362**	**62**	**2 891**

The survey sample was made of 62 teachers and 2 891 learners. Table 4.1 shows that the number of Grade 3 teachers (37) was higher than the number of Grade 4 teachers (25). This is because in the IP teachers generally specialise and there is one mathematics teacher for the grade while in Grade 3 there is usually one teacher per class, so each class in Grade 3 has its own, different teacher for mathematics. There were also a larger number of Grade 3 learners than Grade 4 learners surveyed. The class sizes varied and one of the schools that participated in the study was an FP school which did not have Grade 4 classes.

The four different survey questionnaires for teachers and learners respectively (eight survey questionnaires in total – as described in 4.1.1) were named in relation to the directed translation activity of the particular questionnaire. The eight teacher and learner survey questionnaires were named as shown in Table 4.2.

Table 4.2: Language survey sample: Teacher and learner language survey questionnaires

	Teacher questionnaires	**Learner questionnaires**
IsiZulu	TZE (teacher IsiZulu-English)	LZE (learner IsiZulu-English)
	TEZ (teacher English-IsiZulu)	LEZ (learner English-IsiZulu)
Setswana	TSE (teacher Setswana-English)	LSE (learner Setswana-English)
	TES (teacher English-Setswana)	LES (learner English-Setswana)

The distribution of survey questionnaires according to direction of translation is shown in Table 4.3.

Table 4.3: Language survey sample: Number of directed teacher and learner translations by grade

	Grade 3		**Grade 4**		**TOTAL**	
	Teachers	Learners	Teachers	Learners	Teachers	Learners
English/Setswana	6	219	1	167	7	**386**
Setswana/English	4	193	3	207	7	**400**
English/IsiZulu	14	585	8	483	22	**1068**
IsiZulu/English	13	532	9	505	22	**1037**
Total	**37**	**1529**	**21**	**1362**	**58**	**2891**

The first column in this table gives the direction of translation, for example, English/Setswana means a translation from English to Setswana. It can be seen in Table 4.3 that all of the learners completed the translation activity, but not all of the teachers did. Since participation was voluntary (and participants could be selective of activities) four teachers chose not to participate in the translation activity.

The naming of schools (per grade) who participated in the survey is shown in Table 4.4.

Table 4.4: Language survey sample: by school and grade

School	LoLT	Grade3(A/B) Survey	Grade4(A/B) Survey
SS1	IsiZulu	S3S1A/B	S4S1A/B
SS2	Setswana	S3S2A/B	S4S2A/B
SS3	Setswana	S3S3A/B	S4S3A/B
SS4	IsiZulu	S3S4A/B	S4S4A/B
SS5	IsiZulu	S3S5A/B	S4S5A/B
SS6	English (IsiZulu/Setswana)	S3S6A/B	S4S6A/B
SS7	English (IsiZulu)	S3S7A/B	S4S7A/B
SS8	English (IsiZulu/Sesotho)	S3S8A/B	S4S8A/B
SS9	IsiZulu	S3S9A/B	S4S9A/B
SS10	IsiZulu	S3S10A/B	S4S10A/B
SS11	English (Setswana/Sesotho)	S3S11A/B	S4S11A/B
SS12	English (IsiZulu/Setswana)	S3S12A/B	S4S12A/B
SS13	English (Setswana)	S3S13A/B	S4S13A/B
SS14	Setswana	S3S14A/B	S4S14A/B
SS15	English (IsiZulu)	S3S15A/B	S4S15A/B
SS16	English (IsiZulu/Sesotho)	S3S16A/B	S4S16A/B
SS17	English (IsiZulu/Sesotho)	S3S17A/B	S4S17A/B
SS18	English (IsiZulu/Sesotho)	S3S18A/B	S4S18A/B
SS19	English (IsiZulu)	S3S19A/B	S4S19A/B
SS20	English (IsiZulu/Sesotho)	S3S20A/B	S4S20A/B

The list in Table 4.4 was drawn up to facilitate the naming of quotations taken from the survey documents. The schools are numbered in this list in the order of the initial random selection list.

Next, the focus group discussion sample is discussed.

4.5.2 Focus group discussions

The focus group discussions were the second data collection activity. All 20 of the sample schools were contacted telephonically at the beginning of Term 1 in 2018 to remind them of the focus group discussion process which followed on from the 2017 survey. Dates were set and principals were asked to invite all teachers from Grades 3 and 4 who were interested, to attend the focus group discussions, not only those who had participated in the survey to allow more teachers to participate in the study. New teachers who joined in the focus group discussions who had not signed consent in 2017 were given the project information and asked to sign to confirm their voluntary consent to participate in the research. The distribution of the participants in the focus group discussion sample according to grade and district is shown in Table 4.5.

Table 4.5: Focus group discussion sample: Number of teachers by school, LoLT and grade

School	LoLT	Grade 3 Focus Group	Grade 4 Focus Group	Total
FGS1	English (IsiZulu/Sesotho)	FG3S1: 2	FG4S1: 2	4
FGS2	English (IsiZulu/Sesotho)	FG3S2: 2	FG4S2: 1	3
FGS3	English (IsiZulu/Setswana)	FG3S3: 2	FG4S3: 1	3
FGS4	Setswana	FG3S4: 4	FG4S4: 1	5
FGS5	IsiZulu	FG3S5: 2	FG4S5: 1	3
FGS6	Setswana	FG3S6: 3	FG4S6: 1	4
FGS7	English (IsiZulu)	FG3S7: 1	FG4S7: 1	2
FGS8	Setswana	FG3S8: 3	FG4S8: 3	6
FGS9	English (IsiZulu/Sesotho)	FG4S9: 0	FG4S9: 1	1
FGS10	IsiZulu	FG3S10: 2	FG4S10: 1	3
FGS11	English (IsiZulu/Sesotho)	FG3S11: 3	FG4S11: 1	4
FGS12	English (IsiZulu)	FG3S12: 4	FG4S12: 3	7
FGS13	IsiZulu	FG3S13: 1	FG4S13: 2	3
FGS14	IsiZulu	FG3S14: 4	FG4S14: 1	5
FGS15	English (IsiZulu)	FG3S15: 2	FG4S15: 1	3
FGS16	IsiZulu	FG3S16: 2	FG4S16: 0	2
FGS17	English (Setswana)	FG3S17: 2	FG4S17: 1	3
FGS18	English (Setswana/Sesotho)	FG3S18: 2	FG4S18: 1	3
FGS19	English (IsiZulu/Sesotho)	FG3S19: 2	FG4S19: 4	6
FGS20	English (IsiZulu/Setswana)	FG3S20: 4	n/a	4
Total		**47**	**27**	**74**

It can be seen in Table 4.5 that altogether 74 teachers (47 Grade 3 teachers and 27 Grade 4 teachers) participated in the focus group discussions. [20] These numbers are higher than the number of teachers who participated in the survey (37 Grade 3 and 25 Grade 4, as shown in 4.5.1), since all teachers from Grade 3 and Grade 4 were invited to participate in the focus group discussions. As in the survey, there was a lower number of Grade 4 teachers, because in the IP teachers generally specialise and there is often only one mathematics teacher for the

[20] School S20 is an FP school and did not have Grade 4 classes.

grade. The unique numbering used in this table is used to reference quotes from the transcripts of the surveys. FG stands for focus group. There was one focus group discussion per grade at most schools and so the qualification FG3 indicates a Grade 3 focus group and FG4 indicates a Grade 4 focus group at a given school, after which the school number according to the ordered list of transcripts is given.

Finally, the observation sample is discussed.

4.5.3 Observation sample

In the first term of 2018 when the focus group discussions were being conducted, all of the participating teachers from the schools in both Grade 3 and 4 were asked if they would be prepared to volunteer to be observed and video recorded while teaching and this information was noted on the focus group discussion register. Teachers who indicated that they were willing to participate in the observations gave their contact details to the person conducting the focus group discussion for later use.

Principals of the schools were first contacted, as were HODs, in order to confirm the availability of the teachers for the observation activity and to set up the dates for the observations. Once principals and HODs had agreed to the observation, the individual teachers were contacted to set up the schedule of dates for the observations. Appointments were set up individually with all of the teachers who volunteered for this activity. Teachers and learners from each grade and class at every school who had not signed consents previously were given information about the study and asked to sign consent forms to indicate that they were willing to voluntarily participate in the study. They were made aware that the video footage was to be used only for the purposes of the study, that it would not be shared with other researchers and that their confidentiality and anonymity were assured.

A total of 17 Grade 3 and 12 Grade 4 teachers volunteered to participate in the observation activity. These teachers were from a subsample of 13 of the 20 project schools spread across the three districts in which the project was located. The schools are numbered according to the order of observations carried out. Although teachers had been asked to prepare lessons on number patterns for the observations and lesson observation times were chosen to fit this in with the teachers' schedule, not all of the teachers managed to present lessons on number patterns. [21] The distribution of the classroom observation data set is summarised in Table 4.6.

Table 4.6: Observation sample: Lessons by LoLT, grade and length in minutes

School	LoLT	Teacher	Grade 3 total (min)	Grade 4 total (min)	Overall total (min)
O3S1	English (IsiZulu/Sesotho)	Gr 3	65.26		65.26
O4S1	English (IsiZulu/Sesotho)	Gr 4		45.85	45.85
O3S2	English (IsiZulu/Sesotho)	Gr 3	36.55		36.55
O4S2	English (IsiZulu/Sesotho)	Gr 4		35.61	35.61
O3S5.1	IsiZulu	Gr 3 T1	61.52		61.52
O3S5.2	IsiZulu	Gr 3 T2	54.73		54.73
O4S5	IsiZulu	Gr 4		33.21	33.21
O4S6	Setswana	Gr 3 T1a	56.91		56.91
O3S6.1	Setswana	Gr 3 T1b	39.65		39.65
O3S7.2	English (IsiZulu)	Gr 3	43.67		43.67
O3S7	English (IsiZulu)	Gr 4		49.38	49.38
O4S8.1	Setswana	Gr 4 T1		33.09	33.09
O4S8.2	Setswana	Gr 4 T2		39.78	39.78
O3S10	IsiZulu	Gr 3	36.5		36.5
O3S11.1	English (IsiZulu/Sesotho)	Gr 3 T1	55.62		55.62
O3S11.2	English (IsiZulu/Sesotho)	Gr 3 T2	39.51		39.51
O4S11	English (IsiZulu/Sesotho)	Gr 4		30	30
O4S12	English (IsiZulu)	Gr 4		11.22	11.22
O3S17.1	English (Setswana)	Gr 3 T1	25.49		25.49
O3S17.2	English (Setswana)	Gr 3 T2	54.55		54.55
O3S17.3	English (Setswana)	Gr 3 T3	55.81		55.81
O4S17	English (Setswana)	Gr 4		46.78	46.78
O3S18	English (Setswana/Sesotho)	Gr 3	40.2		40.2
O4S18	English (Setswana/Sesotho)	Gr 4		55.89	55.89
O3S19	English (IsiZulu/Sesotho)	Gr 3	41.31		41.31
O4S19.1	English (IsiZulu/Sesotho)	Gr 4 T1		32.53	32.53
O4S19.2	English (IsiZulu/Sesotho)	Gr 4 T2		44.98	44.98
O3S20.1	English (IsiZulu/Setswana)	Gr 3 T1	59.62		59.62
O3S20.2	English (IsiZulu/Setswana)	Gr 3 T2	56.99		56.99
TOTAL			**831.89**	**456.32**	**1290.21**

It can be seen from Table 4.6 that 832 minutes of video footage were obtained from the 17 Grade 3 lessons that were observed and 458 minutes of video footage were obtained from the

[21] Of the 29 observed lessons, there were three lessons on measurement and one lesson on fractions – all of the other lessons were on patterns as planned. All of the lessons were analysed for language use.

12 Grade 4 lessons that were observed. The Grade 4 lessons were shorter than the Grade 3 lessons (this aligns with curriculum policy which allocates 84 minutes to the average Grade 3 lesson and 30 minutes to the average Grade 4 lesson). On average the sample lessons for Grade 3 were 50 minutes long and the Grade 4 lessons were 38 minutes long. The unique numbering used in this table is used to reference quotes from the transcripts of the observed lessons. O stands for observation and since observations were grade specific, observations are grade referenced (O3 for a Grade 3 observation and O4 for a Grade 4 observation). Since at some schools more than one teacher was observed per grade, if there was more than one teacher observed in a grade the indicator .1 or .2 was added at the end of the unique number for the observation.

The schools in the observation sample included single and double LoLT schools. The LoLT present in the sample were IsiZulu, Setswana, Sesotho[22] and English. English was the LoLT at nine of the 13 schools which were observation sites and only four schools in the sample had maintained the indigenous language LoLT (two IsiZulu and two Setswana). This is in spite of the fact that none of the schools have a learner population whose dominant home language is English (the dominant learner home languages at the schools are given in brackets in Table 6). This results in a double/triple LoLT in many of the schools. All of the double (and some of the single) LoLT schools in the sample had opted for English as LoLT but they still acknowledged their learner population with a "sub" LoLT which is recorded in the Gauteng list of schools. [23] The double/triple LoLT represented in the sample were English (IsiZulu), English (Setswana), English (IsiZulu/Sesotho), English (IsiZulu/Setswana) and English (Setswana/Sesotho).

Episodes from lessons in the full quantitative observation sample where complex language use was identified were selected for the qualitative analysis. One episode was selected per grade and per home language LoLT represented in the sample. Thus four episodes were selected for qualitative analysis: one Grade 3 dominant IsiZulu episode, one Grade 3 dominant Setswana episode, one Grade 4 dominant IsiZulu episode and one Grade 4 dominant Setswana episode.

[22] Sesotho was not one of the project sample LoLT and Sesotho lessons were not observed. The sample LoLT distribution is evidence of the schools choosing more than one LoLT, which, as it has been said, is permissible by CAPS policy.
[23] Many schools opt for English as LoLT in order to teach Mathematics in English. Some of the sample schools did not have English as the LoLT when they were selected as project schools but they had changed to English LoLT when the project started. Schools are allowed to change their LoLT if the School Governing Body decides that this should be done in the interests of the school learner population.

The data analysis for each of the sample sets, which involved capturing, coding and analysing, is discussed in Section 4.6 below.

4.6 Data analysis

Language use was analysed for variation in all of the data sets. I set out to map the variation, since the theory emphasises variation, but while doing so I became more aware of the tension between variation and standardisation. My analytical framework finally enabled me to map the drivers of language use – ideology, research and policy (as authority figures) and see how they play out in practice influencing both variation and standardisation of language use. Language ideologies provided a lens to unpack the data in a more nuanced way, since language ideologies expose connections between the beliefs speakers have about language and the larger social and cultural systems of which they are a part. It is important to emphasise that not all language use choices are ideological (although some might argue this is not possible) – pedagogy might guide language use choices as well (some might argue that even pedagogical choices have an ideological basis). Since this is a language ideological study, I developed an analytical framework that could be used to expose language ideologies that are embodied or articulated in the language use evidenced in the data. As I explained in my theoretical framework (Section 3.2), drawing on the work of Bakhtin (1981), in this study on language use, the "concrete utterance" is my unit of analysis. What this meant in my analysis was that I examined the spoken and written utterances of teachers and learners in the various data sources and analysed them for variation in language use, guided by my analytical framework which I now discuss.

4.6.1 Analytical framework

My analytical framework presents the way in which drivers of language use shape language use which is evidenced in practice. The evidence is primarily of variation but within the variation there is standardisation and sometimes because of variation there is a drive towards standardisation. As discussed in the theoretical framework chapter of this study (Chapter 3) two ideologies prevail with regard to language use. Monoglossic ideologies drive pure language use, based on a belief in the value of pure language use – that only one pure language should be used to express ideas and give explanations. Heteroglossic ideologies drive mixed language use based on a belief in the value of mixed language use – that a pluralist (mixed) use of the full language repertoire of the speaker should be used to express ideas and give explanations. The analytical framework diagram in Figure 4.2 illustrates how language ideologies (which, as it was explained in Chapter 3, may be embodied or articulated) play out in the language use of speakers.

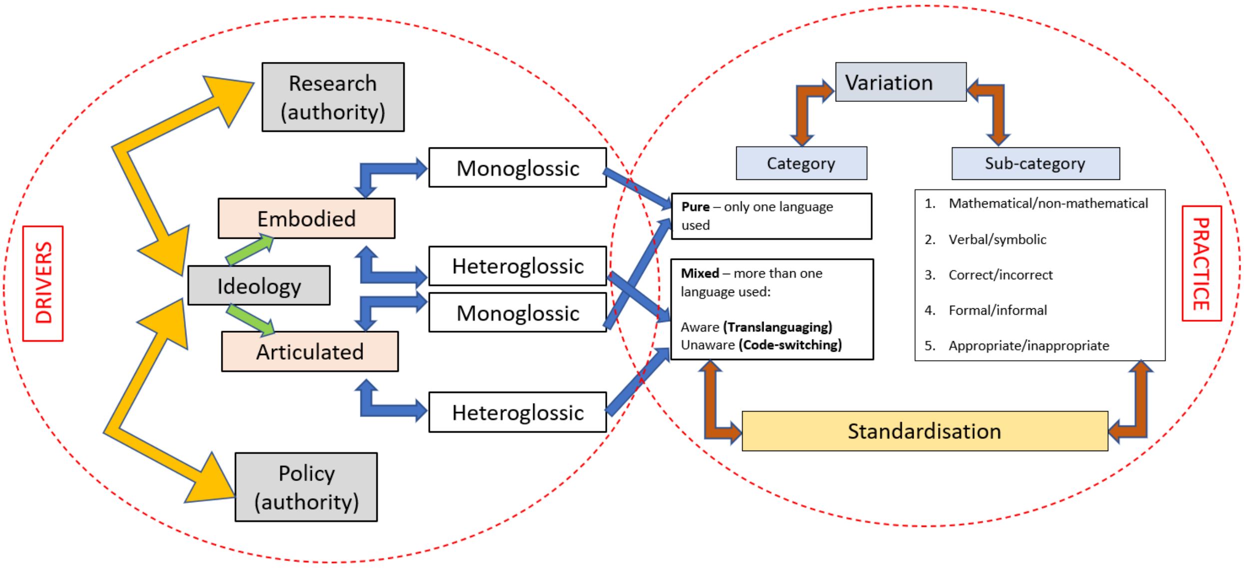


Figure 4.2: Analytical framework

My analytical framework diagram (Figure 4.2) shows how research and policy (which are seen as sources of authority) and ideology all drive language use. Pushing against this in practice, is standardisation of language use. Research and policy are more visible drivers while ideology (which influences both policy and research) may be less visible but is ever present. Although, as discussed (Section 3.2.1), language use lies on a continuum between multilingualism and monolingualism, for the purposes of my research I identified categories of language use. At the outset of my study I was more aware of variation in language use and initially developed categories and an analytical framework in relation only to variation. As my study progressed, I realised that variation and standardisation are in constant tension and that my framework needed to include both of them. Indicators for the categories in my framework are given and operationalised in Table 4.7 after which the subcategories are discussed and exemplified. I argue that a study of language use is not complete if it only considers variation but that it needs to consider the dynamic introduced by the language standardisation debate.

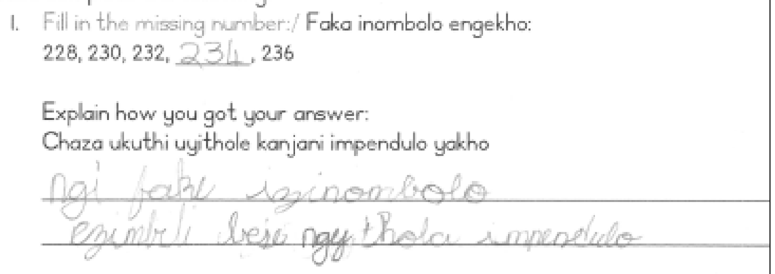
4.6.1.1 Language use variation categories

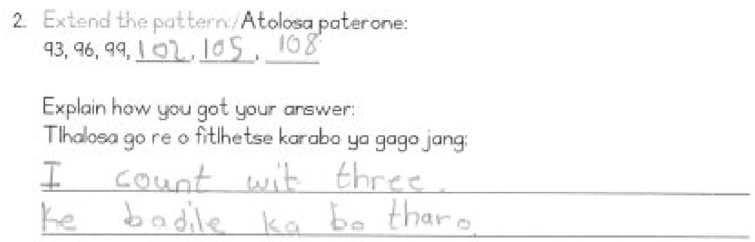
Variations in language use are evidence of an embodied or an articulated language ideology which may be monoglossic or heteroglossic. There are three variations in language use that can be linked directly to language ideologies. I classified these into three categories of language use for analysis: pure, mixed (code-switching) and mixed (translanguaging).

- Pure language use is identified when a speaker speaks using only one language without any language mixing. Pure language use is evidence of a monoglossic ideology, which may be embodied or articulated.
- Mixed language use is identified when a speaker speaks using more than one language and is evidence of a heteroglossic ideology, which may also be embodied or articulated. Mixed language use may take the form of codeswitching or translanguaging (both are mixed language use practices) and these two categories give further insight into the language ideology of a speaker using mixed language.
- The two mixed language categories include what could be a subcategory (aware/unaware), but I used the distinction between aware and unaware to create two categories because this distinction clearly categorises two forms of language mixing which are well established in the literature. I classified code-switching as an alternation between two (or more) languages when the speaker was aware of making the switch when speaking (or writing) and translanguaging as an alternation between two (or more) languages of which the speaker was unaware when speaking (or writing). Translanguaging is thus seen as a more fluid or flexible mixed language use. Other variations in language use were also identified, giving rise to four subcategories for analysis.

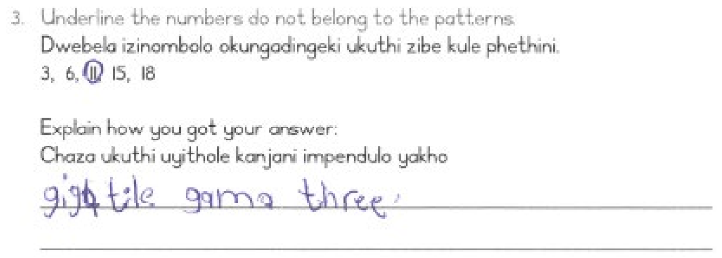
The examples given in Table 4.7 below, show that variation in language use emerged across the three data sources (survey, focus group discussions and observations) analysed in this study. While variation is the first focus in the analysis of language use, this is then analysed in relation to standardisation since the push towards (or away from) standardisation constrains variation.

Table 4.7: Analytical framework – indicators and examples from data sources

Category: language use (language ideology)	Indicator (data source)	Example	Comment
Pure language (embodied monoglossic)	One language used when writing mathematical answers or giving mathematical explanations. (Survey and observation data.)	**Survey [maths questionnaire] (S3S13A)**  1. Fill in the missing number:/ Faka inombolo engekho: 228, 230, 232, 234, 236 Explain how you got your answer: Chaza ukuthi uyithole kanjani impendulo yakho Ngi fake izinombolo ezimbili bese ngithola impendulo [I wrote two numbers and then I found the answer]	The mathematical explanation here is written in IsiZulu. Thus it embodies a monoglossic ideology.
		Observation (O4S6) Sometharo ke e (writes 13 on the board), a ke lekgolo? Ka na wa re ke lekgolo akere? [Here is thirteen, (writes 13 on the board) is it a hundred? You guys are saying it's hundred, right?]	The mathematical explanation here is written in Setswana. Thus it embodies a monoglossic ideology.
Pure language (articulated monoglossic)	Expressed view that one single language should be used in the teaching of mathematics. (Survey and focus group discussion data.)	**Survey [open ended questions]** The mathematics is more easy if we teach in English in Foundation Phase **(S3S9B)**. We teach in IsiZulu as it is compulsory, and it is the LOLT **(S3S20B)**.	These two responses from the survey are examples of an articulated monoglossic ideology as they express the view that one specific language is preferable for the teaching of mathematics. The teacher says she finds it easier (the reason for this given most often is a terminology advantage in English) to do so while the second one shows that there is policy driving her choice.

Category: language use (language ideology)	Indicator (data source)	Example	Comment
		Focus group discussion (FG4S19) I think it is important from FP when it comes to mathematics let them teach in English so that when they get to Grade 4, 5, 6 and 7 they no longer have to be in this transitional phase, let it start from the beginning that way it will be easier for teachers to just add on and not start afresh like starting with a new child from Grade R.	This teacher response from one of the focus group discussions is another example of an articulated monoglossic ideology, expressing a preference for the use of English for the teaching of mathematics. The reason this teacher gives relates to the transitioning to Grade 4 – this is her professionally considered choice to ease the transition from the FP to the IP.
Mixed language – code-switching (embodied heteroglossic)	More than one language used, where the speaker made a choice to use these languages (showing awareness) when writing mathematical answers or giving mathematical explanations. (Survey and observation data.)	**Survey [maths questionnaire] (S3S14A)**  2. Extend the pattern:/Atolosa paterone: 93, 96, 99, 102, 105, 108 Explain how you got your answer: Tlhalosa go re o fitlhetse karabo ya gago jang: I count wit three. ke bodile ka bo tharo.	The mathematical explanation is written twice, first in English and then in Setswana. Thus it embodies a heteroglossic ideology. It is an example of mixing language using code-switching because of the use of two distinct languages to give the explanation.
		Observation (O4S2) So here, you must also know, kufanele wazi ukuthi, which rule that you must use. [So here, you must also know, you must know, which rule that you must use.]	The mathematical explanation is given using two languages –English and IsiZulu. Thus it embodies a heteroglossic ideology. It is an example of mixing language using code-switching because the teacher repeats one phrase (*you must know*) first in English and then in IsiZulu.

Category: language use (language ideology)	**Indicator (data source)**	**Example**	**Comment**
Mixed language – code-switching (articulated heteroglossic)	Expressed view that more than one language (code-switching) should be used in the teaching of mathematics. (Survey and focus group discussion data.)	**Survey [open ended questions]** I use [switch to] English to explain certain terms because it is easier for them to understand **(S3S18B)**. I switch to Sesotho for explanations and clarities. We experience language barrier in Grade 4 as they are coming from Grade 3 where things were done in Setswana **(S3410A)**.	These two responses from the survey are examples of an articulated heteroglossic ideology as they express the view that more than one language can be used in a code-switching manner when teaching of mathematics. The first teacher says she finds it easier to switch to English for certain terms, while the second one explains that she uses the indigenous language for certain explanations in her Grade 4 class (where the LoLT is officially English).
		Focus group discussion (FG3S6) You code-switch. *Mina*, in most cases if they don't know and I want them to know that sixty plus three, they know it's sixty-three. But they don't know if I can ask them in Setswana *matharo hlakanya le hlano*, they even confuse *thataro le tharo, hlano le tharo* but if you can say sixty-three …	This response from a focus group discussion is another example of an articulated heteroglossic ideology as it expresses the view that more than one language can be used (code-switching) when teaching of mathematics. It is an example of a teacher expressing a preference to use code-switching to refer to the number 63 and the breaking down of 63 into tens and ones using both English and Setswana.
Mixed language – translanguaging (embodied heteroglossic)	More than one language used, where the speaker used language fluidly and flexibly when writing mathematical answers	**Survey [maths questionnaire] (S3S12B)**	The mathematical explanation is written using two languages – IsiZulu and English. Thus it embodies a heteroglossic ideology. It is an example of mixing language using translanguaging because of the fluid use of the language repertoire of the learner.

Category: language use (language ideology)	Indicator (data source)	Example	Comment
	or giving mathematical explanations. (Survey and observation data.)	 3. Underline the numbers do not belong to the patterns. Dwebela izinombolo okungadingeki ukuthi zibe kule phethini. 3, 6, 11 15, 18 Explain how you got your answer: Chaza ukuthi uyithole kanjani impendulo yakho gigtile gama three [I counted in threes]	
		Observation (O3S2) Njengamanje ngikunikeze bani? U three angithi? Okay emva ka three ngifuna u jampe kangaki? [Right now, what number have I given you? Three, right? Okay, after three I want you to jump how many times?]	The mathematical explanation here is given using two languages (IsiZulu and English). Thus it embodies a heteroglossic ideology. It is an example of mixing language using translanguaging because of the fluid use of the language repertoire of the teacher.
Mixed language – translanguaging (articulated heteroglossic)	Expressed view that more than one language (translanguaging) should be used in the teaching of mathematics. (Survey and focus group discussion data)	**Survey [open ended questions]:** I use English and IsiZulu because some learners don't understand English and some terminology of mathematics **(S4S5A)**.	This teacher response from the survey is an example of an articulated heteroglossic ideology, expressing a view that the teacher moves between languages (using both of them) in order to support learner understanding.
		Focus group discussion (FG3S3) Remember they are coming from those Grade 3s and then now they are in Grade 4. So for you to make sure that they understand you, you use bilingual language, you go this way then ... trans it, to go the other language. So that's how we work. We use both languages.	This response from a focus group discussion is another example of an articulated heteroglossic ideology, an expressed view that moving between languages is useful when teaching mathematics. This teacher gives supporting learner understanding as the reason for this language use.

In Table 4.7 the categories that are linked to monoglossic ideologies and heteroglossic ideologies are operationalised. There are only two categories which capture a monoglossic ideology (one embodied and one articulated) but there are four linked to heteroglossic ideology (two embodied and two articulated). The categories exemplified in Table 4.7 (aligned with the diagram in Figure 4.2) were used to inform the quantitative coding of the survey and the video data from the classroom observations. The process of development of specific codes for these data sets is discussed in more detail for each of the data sets in the sections specific to the analysis of each of these data sets (Sections 4.6.2, 4.6.3 and 4.6.4). The categories also informed the qualitative thematic content analysis in the development of themes that emerged from the responses to the open-ended questions in the survey and the focus group discussions. The process of development of themes is discussed in more detail for each of the data sets in the sections specific to the analysis of each of these data sets. I now explain and exemplify the subcategories in my analytical framework in Section 4.6.1.2.

4.6.1.2 Language use variation subcategories

The five subcategories in my analytical framework (Figure 4.2), namely mathematical/non-mathematical; verbal/symbolic, correct/incorrect, formal/informal and appropriate/inappropriate, capture variation which nuances the study of language use.

- The first sub-category, **mathematical/non-mathematical** gives insight into the extent to which the mathematical register is used in mathematical explanations and mathematics lessons. For example in a lesson a teacher might rigorously and regularly use the language of mathematics and allow learners opportunities to do so. However, she might just indicate to learners that their answers are correct or incorrect, without engaging in the mathematical substance of what has been said (insubstantial mathematical engagement), or she might engage more in non-mathematical ways, spending more time giving learners instructions, reprimanding them, and so on.

- The second subcategory, **verbal/symbolic** gives insight into the extent to which mathematical symbols (which include diagrams) are used in mathematical explanations. These symbols are part of the mathematical register. For example, in the FP, the numerals (the symbols used to write numbers) are amongst the first symbols learned. The use of symbols used to represent mathematical concepts is not seen as an ideological choice but rather a pragmatic one, as symbols are a more efficient form of recording the mathematical concepts which they represent.

- Learners in Grade 3 and 4 are still learning how to read and write and they may not always spell words correctly, thus the third subcategory **correct/incorrect** allows for variation in spelling which can be accepted as correct because it is clear that the "correct" word was being written in spite of the literal incorrect spelling given by the learner. For example, some alternatives that were provided for the term subtract in the translation activity were *sabration, sabstractions, suptract, subtection*. Learners who write these words know the word subtract/subtraction but they do not know how to spell it. It is particularly important in the multilingual context to make allowances for such inconsistences in spelling (and regard them as correct in spite of the "incorrect" spelling) in order to maintain the focus on the concept. In terms of the standardisation debate, this category raises the issue of "standardised spelling".

- The fourth subcategory, **formal/informal** captures variation in language use when the expected formal term may not be used but a word that clearly expresses the same meaning and indicates an understanding of the term being discussed is used. The subcategory formal/informal may also give insight into the language ideology of the speaker when the choice the speaker makes is based on a link with the main categories in the framework pure/mixed code-switching/mixed translanguaging. In such an instance, the choice between a formal mathematical expression and an informal one is made based on language of expression and can thus be inferred as being ideological. The choice may be grounded in pedagogy (teaching for understanding) – choosing to use various words with the same meaning in order to maintain the focus on the concept rather than the language. For example, in patterns, one might say that the term 4 is between the terms 2 and 6 in the sequence of even numbers. The formal word *between* is used here. When giving translations for the term *phakathi nendawo* (the DAC IsiZulu term for between in this context) learners gave many different versions of the spelling for between (subcategory two) but they also used less formal synonyms (with variations in spelling) – namely middle and inside. Both of these informal expressions indicate that the learner understands the concept of the term *between*. Allowing for informal expressions is also important in the multilingual context where the focus should be on the concept. In terms of the standardisation debate, this category raises the issue of “standardised mathematical terminology”.

- Finally, the fifth subcategory **appropriate/inappropriate** captures choices that may, in the context, be seen as appropriate/inappropriate, specifically in relation to the use of anglicisations or dialect choices in indigenous languages. The anglicisations which correctly express a term being spoken about are examples of appropriate terminology, for example, *inamba, divida, timesa*. In the team, we started to use the term trans words to refer to such words which are made up by the teachers/learners drawing on more than one “code” of expression.[24] These choices also have an ideological basis (when there is a link to language of expression – pure/mixed) if one particular choice is arbitrarily made over another when both words are actually correct. This subcategory is closely aligned with subcategory 3 (correct/incorrect) since dialectical differences might surface as differences in spelling and with subcategory 4, since dialectical differences might surface as differences in particular words used. For example, teachers spoke about some of the different words used for the word circle in IsiZulu – *indilinga* and *isiyingi*. They made the point that some learners knew the word *indilinga* while others knew the word *isiyingi* (and they did now know both). One teacher noted she had seen that, “they mark you wrong” (FG3S13), for using one or other of the words. In terms of the standardisation debate, this category raises the issue of “standardised dialect”.

The discussion of the subcategories above shows that in learning and teaching mathematics, language use choices may be related to general mathematical language use and pedagogy which could be seen not to have an ideological basis. But the argument (as put forward by Bakhtin in his conception of heteroglossia – see Section 3.2.2) that every utterance is ideological bears weight. In my analysis of language use, I first used the categories in my analytical framework to identify the language ideology of the concrete utterances being analysed (monoglossic/heteroglossic). Although it is acknowledged that all language use lies on a continuum between multilingual and monolingual, codes were assigned that enabled the distinction between pure and mixed language according to the dominant language use evident in the utterance. I then used the subcategories to analyse for nuance in terms not only of

[24] This followed from the expression used by a teacher in one of the focus group discussions who said “trans it, to go the other language” (FG3S3).

ideology, but also of the other drivers such as policy and research on mathematics education in multilingual contexts.

In the presentation of findings, variation in language use is discussed in Chapter 6 and extending the discussion, variation in relation to standardisation is discussed in Chapter 7. In Chapter 6 the three categories and Subcategories 1 and 4 (mathematical/non-mathematical and formal/informal) were applied, while in Chapter 7, the three categories and all subcategories were applied.

All data capture, coding and analysis for the study was carried out by me with the assistance of the multilingual research team that I led, because of the multilingual nature of the study. The survey data capture, coding and analysis is discussed first.

4.6.2 Survey data capture, coding and analysis

4.6.2.1 Survey data – capture

The Grade 3 and 4 teachers and learners at the 20 school sites (two classes per grade) completed the survey instruments at their schools after which the instruments were sorted and prepared for digital capture. I designed Excel spreadsheets for the data capture – there was one spreadsheet for the teacher participants and one spreadsheet per grade per school for the learner participants. File names were allocated to anonymise the captured data. The digital capture of the survey data was carried out by the multilingual research team under my supervision.

4.6.2.2 Survey data – coding

All survey data (school background and teacher/learner biographical information, data relating to the three mathematical questions on the survey and the translations) were captured digitally in Excel spreadsheets to facilitate consistent entry of codes for analysis. The codes that I developed for the capture of the data in the Excel spreadsheets are shown in the tables in *Appendix 4.3* (teacher data) and *Appendix 4.4* (learner data). In these tables, explanations of every one of the teacher and learner survey codes are given. Data were entered into the Excel sheet columns according to the codes which were recorded as a header row in the first row of the survey coding sheets. The way in which the analytical framework categories of "pure/code-switching/translanguaging" were coded is discussed next.

I met the team to discuss the entry of data in the Excel sheets and we worked together on the first few sheets to ensure that all team members entered the data in the same way to ensure the reliability of the data. Several meetings were necessary to enable consensus on the coding of the explanations. For example, agreement had to be reached on what would be coded as "pure" language use, what would be coded as "code-switching" and what would be coded as "translanguaging". After sufficient questionnaire responses had been coded, I finalised the codes with the team. The agreement was that "pure" language was the use of only one language, not even one word of another language could be present for a code of "pure" to be assigned. The codes for "mixed" language use were agreed upon in terms of the way in which more than one language was used to write an explanation. "Code-switching" was identified when at least two languages were used in such a way that that the writer translated what was written (and thus repeated the same thing) using more than one language. "Translanguaging" was identified when at least two languages were used together in an explanation with the writer moving fluidly between languages using the language repertoire as a resource, not languages as alternative means of expression.

The code for language use in explanations was assigned in column BE of the teacher coding sheets (*Appendix 4.3*) and column Y of the learner coding sheet (*Appendix 4.4*). Agreement on the codes enabled consistency of all coding entries. Agreement was also reached on the verbatim capturing of the translation entries. In the coding of the translations, synonyms and variations in spelling were not penalised and appropriate drawings or symbols were accepted as correct. Once consensus was reached on the data coding, I allocated schools to the team members for capture. To ensure the validity of the data, the Excel sheets were all cross checked by the most senior team member and I finally checked and cleaned the data in preparation for statistical analysis.

Data collected through the survey consisted of two types: that which was coded for quantitative analysis and that which needed to be qualitatively analysed. I will first discuss the quantitative analysis of the coded survey data and then the qualitative analysis of the data.

4.6.2.3 Survey data – quantitative analysis

The descriptive statistical analysis of the coded quantitative data was undertaken by a member of the Wits Department of Economics, Wits School of Economic and Business Sciences. I worked with him because although I am proficient in Excel, this data set was large and I wanted to be sure the tables that I needed would be drawn up correctly and efficiently using all of the data by a person who could verify that the data set was clean and could produce valid results. I drew up the lists of the tables that I needed, and he provided me with all these tables. I then used the tables to do further analysis and draw up the necessary graphs to represent the data.

The tables (and related graphs) provided descriptive findings in relation to the sample biographical data (home language and LoLT of the survey participants) and the responses (answers and explanations) to the mathematical questions. These are explained below.

4.6.2.3.1 Survey data – quantitative analysis: home language and LoLT

The following tables were drawn up in relation to the language background data of the participants in the study. These tables enabled me to summarise the contextual data of the sample in regard to LoLT, home language and other languages used for learning and teaching.

- Summaries of school LoLT, teacher home language, other spoken languages and other teaching languages and learner home language and other spoken languages. (Table 5.1 and Figure 5.1, Section 5.2)
- The relationship between teacher home language and school LoLT. (Table 5.2, Section 5.3.1)
- The relationship between learner home language and school LoLT. (Table 5.3, Section 5.3.2.1)
- The relationship between teacher home language and learner home language. (Table 5.4, Section 5.3.2.2)

4.6.2.3.2 Survey data – quantitative analysis: Mathematical questions – explanations

The following tables were drawn up in relation to the responses to the mathematical questions per question for the teacher and learner participants in the study.

- Mathematical questions answered/not.
- Mathematical questions answered correctly/not.
- Explanations given for the mathematical solutions/not.
- Explanations given for the mathematical solutions valid/not.
- Language use in the explanation of the mathematical solution.

The first four sets of tables enabled me to summarise the contextual information in relation to the completion of the text by the sample participants.[25] The final set of tables (showing language use in explanations) was used to give insight into my research question about variation in language use. Using this set of tables I produced the figures to represent variation in language use emerging from the survey data that are presented in my study (Figures 6.6-6.12).

4.6.2.3.3 Survey data – quantitative analysis: translations

The teacher and learner translations were recorded verbatim in Excel data capture sheets for analysis by the multilingual research team using filters and counts in Excel – to summarise the number and variation in the correct translations. I designed a template for the recording of variation in the translations. The student team used this template to produce tabulated summaries for all of the survey participants (Grade 3 and 4 teachers and learners), in all four directions of translation – IsiZulu to English and Setswana to English; English to IsiZulu and English to Setswana (see *Appendix 5* for exemplars of the translation summary tables). The team studied the variation in the translations to gain insight into the use of the mathematical register of patterns and to consider the value of the development of standardised terminology. The Excel sheets and summary tables were used to produce figures for analysis (Figures 7.2-7.11) and tables with descriptive examples (Tables 7.1-7.4).

I will now discuss the qualitative analysis of the survey data.

[25] This data was reported on in Sapire, 2017b.

4.6.2.4 Survey data – qualitative analysis

The qualitative analysis of the responses to the open-ended questions by teachers in relation to language use was carried out using thematic content analysis, drawing on the categories in my analytical framework (Figure 4.2). McMillan and Schumacher explain that "qualitative analysis is the relatively systematic process of coding, categorising, and interpreting data to provide explanations of a single phenomenon of interest" (2006, p. 364). While going through the responses to the open-ended questions I created thematic categories for responses which occurred more often. These categories linked to the categories in my analytical framework. For example many respondents spoke about using code-switching to support learners' understanding, which led to the creation of a theme "*I code-switch to support learners' understanding*" (an example of an articulated heteroglossic ideology, code-switching). Another theme captured teachers' preference to use the home language of the learners, for which I created the theme *"IsiZulu/Setswana is better – it is the home language and better understood by learners"* (an example of an articulated monoglossic ideology). A third theme I created, captured the opinion that English was preferable in the FP because it would prepare learners for the use of English later in schooling – this was expressed as *"English should be used because of the policy switch to English in Grade 4"* (another example of an articulated monoglossic ideology).

I highlighted the responses using different colours to enable me to see repetitions, differences and similarities between responses. In this way I was able to identify themes that emerged from the data and I used these themes to organise and interpret the data. There were seven themes that I identified in the teacher responses to the open-ended survey questions (Table 6.7). This thematic content analysis enabled me to gain insight into language use preferences of teachers as expressed in the survey. Some of these themes recurred in the focus group discussion data, as is explained in Section 4.6.3.

The focus group discussion data capture, coding and analysis is discussed next.

4.6.3 Focus group discussion data capture and analysis

4.6.3.1 Focus group discussion data – capture

A register was taken at each of the focus group discussions. The record on the focus group discussion register included some teacher background information (home language, grades taught, number of years of teaching experience) of the participants in the discussions. All focus group discussions were audio recorded so that they could be transcribed for the data analysis in order to prevent any bias that might have arisen from simple notetaking during the discussions. I coordinated the transcription process and transcribed some of the focus group discussion audios myself. The transcription process was discussed with the team and agreement was reached on the use of templates to ensure uniformity of transcription across all of the recorded focus group discussions (see *Appendix 6.3* for the transcription template).

Once agreement had been reached on the transcription template, team members were assigned focus group discussion recordings to transcribe. Transcriptions were done verbatim. All responses in mixed or pure IsiZulu or Setswana were translated into English for analysis.

I will now discuss the qualitative coding and analysis of the focus group discussion data.

4.6.3.2 Focus group discussion data – qualitative coding and analysis

I drew up a reporting template which was informed by the categories in my analytical framework and the themes that had emerged from the open-ended survey questions (Section 4.6.2.2) to guide the thematic content analysis of the focus group discussion data. The transcription process was carried out over a period of six weeks during which I conducted the coding and preliminary analysis of the focus group discussion data. Each week, team members were assigned one focus group discussion audio to transcribe, for which they had to submit the full transcript together with a report on the transcribed discussion using the reporting template.

The reporting template called for discussion under the following themes: language policy; language use; mathematical vocabulary; classroom practices; curriculum policy; other. The reports and transcriptions were used to inform the discussion at weekly analysis meetings of the focus group discussion data. Each week, the six transcribed recordings were discussed by the team and emerging themes were written up in tables. Notes of the emerging themes were drawn up cumulatively over the weeks. I highlighted the responses written up in the tables using different colours to enable me to see repetitions, differences and similarities between responses. In this way (similarly to the qualitative analysis of the open-ended survey questions) I was able to identify themes that emerged from the data and I used these themes to organise and interpret the data. After the cumulative table was drawn up and analysed, I used it to draw up the findings and then searched the transcripts to confirm the findings and extract relevant quotations to support the findings.

Finally, the observation data capture, coding and analysis is discussed.

4.6.4 Observation data capture, coding and analysis

4.6.4.1 Observation data – capture

The observations were all video recorded so that they could be studied and transcribed for the data analysis, again to support the trustworthiness of the data and help prevent bias in the analysis. The main object of analysis of the observation data was language use (by teachers and learners) during the lessons, although the focus of the analysis was on the teachers' speech since learners spoke very little during the lessons and when they did speak it was not always easy to hear them. Since the mathematical content focus of the study was patterns, the specific use of language related to the learning and teaching of patterns was also analysed.

I designed a template for the video transcription (*Appendix 7.3* for the observation transcription template). The transcripts were written in Excel sheets indicating minute by minute progression in the timing of the video to facilitate easy cross-referencing back to the video recording when necessary in later analytical discussions (*Appendix 7.4* for an example of a full video transcript). Transcriptions were done verbatim and translated into English for analysis where necessary. Actions of the teachers and learners were given as annotations in the transcriptions. The transcripts were also used to study the extent to which mathematical language was used in the lessons.

4.6.4.2 Observation data – coding

Video observation data is coded quantitatively and qualitatively in different ways in different studies (Jacobs, Kawanaka, & Stigler, 1999; Ramey, 2016). In this study, time segments of five-minute intervals were coded across the entire time of videoed data for each observed lesson. The choice of the length of the time segments (five minutes) was made in order to give fair representation to changes in language use during the lessons as time passed. Five-minute intervals were identified as intervals over which some interaction was established which could be meaningfully coded. I developed a video analysis coding sheet drawing on the categories and subcategories in my analytical framework (Figure 4.2). The analytical framework categories of "pure/code-switching/translanguaging" were directly incorporated in the coding (codes in columns K, L and M of the coding sheet). The codes enabled analysis of the lessons for teaching style, language use, teaching strategies and resources used during teaching. Analysis of the mathematical nature of the lessons was also enabled. There was a column for notes (at the end of the coding sheet) which gave room for important observations made during the coding process to be recorded. These notes included a basic description of the flow of the lesson over the five-minute segments and any note-worthy incidents that occurred during the interval. This coding sheet was refined by the team over a period of weeks for the purposes of the quantitative analysis.

The team met to establish and formalise the codes, after which coding of all of the videos was done in the same way by the team. [26] The majority of the videos were coded collectively by the whole team. The first set of videos was coded collectively while consensus on codes was being achieved after which videos were coded twice, first by independent team members and then again collectively. Codes were assigned and entered into the Excel coding sheets per column according to the column headers (codes which were recorded in the first row of the coding sheets) to create the observation dataset for analysis (*Appendix 7.2* for an explanation of all of the observation codes).

The observed lessons were thus transcribed and coded for quantitative analysis as described above. Some episodes from the observation data set were selected for qualitative analysed. I

[26] Since the coding of the videos was done in segments that were made up of 5-minute intervals altogether 166 segments were coded for Grade 3 and 90 segments were coded for Grade 4. See Section 4.5.3 for the sample specification.

will first discuss the quantitative analysis of the coded observation data after which I will discuss the qualitative analysis of the observation data.

4.6.4.3 Observation data – quantitative analysis

Summary data tables were drawn up for all of the observation data codes according to grade, LoLT and dominant language to enable analysis. The total number of coded segments per grade (166 segments for Grade 3 and 90 segments for Grade 4) was used to calculate the relative percentages for each of the codes so that comparisons could be made using the tables (and graphs generated using the tables) of similarities and differences in the data across all of the variables.

The text of the lesson observation transcriptions was used to do a quantitative analysis of mathematical words spoken during the observed lessons. [27] The observation transcripts were compiled into one Excel file for this purpose. *Appendix 7.3* provides the transcript template and *Appendix 7.4* gives an exemplar transcript (these documents were in Excel in the original). The word count in Excel (using the "Find" function) was first done using the list of 20 terms from the survey translation activity. Since the standard form of the terms on the survey list yielded very low results, a second search for the terms, expressed in other ways (synonyms/other appropriate equivalents) was done (Figure 4.2, subcategories 4 and 5). This search yielded more productive counts that were used to discuss the use of mathematical language in the observed lessons in terms of the subcategories in my analytical framework.

4.6.4.4 Observation data – qualitative analysis

Selected episodes from the observation data set were also analysed qualitatively using language use analysis. The team had a series of qualitative observation data analysis meetings to discuss the transcriptions, select the episodes and carry out the language use analysis together. The criteria for selection of episodes for analysis was complexity of variation in language use and the analysis was carried out to highlight the potential of language mixing in multilingual contexts.

[27] For the purposes of the word count analysis, which was focused on the language of number patterns in the observed lessons, the four non-patterns lessons that were observed were not included. Hence 25 lessons were included in the word count analysis – 16 Grade 3 lessons and 9 Grade 4 lessons.

The qualitative language use analysis enabled a more fine-grained analysis of the language use in the selected episodes, using the categories of language mixing (pure/code-switching/translanguaging) as defined for the survey and observation data coding. The language use analysis of the lesson discussions between teachers and learners was done according to a process described by Henning, van Rensburg and Smit (2004). This involved identifying language use patterns (for example the use of pure/code-switching/translanguaging) and the extent and manner in which these were used. The recognition rules for the identification of language use patterns were derived from the analytical framework.

Steps that were taken to ensure the trustworthiness of the study are discussed in the next section.

4.7 Trustworthiness

Steps were taken to facilitate the four components of the trustworthiness of the data collection, capture and analysis. The four components are credibility: the validity of the findings; transferability: the applicability of the findings in other contexts; dependability: reliability of the findings at another time; and confirmability: objectivity of the researcher while carrying out his/her research (Loh, 2013). Credibility (internal validity) of the findings was aimed for by means of triangulation across multiple data sources (McMillan & Schumacher, 2006). To further strengthen the triangulation, three analytic tools were used – descriptive statistics, thematic content analysis and language use analysis. Transferability (or external validity) is determined by the degree of similarity between the research sites and other sites (Lodico, Spaulding & Voegtle, 2010). The 20 schools selected as the sample for this research are representative of schools in Gauteng. This is assured because they were randomly selected (using purposive random sampling) from the list of all schools in the three districts for which permission was granted to do the research, according to LoLT and proximity to the university where the multilingual research team was located. Rich descriptions are given in the data presentation to facilitate effective transferability of the data. The dependability (reliability) and confirmability of the data collection, coding and capturing was addressed in the research design. Reliability of the coding was ensured as discussed above in Section 4.6.3.3. (thematic analysis of the focus group discussion was carried out by the whole team and confirmed with reference back to the original transcripts) and Section 4.6.4.3 (quantitative coding of videos: all final codes were assigned collectively by the team so that there was consensus on codes).

Trustworthiness of the focus group discussion dataset was ensured through the piloting of the focus group discussion schedule to check the usefulness and relevance of the schedule. Research team members were all supported by an experienced researcher who guided them in the focus group discussions. A focus group discussion could be directed and influenced by the presence and interpretations of the researcher (Hitchcock & Hughes, 1989; Silverman, 1998). The focus group discussions were thus recorded and to facilitate the trustworthiness of the data analysis by minimising the possibility of the researcher influencing the record of the discussion. Classroom observations were similarly video recorded and transcribed. All of the participants in the study were assured of the confidentiality of the research and of their anonymity in order to enhance their trust and establish the validity of the data (Mouton, 1996).

Since this study was part of a larger study of language use in multilingual contexts (section 1.3) other datasets on which I was able to draw to support my findings were also available. This further addresses the trustworthiness of the data analysis. As it has been discussed in Section 1.3, there were five project tasks and this study drew directly on the data sets of the third, fourth and fifth project tasks. Findings from the first and second tasks were used to substantiate my findings. These data sources were used for further validation of the findings where appropriate.

Finally the steps taken to ensure that ethical requirements for the research study were complied with are discussed.

4.8 Ethical considerations

I took care to comply with the requirements of the submission to the ethics committee. I drafted letters addressed to all of the participants in the research to set out the participation that was required and to request their agreement to participate in the classroom observations, focus group discussions, questionnaire and completion of the language survey. I drew up all of the necessary consent forms which were completed by all participants. The information letters included with the consents outlined the study briefly and contained an offer to report back on the study to those involved in the research process. Reports on the three school-based project tasks were sent to every school that participated. The information letters also assured participants of confidentiality and the means by which I would assure this confidentiality. The information letters and consent forms are all attached (*Appendices 8-13*). My application for ethics clearance was granted (Protocol Number: 2016ECE024D) as confirmed in a letter dated

05 December 2016 (*Appendix 1*). I also completed and submitted the Gauteng Department of Education research request form and received the letters of approval to undertake the research data collection in the years of 2017 and 2018 in letters dated 28 November 2016, reference D2017/368 (*Appendix 2.1*) and 4 December 2017, reference D2017/368A (*Appendix 2.2*).

Although I carried out the data collection for this study over two years, as part of a funded research project, produced five project reports and have now written up this PhD study, there are limitations to this investigation which are noteworthy, which I will now discuss.

4.9 Limitations

I grounded my research in the literature of mathematics education in multilingual contexts but even in this literature there are still gaps. My study pointed to at least one question that remains unanswered, *What is the most effective form of language use in multilingual mathematics teaching*? I could not answer this question through the research I carried out, as it was beyond the scope of this study. I investigated and analysed the terrain of language use in three different contexts (survey, focus group and classroom observation). Although I used the lesson observation transcripts to identify when, why and how teachers use language mixing I did not use any measures (such as pre and post-test) to test the efficiency of language use I observed or the ways in which different language uses affect learning achievement.

The transferability of the findings beyond the urban context in the Gauteng province is potentially limited. Although the sample schools are representative of urban schools in Gauteng with highly mixed learner and teacher populations, they are not necessarily adequately representative of schools in more rural parts of the province, or in other rural contexts.

Although I set out to investigate the mathematical register of patterns, the scope of the study prevented my being able to do so to the level of rigour which would be required to properly inform the development of the mathematical register of patterns. Such a study would require more time and a specific focus on the mathematical register. I was also not able to investigate the register of all of the mathematics content areas due to the restriction on the mathematical content scope of the study.

There are always limitations to a study and while I was aware of these, I took the steps that I was able to and wrote up my findings to the best of my ability within the parameters of the study.

4.10 Conclusion

As it has been discussed in this chapter, guided by the analytical framework of language use that was developed, the study drew on quantitative and qualitative analysis of three data sets. The survey data were analysed both quantitatively (descriptive statistics were drawn up using data entered in Excel sheets) and qualitatively (thematic content analysis of open-ended questions). The focus group discussion data were analysed qualitatively using thematic content analysis. The classroom observation data were analysed both quantitatively (the videos were coded, and codes were entered in Excel sheets to carry out the descriptive analysis) and qualitatively (language use analysis). Findings that emerged from the data are presented in the next two chapters.

The findings of the study are presented in the next three chapters. Chapter 5 presents findings on the multilingual context. Chapter 6 presents findings about teachers' and learners' language use and teachers' perceptions on language use and Chapter 7 presents findings in relation to the language standardisation debate and teachers' perceptions of this debate.

Chapter 5 Findings – The multilingual context

5.1 Introduction

The first set of findings that I present relates to the LoLT and home language of the teachers and learners in the sample schools. Data from the survey was used to analyse the reality of the multilingual context in the schools that formed my sample and to answer the research question: *What is the relationship between the LoLT and home language of the teachers and learners?* The data presented in this chapter enables me to provide a detailed description of the sample schools in relation to languages spoken by teachers and learners at these schools and the way in which this relates to the LoLT of the schools. This is important contextual information that provides a backdrop to the language use analysis that follows in Chapter 6 and Chapter 7 where a key argument I will make is that the question is not "which language" but what language repertoire is enabled in multilingual contexts. All of the findings presented in Chapters 5, 6 and 7 will be used as the basis for the discussion of my overarching research question: *What factors drive the language use of multilingual Grade 3 and Grade 4 mathematics teachers and learners on the topic of patterns?*

Before one can speak about the relationship between the home language of the teachers and learners in the system and the LoLT of the schools one needs to have a clear picture of the home languages spoken in the schools. I used data from the survey to map contextual information about the home languages spoken by the participants in my sample. This is described in Section 5.2. The relationship between home language and LoLT is presented in Section 5.3 of the chapter. I have used two key findings to structure Chapter 5. The first finding is that the context of the study sample has a complex multilingual make-up – more so than the simple LoLT choices made by the schools might indicate. The second finding, which is presented in detail in the next section, is that there is poor alignment between home language and LoLT for both teachers and learners in the sample. I will now flesh out the first finding in order to give a detailed description of the home language data of the sample and set the scene for the mapping of the relationship between the home languages spoken by the sample participants and the LoLT of the schools in which they are located.

5.2 The early grade context is a complex multilingual system

The design of my study led me to select schools with LoLT IsiZulu and Setswana but from the start this was expanded to include English LoLT as explained in Chapter 4. As was also explained in Chapter 4, a further language, Sesotho, was represented as a LoLT in my sample, because of the dual LoLT system permissible according to policy. Thus the home languages that we would expect to find spoken at the sample schools, according to their chosen LoLT, are IsiZulu, Setswana, Sesotho and English. However as explained in the introduction and background to this study, a school's LoLT selection is not only determined by the home language of the learner population, although this is one of the factors taken into consideration by the School Governing Body when deciding on the LoLT of the school. To probe the reality of the language context, my survey collected data on teacher and learner home languages and other languages spoken by teachers and learners. [28] The survey findings paint a far more complex home language distribution picture than a simple four-way split according to the LoLT. This context is ideal for my study since it sets the stage for variation of language use.

Although there were only four official LoLTs in the sample of 20 schools that participated in the study (IsiZulu, Setswana, Sesotho and English), the teachers indicated that they spoke seven home languages between them and that they could speak 11 languages between them, when other spoken languages are taken into account. This finding is not surprising since it is well known that many teachers in South Africa speak more than one language, something that is useful in the context of multilingual classes. The distribution of home language and other languages spoken by teachers according to grade (Grades 3 and 4) in the sample is shown in Table 5.1 confirm this finding.

[28] I also collected data on the number of different languages in which the teachers have taught but I do not report on it in this study.

Table 5.1: Languages spoken by teachers by grade (n=62)

		Home language		Other L1		Other L2		Other L3		Other L4		Other L5		Other L6		Total (other)
		Grade 3	Grade 4	Grade 3	Grade 4	Grade 3	Grade 4	Grade 3	Grade 4	Grade 3	Grade 4	Grade 3	Grade 4	Grade 3	Grade 4	Gr 3&4
1	Afrikaans			1	1	5	3	7	2	1	2	1	0	0	0	23
2	**English**	4	3	24	11	4	1	1	2	2	0	1	0	0	0	**46**
3	IsiNdebele			0	0	1	0	0	0	0	1	0	0	0	0	2
4	**IsiXhosa**	1	2	3	0	7	4	4	1	4	4	0	1	0	0	28
5	**IsiZulu**	23	8	3	6	4	6	4	4	0	1	1	0	0	0	29
6	**Sepedi**	0	2	0	0	4	4	2	2	1	0	0	1	0	0	14
7	**Sesotho**	2	5	5	3	7	3	4	7	2	2	0	0	0	0	33
8	**Setswana**	6	4	1	1	0	1	3	0	1	0	0	0	0	1	8
9	SiSwati			0	0	1	0	4	0	1	0	1	1	0	0	8
10	Tshivenda			0	0	0	0	0	0	0	0	0	3	1	0	4
11	**Xitsonga**	1	1	0	2	0	1	0	0	3	1	1	0	0	0	8
	Total	37	25	37	24	33	23	29	18	15	11	6	6	1	1	204
	Overall Total	62		61		56		47		26		12		2		

Table 5.1 shows the range of languages spoken by the teachers in the sample. I have given this data using actual numbers rather than percentages, but I provide percentages in certain instances in my interpretation of this table to clarify proportional relationships which are of interest. As it can be seen in the table the seven home languages of the teachers in the sample are English, IsiXhosa, IsiZulu, Sepedi, Sesotho, Setswana and Xitsonga. The majority of teachers speak up to three other languages: 61, 56 and 47 out of 62 teachers indicated that they speak one, two or three other languages respectively (as percentages this is 98%, 90% and 76% respectively). Two teachers indicated that they speak six other languages. Since English is used as the LoLT at many schools[29] and terminology from English is commonly incorporated in mixed language use, it is noted that seven teachers (11%) indicated that they speak English as

[29] Schools are allowed to change their LoLT and some schools in the sample had changed from Setswana or IsiZulu to English as LoLT in the years prior to the study and one school changed its LoLT in 2017, the year in which the data was collected. Thus the number of English LoLT schools in the sample increased by one from 11 in 2017 to 12 in 2018.

their home language and 46 teachers (74%) indicated that they speak English as another language.

Learners are meant to enrol at schools where they can be taught in their home language. Figure 5.1 shows the spread of home languages spoken by learners at the sample schools, by number.

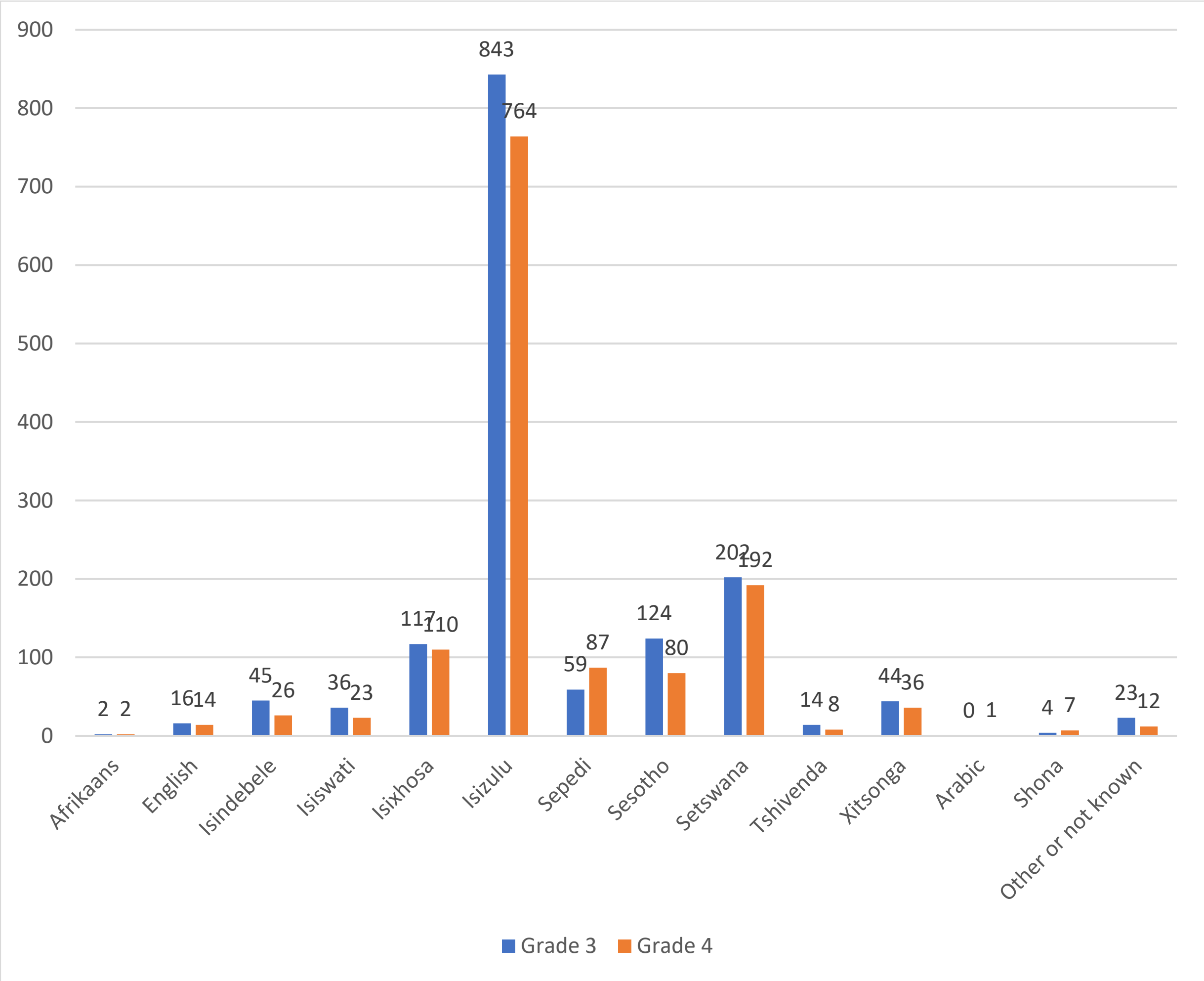


Figure 5.1: Learner home language Grade 3 and Grade 4 (Gr 3 n=1529; Gr 4 n=1362)

It can be seen in Figure 5.1 that there are several (at least 14) home languages represented in the sample, including at least two non-South African languages (Arabic and Shona). There is a large number of IsiZulu learners in the sample (843 and 764 Grade 3 and Grade 4 learners respectively) and a fairly high number of Setswana learners (202 and 192 Grade 3 and Grade 4 learners respectively), another LoLT at the sample schools. The information obtained on other languages spoken by learners was less extensive than that of the teachers in the sample.[30] In spite of this, it was found that at least 15 other languages[31] were spoken by learners in the sample (including at least four non-South African languages, such as French and Portuguese). It can also be seen in Figure 5.1 English is the home language of only a very small number of the learners in the sample. It was however reported as a second (or other) spoken language by 68% of the learners (Sapire, 2017b, p.32). The findings in relation to learner home languages is evidence of schools selecting LoLT based on other than learner population data, a trend which has been noted in South African schools, due to various reasons (McKinney, 2017; Phakeng, 2017), one of them being the desire of teachers to teach Mathematics in English. This is expanded on in Chapters 6 and 7 when teacher's perceptions of language use are discussed, and it will also be taken up in Chapter 8 in the discussion of the findings since it is evidence of pressure on teachers and schools in relation to the selection of LoLT.

The alignment between LoLT and teacher and learner home languages is presented in the next section of this chapter which is framed by the second key finding in relation to my first research question: *What is the relationship between the LoLT and home language of the teachers and learners?* The second finding, which is presented in detail in the next section, is that there is poor alignment between home language and LoLT for both teachers and learners in the sample. This leads to interesting related questions -whether teachers and learners use purist or pluralist language in the context (this will be discussed further in Chapter 6) and what can be learned about the standardisation debate (which will be discussed further in Chapter 7).

5.3 There is poor alignment between home language and LoLT

In the previous section of this chapter the rich multilingual context of the sample schools was presented. The multilingual context creates a fertile ground for multilingual language use and the study of this language use. However, the context presents a challenge to schools in relation to the selection of a LoLT, since the LoLT is a single language which must be used as the language of instruction in classes, according to CAPS policy. The CAPS interpretation of the multilingual South Africa LiEP provides for multilingual education through the selection of a

[30] Not all learners indicated other spoken languages in their survey questionnaires, and this was not followed up since it was not seen as critical to the overall survey findings.
[31] The full information on learners' other spoken language is not reported here. For further information the project survey technical report (Sapire, 2017b) can be consulted.

LoLT which may be any one of the 11 national languages. In the introduction to my study I noted that the choice of LoLT by schools rests on at least two assumptions: the first is that learner populations are homogeneous and the second is that language is standardised. The homogeneity assumption is tied to the standardisation assumption because it falsely presumes that one language can be used in a classroom. This study challenges both assumptions. [32] As it was shown in Section 5.1 the schools are richly multilingual (which challenges the homogeneity assumption). To challenge the assumption further I investigated the alignment between the teacher and learner home languages and the LoLT of the school.

In the next two subsections the alignment between home language and LoLT for teachers and learners in the research schools is presented. In Section 5.3.1, I present the finding that many teachers are not teaching in their home language and in Section 5.3.2 I present the finding that the majority of learners are not being taught in their home language.

5.3.1 Many teachers are not teaching in their home language

According to the literature that speaks about proficiency in a language as important in learning and teaching (Barwell, 2016; Halai & Muzaffar, 2016), teachers teaching (and learners learning) in their home language would provide for optimal context, since home language[33] would be the language in which a speaker is most likely to have the highest proficiency. The alignment between teacher home language and LoLT is thus important in the FP (Grade 3 classes in this study) since this is where, according to CAPS policy, teaching is in the home language. It is also of interest in this study to consider the Grade 4 alignment between teacher home language and LoLT, even though in Grade 4 teaching of mathematics is in English. This is because learners in Grade 4 have just emerged from three years of teaching in their home language and suddenly they have to transition to learning in English. Thus, if a teacher speaks their home language, she could support them with explanations in that language even if this is not officially sanctioned by policy (as seen in my conceptual framework, Table 3.1, Teachers use home language to mediate the teaching of mathematics which can have positive effects on

[32] In this subsection the focus is on language distribution and LoLT. Discussion on the standardisation of language is presented later in Chapter 7.

[33] In multilingual contexts some argue that "home language" is no longer easy to define and it cannot simply be assumed that a learner has a "home language" (Barwell & Setati, 2005). But as it was explained in the introduction to my study I use "home language" to speak about the main language spoken by an individual because this is the terminology of the policy developed of the CAPS and I would like my study to be easily interpreted by policy makers.

learning outcomes). The language use findings which are discussed in Chapter 6 show that this is indeed the case, since Grade 4 teachers used mixed language more than those in Grade 3 did. The distribution of home languages of the teachers in the sample according to the LoLT of the schools (by grade) is shown in Table 5.2.

Table 5.2: Teacher home language and LoLT of school by grade (n=62)

	LoLT	**English**		**IsiZulu**		**Setswana**		**Total**	
	Teacher HL	**Grade 3**	**Grade 4**	**Grade 3**	**Grade 4**	**Grade 3**	**Grade 4**	**Grade 3**	**Grade 4**
1	**English**	2	2	0	0	2	1	4	3
2	**IsiXhosa**	0	0	1	1	0	1	1	2
3	**IsiZulu**	5	2	18	6	0	0	23	8
4	**Sepedi**	0	0	0	2	0	0	0	2
5	**Sesotho**	2	1	0	4	0	0	2	5
6	**Setswana**	1	2	0	0	5	2	6	4
7	**Xitsonga**	0	1	0	0	1	0	1	1
	Subtotal	10	8	19	13	8	4	37	25
	Overall total	18		32		12		62	

As it was shown in Section 5.2, although there were only four LoLTs in the sample of 20 schools that participated in the study, the teachers speak seven home languages between them. Table 5.2 shows that many teachers are teaching at schools where the LoLT does not align with their home language. Of the 18 teachers at the English LoLT schools, 4 (22%) indicated English as their home language, of the 32 teachers at the IsiZulu LoLT schools, 24 (75%) indicated IsiZulu as their home language and of the 12 teachers at the Setswana LoLT schools, 7 (58%) indicated Setswana as their home language. The alignment is thus best at the IsiZulu LoLT schools. If one considers only the Grade 3 classes where teaching is meant to be taking place in the LoLT of the school – the alignments are higher for IsiZulu and Setswana (18 out of 19 teachers or 95% and 5 out of 8 teachers or 63% respectively) but low for English LoLT schools (2 out of 10 teachers or 20%). Teachers are educated professionals and it is likely that they are fluent in the languages in which they are expected to teach and that their language proficiency will be of an adequate standard to teach with this language. This is not meant to imply that home language teachers will teach better than non-home language speakers, but in relation to literature of language proficiency, teaching in your home language would be optimal. It certainly also reveals that the policy assumption about homogeneous populations and CAPS providing home language instruction across the board is false.

In the next section the home language of the learners is discussed where the key finding is that learners are not learning in their home language.

5.3.2 The majority of learners are not learning in their home language

As it has been shown above, the multilingual nature of the sample schools is also characterised by poor alignment between the home languages spoken by teachers and the school LoLT. The alignment between home language and LoLT is even more critical when it comes to learners since they are the ones being taught, they are acquiring language and learning other concepts. There is a large body of research that has shown that this initial learning is best in the home language in conjunction with other languages when doing mathematics (Adler, 1999; Moschkovich, 1999; Setati, 2005, 2008, 2012; Setati, Molefe & Langa, 2008; Taylor & von Fintel, 2016). Since this is such an important contextual consideration, I investigated the alignment between learner home language and LoLT as well as the alignment between learner and teacher home languages. As discussed in Section 5.3.1 the home language-LoLT alignment is relevant in both Grade 3 and Grade 4 (where English becomes the LoLT) because learners cannot be expected to become fluent in English with the change of the calendar year. As seen in my conceptual framework (Table 3.1), language can interfere with, but can also be supportive of the learning of mathematics (Chitera, 2011; Essien 2018). Support in their indigenous home languages, if it were possible (through teachers using mixed language), would still be useful to learners (Jorgenson, 2018; Mukucha, 2012).

The question of learners learning in their home language is presented through two distinct but related findings. The first relates to the alignment between the learners' home language and the school LoLT and the second relates to the alignment between the teachers' and the learners' home languages. The alignment between learners' home language and the LoLT of the school is presented in the next subsection.

5.3.2.1 The majority of learners are not enrolled at a school that offers their home language as LoLT

This finding is evidence that, at least in the urban context where the sample schools in this study were located, the assumption about homogeneous learner populations is not valid. Table 5.3 shows the relationship between Grade 3 and 4 learners' home languages and the LoLT of the schools at which they are enrolled. Both are relevant as contextual findings because they indicate the extent to which multilingual support of learning would be possible.

Table 5.3: The relationship between learner home language and LoLT: Grade 3 and 4 (Gr 3 n=1506; Gr 4 n=1352)

		LOLT							
		English		**IsiZulu**		**Setswana**		**Total**	
	Learner HL	Grade 3	Grade 4	Grade 3	Grade 4	Grade 3	Grade 4	Grade 3	Grade 4
1	**Afrikaans**	0%	0%	0%	0%	0%	0%	0%	0%
2	**English**	0%	0%	1%	1%	0%	0%	1%	1%
3	**IsiNdebele**	0%	0%	2%	2%	1%	0%	3%	2%
4	**IsiSwati**	0%	1%	2%	1%	0%	0%	2%	2%
5	**IsiXhosa**	2%	2%	5%	5%	1%	1%	8%	8%
6	**IsiZulu**	15%	16%	37%	36%	4%	4%	56%	56%
7	**Sepedi**	0%	0%	1%	1%	4%	5%	5%	6%
8	**Sesotho**	3%	1%	2%	3%	2%	2%	7%	6%
9	**Setswana**	3%	3%	0%	0%	11%	11%	14%	14%
10	**Tshivenda**	1%	0%	0%	1%	0%	0%	1%	1%
11	**Xitsonga**	1%	1%	2%	2%	0%	0%	3%	3%
12	**Arabic**	0%	0%	0%	0%	0%	0%	0%	0%
13	**Shona**	0%	0%	0%	0%	0%	1%	0%	1%
	Total	**25%**	**24%**	**52%**	**52%**	**23%**	**24%**	**100%**	**100%**

It was shown in Section 5.2 that the learner population is linguistically diverse, speaking at least 14 different home languages between them. It is thus not surprising that, as it can be seen in Table 5.3, there is not good alignment between learner home language and LoLT at all schools. There is very little difference between the alignment for the Grade 3 and Grade 4 learners. The best alignment is found at IsiZulu LoLT schools, with 37% Grade 3 and 36% Grade 4 learners enrolled at a school with a LoLT that aligns with their home language. This is well below half the learners in the class. This does put to question the policy assumption that the LoLT system in schools provides for home language instruction. [34] For Setswana learners this percentage is only 11% for both grades while for English this percentage is 0% for both grades. There is quite a high cluster of IsiZulu home language speakers at the English LoLT schools, most likely resulting from IsiZulu LoLT schools in the sample that have opted for English as LoLT, but apart from that there is a very wide spread of learner home languages

[34] Analysis of schools according to LoLT is what is used to infer home language instruction in the system (Sapire & Roberts, 2017).

across the sample. The findings in relation to linguistic diversity lead to the question of the extent to which and manner in which teachers are able to use language resources to mediate mathematics optimally.

The alignment between learners' home language and the home language of their teachers is presented in the next subsection.

5.3.2.2 The majority of learners are not being taught by teachers whose home language is the same as their own

Table 5.4 shows the relationship between Grade 3 and 4 learners' and teachers' home languages at the schools at which they are enrolled. Again, both are relevant as contextual findings because they indicate the extent to which multilingual support of learning would be possible.

Table 5.4: The relationship between teacher and learner home language: Grade 3 and 4 (Gr 3 n=1506; Gr 4 n=1352)

	Teacher HL															
	English		IsiXhosa		IsiZulu		Sepedi		Sesotho		Setswana		Xitsonga		Total	
Learner HL/Grade	Grade 3	Grade 4	Grade 3	Grade 4	Grade 3	Grade 4	Grade 3	Grade 4	Grade 3	Grade 4	Grade 3	Grade 4	Grade 3	Grade 4	Grade 3	Grade 4
Afrikaans	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
English	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%
IsiNdebele	0%	0%	0%	0%	2%	1%	0%	2%	0%	0%	0%	0%	0%	0%	2%	3%
IsiSwati	0%	0%	0%	0%	2%	1%	0%	0%	0%	0%	0%	0%	0%	0%	2%	1%
IsiXhosa	2%	2%	0%	0%	5%	3%	0%	0%	1%	2%	1%	1%	0%	0%	9%	8%
IsiZulu	4%	4%	2%	3%	45 %	21 %	0%	4%	2%	17 %	3%	5%	1%	3%	57 %	57 %
Sepedi	0%	1%	0%	0%	1%	1%	0%	0%	0%	0%	3%	4%	0%	0%	4%	6%
Sesotho	1%	0%	0%	0%	5%	2%	0%	0%	0%	2%	2%	2%	0%	0%	8%	6%
Setswana	3%	1%	0%	3%	0%	0%	0%	0%	1%	0%	7%	10 %	1%	0%	12 %	14 %
Tshivenda	0%	0%	1%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%
Xitsonga	0%	0%	0%	0%	2%	1%	0%	0%	1%	1%	0%	0%	1%	0%	4%	2%
Arabic	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Shona	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	1%
Total	10 %	8%	3%	6%	63 %	32 %	0%	6%	5%	22 %	16 %	22 %	3%	4%	100 %	100 %

Table 5.4 once again indicates poor alignment – this time between learner and teacher home languages. The alignment for IsiZulu is again the highest (45% and 21% for Grade 3 and Grade 4 learners respectively) but considering that, as it was shown in Section 5.2.1 above, 95% of the Grade 3 teachers at the IsiZulu LoLT schools are IsiZulu home language speakers, this is lower than might be expected at the IsiZulu LoLT school. The alignment for both grades for Setswana is very low (7% and 10% for Grade 3 and Grade 4 learners respectively) and for English, again it is 0% for both grades. Apart from IsiZulu Grade 3 learners, very few learners are being taught in their home language by a home language speaker of their language. Although it is not the only factor[35] that would impact on quality of learning and teaching, language proficiency is a factor in quality of instruction as some literature indicates (Barwell, 2016; Halai & Muzaffar, 2016) and it also influences choice of language use. The teachers

[35] Although language is an important factor, teacher knowledge of the mathematical content must be the key factor because without it meaningful teaching cannot happen, but that is not the focus of my study.

might hold the view that mixing languages supports learner understanding, but they are not able to do it because of inadequate language proficiency. Thus it is of contextual interest to my study to understand the depth of the complexity, alignment and misalignment in terms of language in my sample.

5.4 Conclusion

I have shown that my study sample has a complex multilingual make-up – more so than the simple LoLT choices made by the schools might indicate. My study sample thus provided a fertile ground for research on language use. It was discussed that teachers are professionals, and they are no doubt proficient in the languages which they use to teach (Section 5.3.1). However, the key finding of this chapter is that the policy assumption that providing teaching in multiple languages (through the LoLT) across the school system is not an assurance that learners will be taught in their home language. [36] As I also discussed, learning in the home language is not the key to successful learning, but it is one of the factors that enables better opportunities for learning. The implications for my study are important. The various dimensions of poor alignment shown in this chapter raise questions about teachers' perceptions of language use; how they deal with possible tensions between policy and the needs of their learners; if they do mix languages – how do they do it and what dimensions of standardisation are highlighted in this process; if they do not mix languages, why not and how do they deal with the poor alignment.

My next two findings chapters, Chapters 6 and 7, present the findings on language use evidenced in my sample. First, in Chapter 6 variation in language use is discussed and after that in Chapter 7, related to variation but pushing against it, standardisation of language use is discussed. In the next chapter the findings on variation in language use are presented.

[36] This has implications for teacher education. Historically the majority of teachers were taught to teach mathematics in English, although this is now changing (Essien, 2010; van Laren & Goba, 2013, Mostert, 2019)

Chapter 6 Findings – Variation in language use

6.1 Introduction

The next set of findings that I present relates to teachers' and learners' language use and teachers' perceptions of language use. This will be used as the basis for the discussion of my overarching research question: *What factors drive the language use of multilingual Grade 3 and Grade 4 mathematics teachers and learners on the topic of patterns?* The second and third sub-questions that guided this study yielded data that is presented in this chapter. The chapter is divided into three main sections. Firstly, in Section 6.2, following on the presentation of data in Chapter 5 on the multilingual context, I present the findings on variation in language use guided by my second research question: *What variation in language use is evident when teachers and learners write and speak mathematics?* Variation is discussed according to the categories and subcategories of my analytical framework (Figure 4.2). Secondly, in Section 6.3 I present the findings on perceptions of "best practice" for language use in the learning and teaching of mathematics in relation to my third research question: *What are teachers' perceptions of the "best practice" in relation to language use in mathematics teaching?* according to the categories in my analytical framework. Thirdly, in Section 6.4, moving towards answering my broad research question, I discuss the variation and perceptions findings in relation to the drivers (ideology, research and policy) according to my analytical framework. I have used key findings to structure the chapter and hence data from the three data sources that informed my study (survey, focus group discussions and observations) are used in this chapter.

Findings in relation to my second research question, variation in language use, are the focus of Section 6.2 which now follows.

6.2 Language use varies – pure and mixed language are used

Two of the datasets (survey and lesson observations) were used to analyse the active (written and spoken) language use of the teachers and learners in order to answer my second research question: *What variation in language use is evident when teachers and learners write and speak mathematics?* The survey yielded written language use in the form of explanations for responses to a series of questions on number patterns and the lesson observations yielded evidence of spoken language during lessons on patterns. In Section 6.2.1 the full range of variation in language use that emerged from the written mathematical explanations that were analysed is presented. The analysis was guided by the categories in my analytical framework. The categories pure and mixed language use were applied to capture the variation. In the sections that follow (Sections 6.2.2; 6.2.3, 6.2.4 and 6.2.5), findings from the observation data are presented.

The key finding that emerged from the evidence of teachers' and learners' language use in the written mathematical explanations in the survey was that despite the multilingual context, pure language use is more common both for teachers and learners.

6.2.1 Pure language use is most common in written mathematical explanations

The survey questionnaire was presented using a bilingual format and participants were told they could answer and write their explanations using any language. Close to 90% of all teachers and learners responded to all questions and gave explanations for their answers. The language use analysis, carried out on all explanations, was thus carried out on a large dataset which had been rigorously prepared and cleaned. In multilingual classes there are many different languages (any of the eleven official languages, but there may be others as well) that teachers and learners may call on as a resource when answering mathematical questions. These may be the same as or different to the LoLT of the classroom. Knowledge of mathematical content is extremely important (the goal of mathematics teaching is mathematics learning), but the purpose of this part of the study was to give the teachers (and learners) an opportunity to "speak" using mathematical language by giving reasons for how they worked out their answers. Teachers and learners used both verbal language and mathematical symbols in their explanations. Percentages of overall pure/mixed/symbolic language use in the sample are given at the end of this section after the examples that illustrate the different types of language use are given. I now present several examples taken from teachers' and learners' survey responses in order to show some of the richness in the variation in language use. This expands on the exemplification of the categories and subcategories which were operationalised in Table 4.7 and explained in Section 4.6.1.2 respectively.[37]

[37] The expanded set of examples is also given to provide insight into the greater range of what was accepted as correct in the quantitative coding.

The *first set* of examples given below in Figure 6.1 illustrates mixed language use (translanguaging) in explanations given by different learners and teachers.

Learners (IsiZulu and Setswana)

1. Fill in the missing number:/ Faka inombolo engekho:
228, 230, 232, 234, 236

Explain how you got your answer:
Chaza ukuthi uyithole kanjani impendulo yakho
Ngoba fanele ubale ngabo two
ukwazi ukuthola inpasa

2. Extend the pattern:/ Khulisa leli phethini
93, 96, 99, 102, 105, 108

Explain how you got your answer:
Chaza ukuthi uyithole kanjani impendulo yakho
gigate gama ma timetabuli
mese gayithola iqastha

[Because you have to count in twos to find the answer.] [I took the times tables and then found an answer.]

3. Underline the numbers do not belong to the patterns.
Dwebela izinombolo okungadingeki ukuthi zibe kule phethini.
3, 6, 11, 15, 18

Explain how you got your answer:
Chaza ukuthi uyithole kanjani impendulo yakho
ngifundile ngatho inamba

3. Underline the number that does not belong to the pattern.
Thalela dipalo tse di sa weleng mo dipateroneng.
3, 6, 11, 15, 18

Explain how you got your answer:
Tlhalosa go re o fitlhetse karabo ya gago jang:

A i tsamayi le paterone

[I studied and found the number.] [It is not going according to the pattern.]

Teacher (IsiZulu)

3. Underline the numbers do not belong to the patterns.
Dwebela izinombolo okungadingeki ukuthi zibe kule phethini.

3, 6, 11, 15, 18

Explain how you got your answer:
Chaza ukuthi uyithole kanjani impendulo yakho
Sibala ngakuthathu – Inamba ezibala ngakuthathu
kungashiyeki nombolo.

[I count in threes, numbers that count in 3's without leaving a number (remainder).]

Figure 6.1: Examples of mixed language use (translanguaging) in written explanations

In the first three examples in Figure 6.1, IsiZulu is used as the main language in a mix with English, or trans words created using English and the home language. The trans words are both used for mathematical terms. In the first example, the number is written in English, in the second example, times tables have been written as *timetabuli* and in the third one *inamba* is used to say number. These words are learner inventions, transliterating from the English, showing a flexible and creative use of their language repertoire (Figure 4.2, subcategory 5, appropriate). When words like these were used, they were coded as examples of translanguaging. In the fourth example, as part of a Setswana explanation, the Sesotho word *paterone* is used for the term pattern (Figure 4.2, subcategory 5, appropriate). The teachers' example is interesting because she uses two forms of the word for *number*: a trans word and a pure word (*inamba* and *nombolo* respectively) (Figure 4.2, subcategory 5, appropriate). She uses the word *nombolo (number)* in the place of saying *remainder* – a more technical mathematical term (Figure 4.2, subcategory 5, inappropriate) which may be a source of confusion. These examples are evidence of heteroglossia in practice, officially disallowed by CAPS policy. The most common form of language mixing found in learner explanations (teachers did not mix language in this way in the written explanations but they did it a lot when they spoke) was learners' writing number names in English. The language mixing here is very simple: English is used for number names together with the home language which is the main language of expression. This is a common translanguaging style used in South Africa (Mostert, 2019) and is a classic "mix" which teachers wish was allowed (seen in the responses to the open-ended questions, discussed later in the findings). There are officials who attempt to stamp out such mixing, in favour of pure language use conforming with a monoglossic language ideology (Makoe & McKinney, 2014; Sapire, 2018a).

Another variation in language mixing was observed: some learners used both English and Setswana/IsiZulu in their explanations, but in full sentences (teachers did not mix language in this way). For example, they might explain Question 1 in IsiZulu and Question 3 in English. Some learners wrote their explanations in two languages – for a particular question they gave an explanation in both English and Setswana (again, teachers did not mix language in this way). The *second set* of examples given below in Figure 6.2 illustrates mixed language use (code-switching) in explanations given by different learners and teachers.

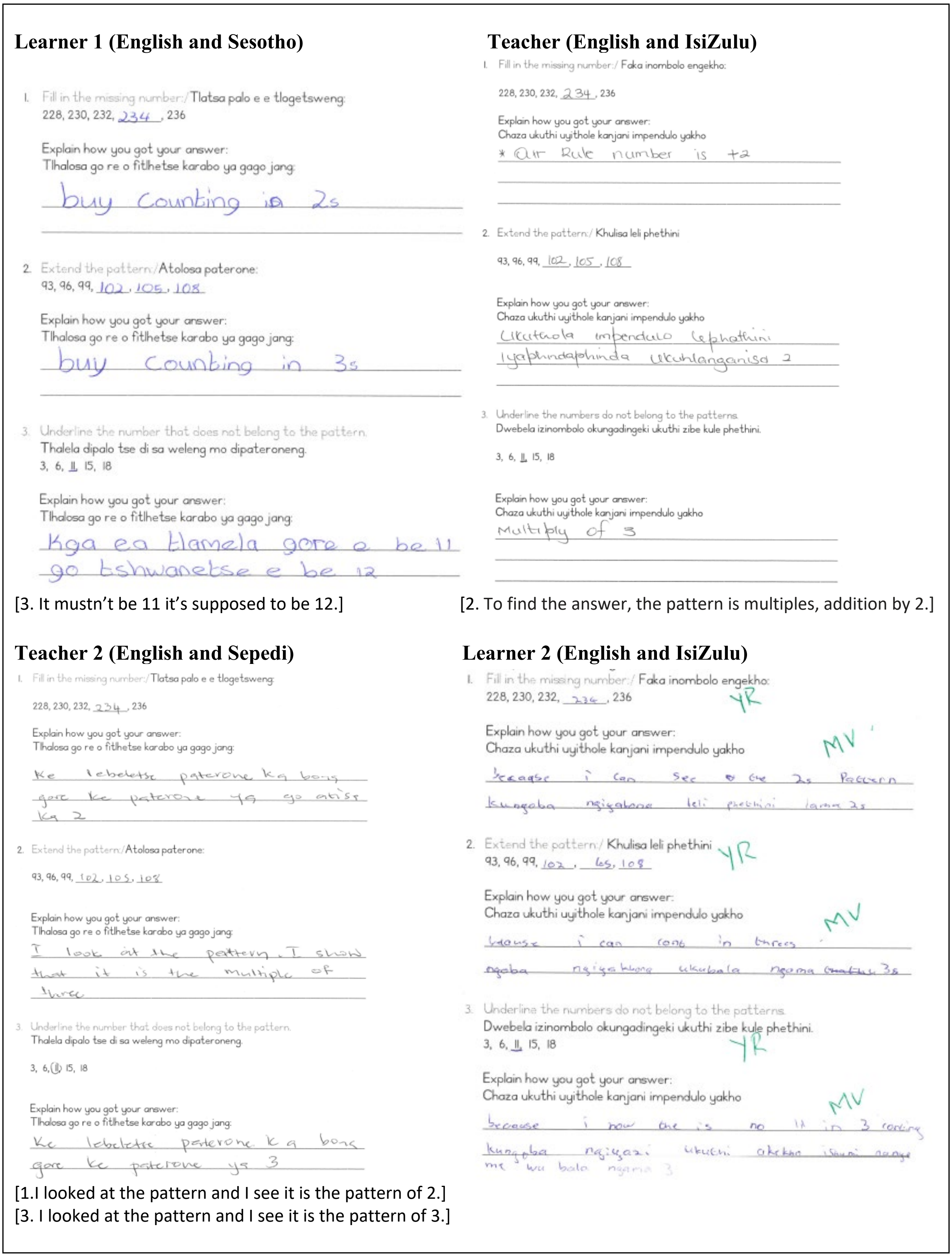
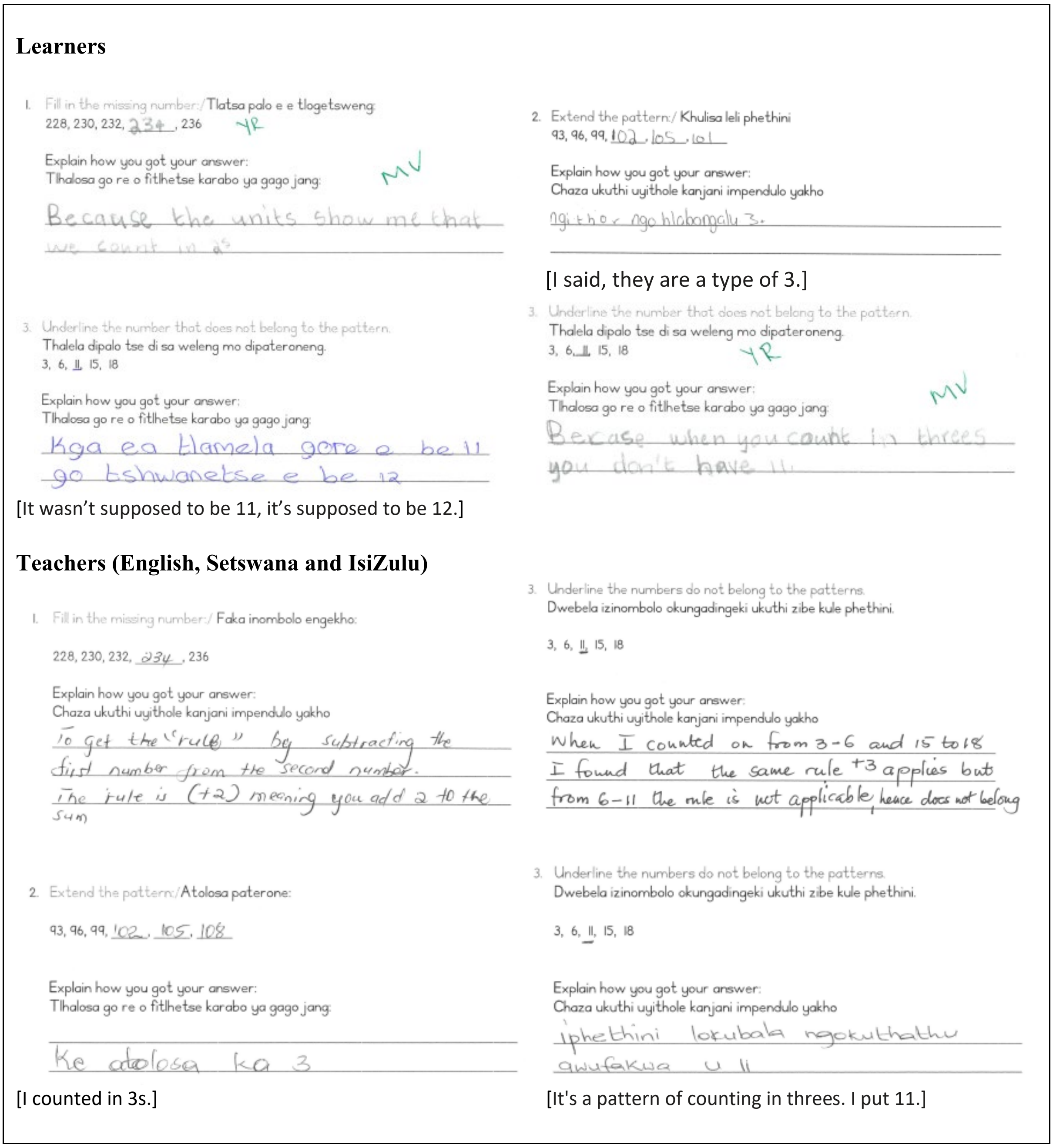


Figure 6.2: Examples of mixed language use (code-switching) in written explanations

In Figure 6.2 the first three examples show a learner's and two teachers' responses to the three survey questions involving a code-switching choice because they choose to use different languages when giving different responses. As it can be seen, they choose to answer different questions in different ways. An interesting use of words is noted in the second teacher's explanations – she uses the term *multiple* in her English explanation while in the Setswana explanations she uses the word *paterone* (*pattern)* (Figure 4.2, subcategory 4, formal/informal). The fourth example shows a learner writing the explanation twice, first in English and then in Setswana. The learner did this for all three questions.[38] These two examples show learners code-switching, according to the definition of code-switching followed in this study, which is to make a conscious use of two different languages.

Numerals (the symbols used to write numbers) are part of the mathematical register and learning what the symbols are (and how to write them) is an important part of early grade mathematics learning. The use of numerals in combination with verbal explanations was fairly common. It was the only evidence in the explanations of a mix of symbols and words, since other symbols or diagrams were not called for in the explanations about number patterns. [39] Examples are included here since in the FP, when language is being learned, the use of words rather than symbols is sometimes promoted, and many learners wrote the full number names using words rather than the numerals in their explanations.[40] The *third set* of examples given below in Figure 6.3 illustrates a mix of verbal and symbolic language use in explanations given by different learners and teachers.

[38] There were other learners who did this as well, but none of the teachers did.
[39] Other symbolic representations were used in the translation activity which will be discussed in Section 7.2 when the findings from the translation activity are presented.
[40] I contend that symbolic mathematical 'short hand' is useful particularly in the multilingual context.


Learners

1. Fill in the missing number:/ Tlatsa palo e e tlogetsweng:
228, 230, 232, 234 , 236 YR

Explain how you got your answer:
Tlhalosa go re o fitlhetse karabo ya gago jang: MV

Because the units show me that we count in 2s

2. Extend the pattern:/ Khulisa leli phethini
93, 96, 99, 102 , 105 , 101

Explain how you got your answer:
Chaza ukuthi uyithole kanjani impendulo yakho

ngithe ngo hlobomgalu 3.

[I said, they are a type of 3.]

3. Underline the number that does not belong to the pattern.
Thalela dipalo tse di sa weleng mo dipateroneng.
3, 6, 11, 15, 18

Explain how you got your answer:
Tlhalosa go re o fitlhetse karabo ya gago jang:

Kga ea tlamela gore e be 11 go tshwanetse e be 12

[It wasn't supposed to be 11, it's supposed to be 12.]

3. Underline the number that does not belong to the pattern.
Thalela dipalo tse di sa weleng mo dipateroneng.
3, 6, 11, 15, 18 YR

Explain how you got your answer:
Tlhalosa go re o fitlhetse karabo ya gago jang: MV

Becase when you count in threes you don't have 11.

Teachers (English, Setswana and IsiZulu)

1. Fill in the missing number:/ Faka inombolo engekho:

228, 230, 232, 234 , 236

Explain how you got your answer:
Chaza ukuthi uyithole kanjani impendulo yakho

To get the "rule" by subtracting the first number from the second number. The rule is (+2) meaning you add 2 to the sum

3. Underline the numbers do not belong to the patterns.
Dwebela izinombolo okungadingeki ukuthi zibe kule phethini.

3, 6, 11, 15, 18

Explain how you got your answer:
Chaza ukuthi uyithole kanjani impendulo yakho

When I counted on from 3-6 and 15 to 18 I found that the same rule +3 applies but from 6-11 the rule is not applicable, hence does not belong

2. Extend the pattern:/ Atolosa paterone:

93, 96, 99, 102 , 105 , 108

Explain how you got your answer:
Tlhalosa go re o fitlhetse karabo ya gago jang:

Ke atolosa ka 3

[I counted in 3s.]

3. Underline the numbers do not belong to the patterns.
Dwebela izinombolo okungadingeki ukuthi zibe kule phethini.

3, 6, 11, 15, 18

Explain how you got your answer:
Chaza ukuthi uyithole kanjani impendulo yakho

iphethini lokubala ngokuthathu awufakwa u 11

[It's a pattern of counting in threes. I put 11.]

Figure 6.3: Examples of a mix of verbal and symbolic language use in written explanations

In Figure 6.3 it is evident that a mix (verbal/symbolic) occurs when English and indigenous languages are used. This is a seamless mix which is expected in mathematical explanations and it was coded according to the predominant verbal language use in the explanation.[41] The four different examples selected from learners' questionnaires all show learners writing using one language but using number symbols to record the numeral given in the given explanations.

[41] For example, an IsiZulu explanation that included numerals was coded as IsiZulu while an English explanation that included numerals was coded as English.

There are also four examples selected from teachers' questionnaires – where evidence shows the same type of language use. This set of examples shows some variation in terms of the mathematical register – the use of words and symbols.

The use of numerals (without any verbal text) to give explanations was not common, but there were some learners who wrote out a number sequence by way of explanation for answers given to some questions.[42] The *fourth set* of examples given below in Figure 6.4 illustrates purely numeric (symbolic) explanations given by four different learners. (There were no teachers who used language in this way.)

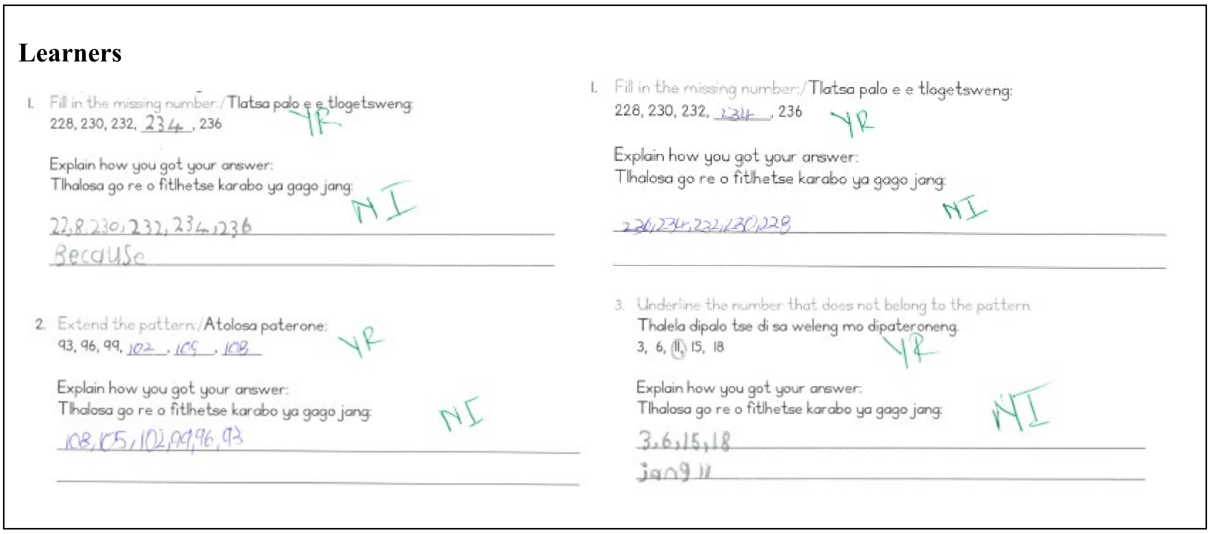


Figure 6.4: Examples of symbolic explanations given by learners

In Figure 6.4, different learners, in response to the three different questions in the survey questionnaire, have all written out a numeric sequence by way of explanation to the answer they gave to the question (Figure 4.2, subcategory 2, symbolic).

Although the literature speaks about the benefits of mixed language use in multilingual contexts, and examples of a range of different mixed language use examples have been given in Figures 6.1 to 6.4 above, in the written mathematical explanations very few teachers and learners showed these mixed language use practices. The majority of them used pure language. When only one identified language was used in an explanation, this was coded as "pure"

[42] These responses were coded as symbolic (numeric/diagrammatic) although no diagrams were used here, they were used in the translation activity that is discussed in Chapter 7.

language use. The *fifth set* of examples given below in Figure 6.5 illustrates pure language use in explanations given by different learners and teachers.

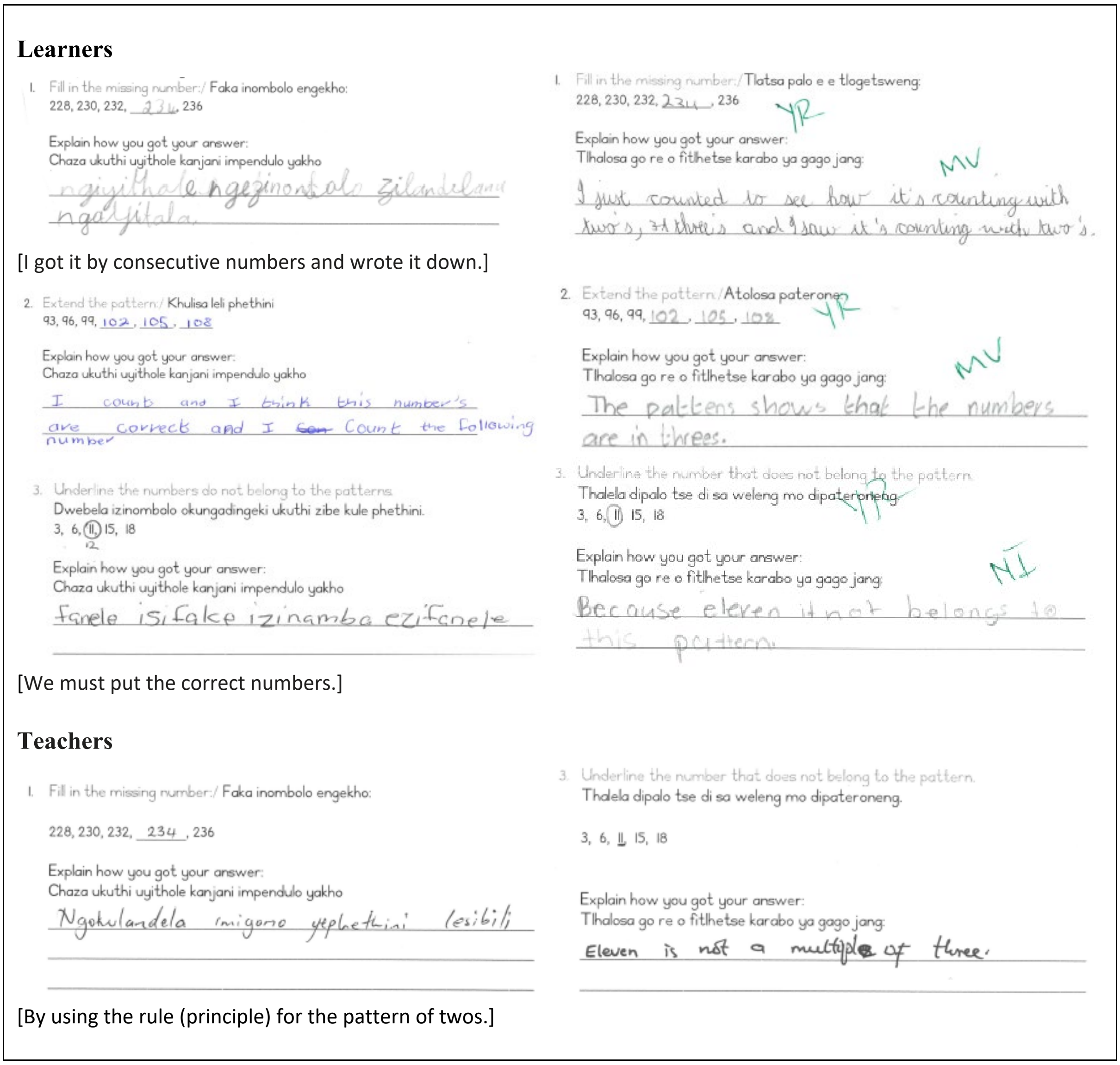


Figure 6.5: Examples of pure language use in written explanations

In the six different learner examples shown in Figure 6.5, only one language is used in the explanation, which was the code for pure language use. The three learner examples on the left are responses on IsiZulu questionnaires where learners respond either in pure IsiZulu (or English) and, similarly, the three learner examples on the right are responses on Setswana questionnaires where learners responded in pure English. The two teacher examples that are shown are in pure IsiZulu and English respectively.

The examples shown and discussed above formed the basis of the quantitative coding of all of the teacher and learner explanations so that variation across the full dataset of explanations could be captured and analysed. Figure 6.6 shows the summary of the quantitative analysis of variation in the written teacher and learner explanations. Variation according the three categories in my analytical framework is shown in the figure as **pure** (only one language of expression) and **mixed** (including both code-switching and translanguaging). Further variation shown in Figure 6.6 is that of **symbolic** (the fourth subcategory in my analytical framework) and **other**. The category 'other' captures variation in the form of other languages that were used in responses and the presence of unintelligible explanations.

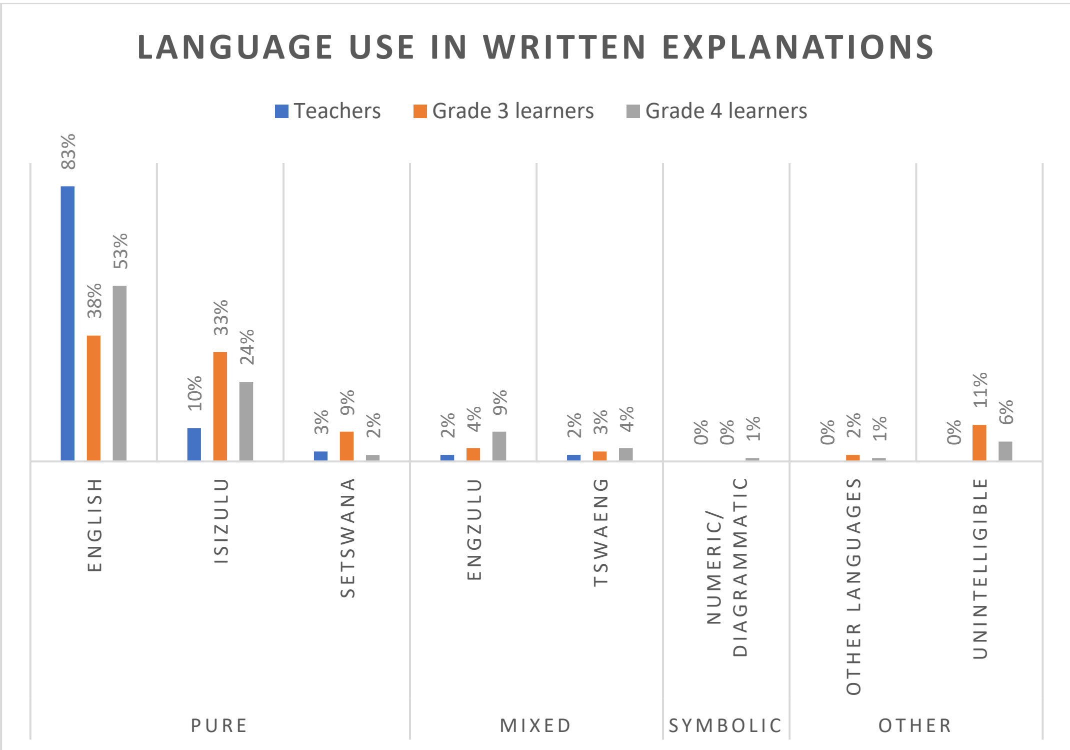


Figure 6.6: Language use in written teacher and learner explanations

The findings show that for both teachers and learners pure language use was most common when giving explanations. Figure 6.6 clearly shows that most of the explanations were given in a pure language. In that category, English was most highly represented for both teachers (83%) and learners (Grade 3 – 38% and Grade 4 – 53%) even though English is not the home language of the majority of the participants. This is evidence that, in spite of the multilingual context, the monolingual LoLT system enforced by CAPS policy pervades and strongly influences language use. The percentages for learners' explanations in all subcategories other than English were higher than the percentages for teachers which shows that learners are more open to using a range of languages and it means that they would require support for this language repertoire when being taught. In the two mixed language use categories (Engzulu and Tswaeng) it can be seen that learners used more mixed language (20% combined overall) than teachers did (4% combined overall).

There are interesting differences between Grade 3 and Grade 4 learners. Grade 3 learners used more indigenous languages than Grade 4s, which is to be expected since the policy requires that Grade 3 learning and teaching is carried out in the home language. Language mixing was not common but was higher in the Grade 4 groups than in the Grade 3 groups. From a policy perspective this is surprising, since the policy expectation for Grade 4 is that learning and teaching is carried out in English (exclusively). However, it is not surprising and it is in line with the research claim that teachers use mixed language to mediate learning (Jorgenson, 2018; Mukucha, 2012). If one considers that the Grade 4s have just transitioned from an indigenous home language in Grade 3 to English in Grade 4, this is evidence that they are mixing languages while they negotiate the transition.

Symbolic language (broader use of the mathematical register) was also not common. It was also used more by Grade 4s which is to be expected since this requires greater knowledge of the mathematical register. Several explanations written by learners were unintelligible, more so in Grade 3 (11% compared to 6% for Grade 4), which is also understandable since Grade 3s have been at school for a shorter time and thus have learned less to date. The unintelligible learner responses (present in both Grade 3 and Grade 4) bear evidence to the poor level of language acquisition in literacy (Spaull, 2016a).

The explanations given in the survey thus gave insight into variation in teachers' and learners' written language use and showed that although there was evidence of language mixing in the written explanations, this was minimal and predominantly pure language was used to give written explanations. I now discuss the observation data which adds to the discussion of variation of language use, in the context of the classroom. [43]

[43] As discussed in Chapter 4, Table 4.6 shows that 832 minutes of video footage were obtained from the 17 Grade 3 lessons that were observed and 458 minutes of video footage were obtained from the 12 Grade 4 lessons that were observed. This formed the sample for the lesson observation analysis.

The observations were also planned to give insight into teachers' and learners' language use, but what emerged from the data was that teachers' voices dominated in the observed lessons (Sapire, 2018a). As a result of this, only variation in teachers' language use is reported on in the quantitative analysis of the observation data (in the qualitative reporting, learners' voices are included). The first finding from the quantitative analysis of the observation data, which is the focus of Section 6.2.2 that now follows, is that English is the dominant language during teaching.

6.2.2 English language use dominates during teaching

As discussed in Section 4.5.3 English was the LoLT at nine of the 13 schools which were observation sites. Thus only four of the 17 schools in the observation sample had maintained the indigenous language LoLT (two IsiZulu and two Setswana). Bearing in mind that the LoLT is not necessarily the home language of the learners, Figure 6.7 presents the indigenous language/English variation according to Grade and Figure 6.8 presents the variation of dominant language (indigenous language/English) according to LoLT in the sample schools.

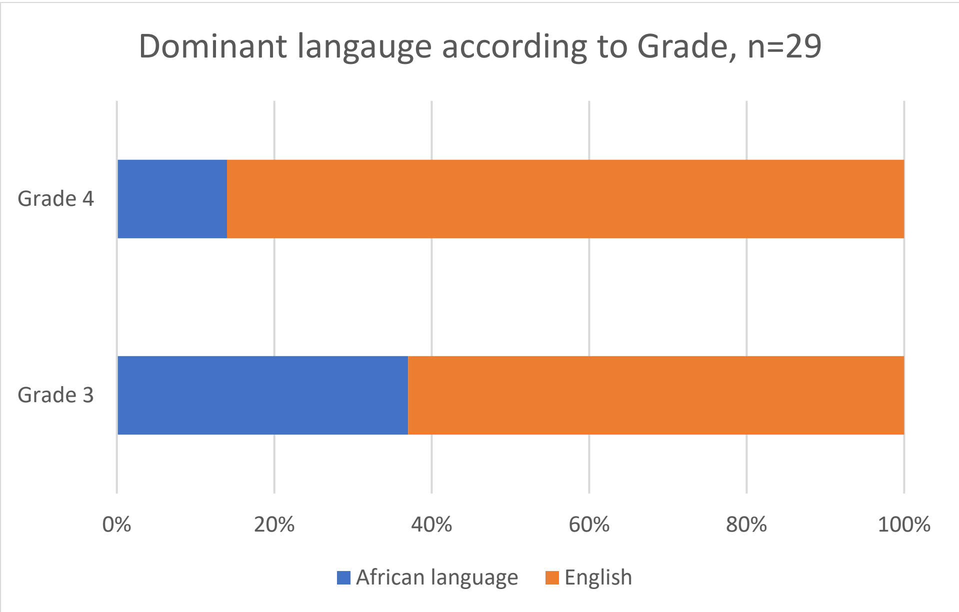


Figure 6.7: Dominant language used in teaching according to grade

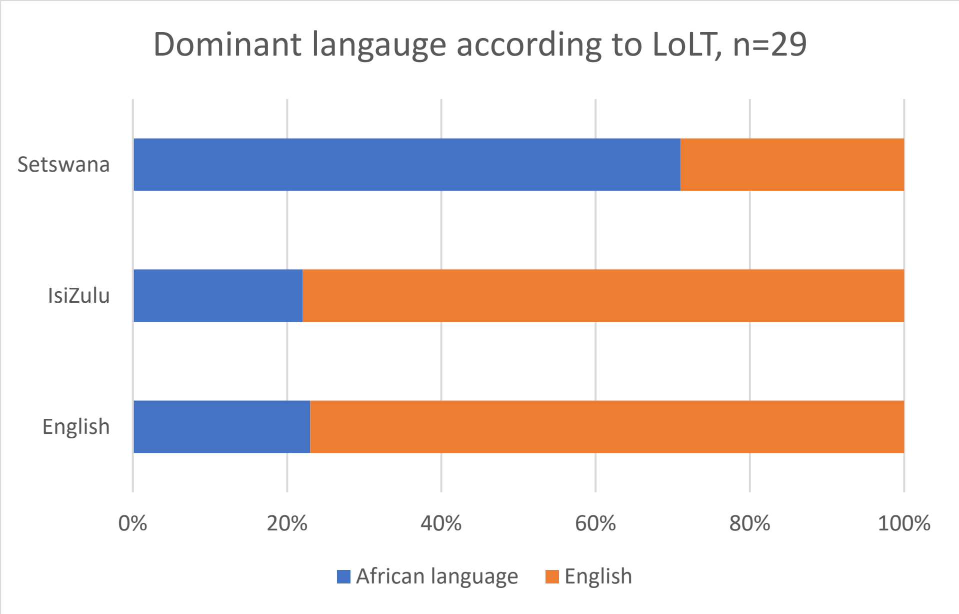


Figure 6.8: Dominant language used in teaching according to LoLT

The dominant language of a time segment is the actual language spoken (predominantly) during that time segment. Figure 6.7 shows that although indigenous languages were dominant for more of the time in Grade 3 lessons, English was the dominant language in both Grade 3 and Grade 4 lessons, even though according to policy only indigenous languages should be used in Grade 3 and only English should be used in Grade 4.[44] The detail according to LoLT in Figure 6.8 shows that indigenous languages and English both feature as the dominant spoken language during the observed lessons (to a lesser or greater extent) at all of the schools. This is further evidence that the LoLT policy is not being adhered to rigidly by teachers in mathematics lessons, since there is not one LoLT grouping of schools where only the LoLT dominates teaching. It can also be seen in Figure 6.8 that dominance of language was different in the Setswana LoLT lessons compared to that in the IsiZulu and English LoLT lessons. In the Setswana LoLT lessons, Setswana was the dominant language for 71% of the time and English dominated for the remaining 29% of the time. In contrast to this, English was the dominant language in the IsiZulu LoLT lessons for 78% of the time and in the English LoLT lessons for 77% of the time. This means that at IsiZulu and English LoLT schools, indigenous languages were used less, only 22% and 23% of the time respectively. Clearly, although according to policy the LoLT should determine the language spoken in a classroom, in both Grade 3 and Grade 4 classes, it does not.

[44] There were some schools in the sample which had elected to use English as the LoLT in Grade 3, which does impact on this finding.

In relation to the research question on variation in language use, this is evidence that teachers are drawing on their multiple language resources, which is in line with the literature on language use in multilingual contexts. The only group of schools where indigenous languages dominated teaching time during the observed lessons were the Setswana LoLT schools. The dominance of English at English LoLT schools is not counter to official policy expectations, but it must be remembered that the learners at these schools are not English home language speakers. The literature cautions that such learners might be challenged if their language proficiency in English is not adequate (Barwell, 2018; Robertson & Graven, 2018). At IsiZulu LoLT schools, English is being used predominantly to teach mathematics, a choice that contradicts policy and, again, might create challenges for learners whose language proficiency in English is not adequate. The finding for IsiZulu LoLT schools is noteworthy, showing that at these schools, teachers are flouting policy more so than teachers at other schools – in Grade 3 teachers are using more English and in Grade 4 teachers are using more indigenous languages than would be expected in order to comply with policy.

This evidence of language use choices being made by teachers aligns with the view that came through strongly in the teacher focus group discussions: teachers choose to use language in a way that they think is best suited to the teaching of mathematics, but it was evident that they also felt pressure to comply with policy. [45] Choices related to language use on the part of teachers extend beyond simply *which* language to use to *how* to use the language. They make significant choices with regard to language mixing and the use of mathematical/non-mathematical language. The categories and first subcategory in my analytical framework (Figure 4.2) were used to code for three more variables that give further insight into variation in language use by teachers in the sample (second research question). The first variable relates to language mixing i.e. **pure** or **mixed** language use during a lesson (Section 6.2.3); the second and third variables relate to teachers' use of **mathematical** and/or **non-mathematical language** during a lesson when teaching mathematics (Section 6.2.4).

[45] In the survey and the focus group discussions, teachers said that they choose to teach mathematics using English (or using code-switching) in order to help learners understand. This choice goes against the current CAPS language policy. Teachers also spoke about the pressure to comply with policy. Teachers' perceptions in relation to language are discussed further in Section 6.3 of this chapter.

Section 6.2.3 now follows, where the finding that teachers choose to use **mixed languag**e in spite of policy compelling them to use pure language is presented. Findings from the quantitative and qualitative analysis of the observed lessons inform this section.

6.2.3 Teachers make language use choices in spite of the school LoLT

Teachers' primary means of communication with learners is language and they make multiple choices daily about language use whether they are aware of it or not. These choices are made based on their language ideologies (discussed in Section 6.4), research and policy.[46] Language mixing (or not) is at the heart of this study about language use in multilingual contexts. In the quantitative analysis of the observed lessons, three codes captured teachers' language use in relation to pure or mixed language use according to the categories in my analytical framework (Figure 4.2). The three codes – pure, code-switching and translanguaging, were refined to apply specifically to time segments for the quantitative analysis of the videos. **Pure** indicated that during a segment the teachers and learners spoke only one identifiable language. **Code-switching** and **translanguaging** indicated that during a segment the teachers and learners spoke more than one identifiable language in a particular way. Examples of code-switching and translanguaging from the observation data are now given to clarify the distinction made between them.

The first category for mixed language use, **code-switching** was identified when teachers made a switch from one language to another, often translating what they had said in one language into the other. The teachers' awareness of the switch was identified through the action of translation which was used to infer that the teacher was choosing to repeat what he/she had just said but using a different language. Examples of code-switching are:

- Make sure that your numbers end on 95. *Yenza sure ukuthi izinamba zakho zigcina ku 95. Angithi wenza lapho kune-line khona.* (Make sure that your numbers end on 95. *Make sure your numbers end where it is 95, do it where there is a line.*) (O3S5.2)
- Okay, now look at the second one; *lebelela e ya bobedi*. (Okay, now look at the second one; *look at the second one*.) (O3S20.1)
- So today we are going to look at the numeric patterns. These numeric patterns we are going to look at the numbers, how the numbers usually work. *Ukuthi izinamba lezi*

[46] Experience also comes into play, informed by research.

iyiphi indlela esentsenziswayo uma ukuthi izinamba lezi, ngabe ziya hlanganiswa noma ziyamultiplaywa. Kuyezwakala angithi? (O4S2) [In this example the teacher also uses two trans expressions – *izinamba* and *ziyamultiplaywa*.]

The second category for mixed language use, **translanguaging**, is evident when more fluid mixing happens without thinking on the part of the speaker, it would appear. This is the nature of translanguaging – it is fluid and the speaker does it by drawing on their full language resources to express ideas (García & Wei, 2014; Makalela, 2019). Even though it involves an alternation between languages (as in code-switching) what differentiates it from code-switching is that there is a fluid move between languages at the "whim" of the speaker to say something in one coherent sentence in which more than one language is used. Examples of translanguaging are:

- *O di lebelele hore wa di tseba nah; a ke tsona nah, akere?* (You should check whether you know them; if they are the right ones, OK?) (O3S20.1) [In this sentence the teacher uses a mix of Sepedi, Sesotho and Setswana.]
- *Wa di bona? Wa di bona di a bonala di*-jumps? If I want you to show the number line and also the jumps *mo bukeng ya gago, o tshwanetse hore o di bontshe akere*? (Can you see them? You see the jumps are visible? If I want you to show the number line and also the jumps in your book, you have to indicate them, OK?) [In this sentence the teacher uses a mix of Sepedi, English and Setswana.]

In some utterances, teachers used both code-switching and translanguaging as shown in the following example. The colours in the text and translation show the fluid moving between languages present in this teacher's utterance from a Grade 3 lesson. Different languages are coloured differently.

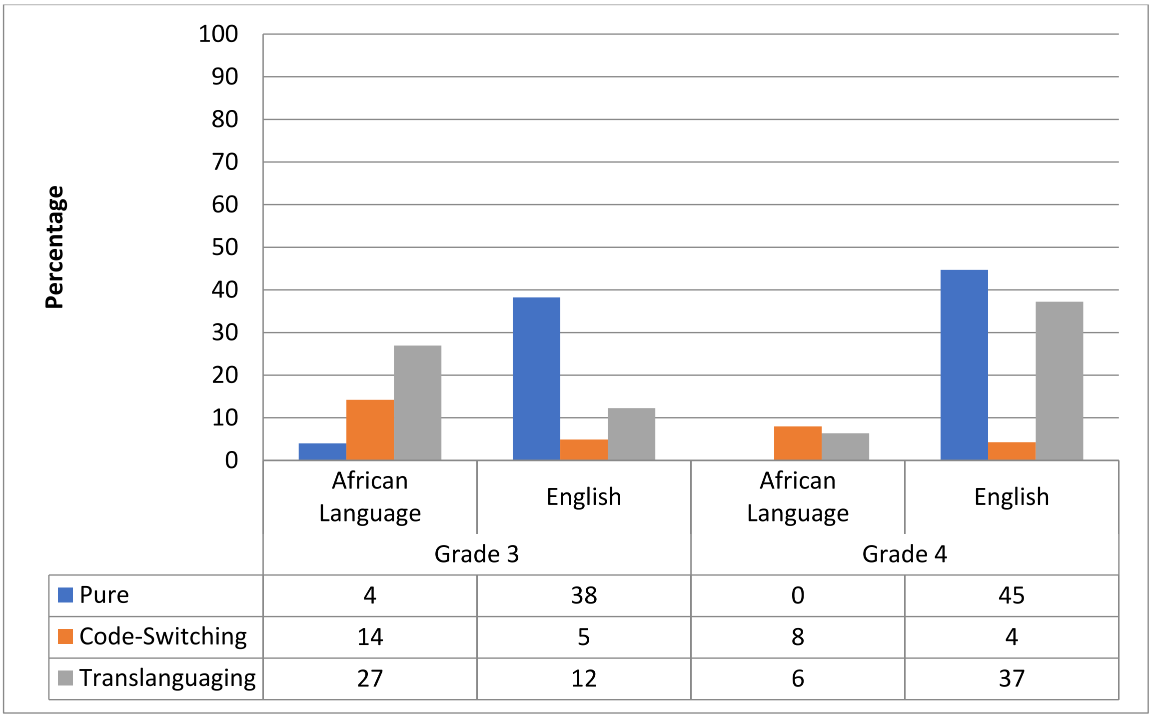
Example 1

O tlo kgona go e dira? NO? OK, e re ke go bontshe. (Draws straight line on chalkboard) Remember number line you can start with any number akere? O kgona go thoma ka number enngwe le enngwe akere? So re thoma ka number mang? Re thoma ka number one (pointing to the first set of numbers on the board) re tlo thoma ka number mang mo? (O3S20.1)

Translation:

> Will you be able to do it? NO? OK, let me show you. (Draws straight line on chalkboard) Remember number line you can start with any number OK? You are able start with any number OK? So what number are we starting with? We start with number one (pointing to the first set of numbers on the board) we will start with which number here?

The overview of the quantitative findings that is presented first gives the overall picture of variation in language use across the whole observation sample. The variation in teachers' pure/mixed language use according to the dominant language (indigenous language/English) in the observed lessons is shown in Figure 6.9.

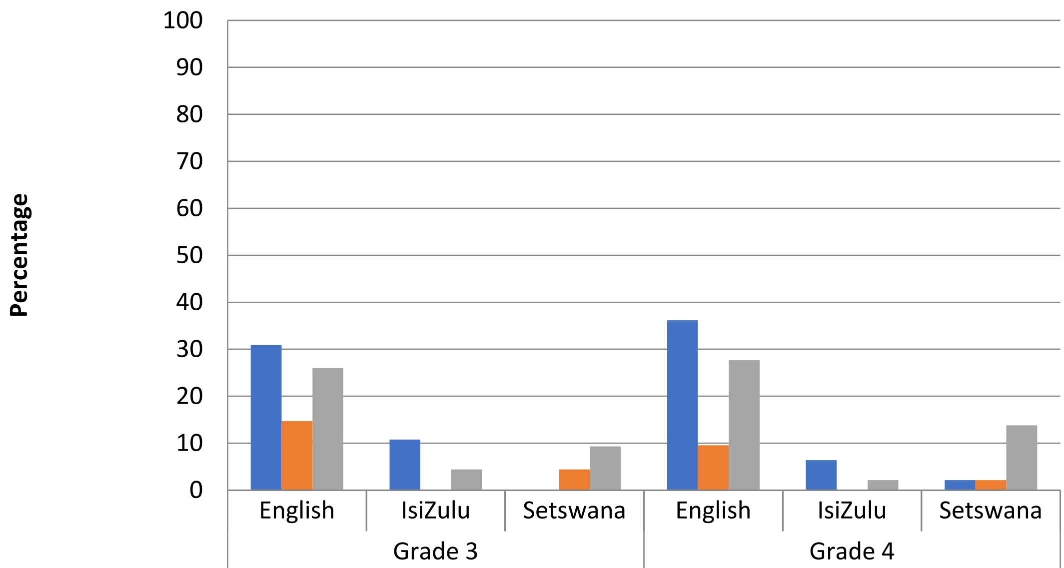


	Grade 3		Grade 4	
	African Language	English	African Language	English
Pure	4	38	0	45
Code-Switching	14	5	8	4
Translanguaging	27	12	6	37

Figure 6.9: Pure, code-switching or translanguaging language use by teachers according to dominant language

It can be seen from Figure 6.9 that in both Grade 3 and Grade 4 when English was dominant, pure language use was more common (38% in Grade 3 and 45% in Grade 4). It can also be seen that there is a difference between Grade 3 and Grade 4 in terms of mixed language use. Translanguaging was the most prevalent language use in Grade 3 classes when indigenous languages were dominant (27%). Translanguaging was highest in Grade 4 classes when English was the dominant language (37%). It can also be seen that translanguaging was more common than code-switching. The highest use of code-switching was in Grade 3 classes when indigenous languages were dominant (14%). Pure language was least common in Grade 3 and Grade 4 when indigenous languages were dominant (4% and 0% respectively). If one considers the totals (overall) there was a higher percentage of language mixing. Translanguaging and code-switching (mixed language use) were observed for 58% and 55% of the time cumulatively in Grades 3 and 4 respectively. Pure language was observed for 42% and 45% of the time cumulatively in Grades 3 and 4 respectively. This is interesting if one considers that in the written explanations, overall, pure language use was highest (Section 6.2.1, Figure 6.6).

The variation in teachers' pure/mixed language use according to LoLT is shown in Figure 6.10. This variation is presented (in addition to the variation according to dominant language shown in Figure 6.9) as the breakdown according to LoLT shows some interesting differences between the IsiZulu and Setswana LoLT schools that are not evident when the indigenous languages are grouped.



	Grade 3 English	Grade 3 IsiZulu	Grade 3 Setswana	Grade 4 English	Grade 4 IsiZulu	Grade 4 Setswana
Pure	31	11	0	36	6	2
Code-Switching	15	0	4	10	0	2
Translanguaging	26	4	9	28	2	14

Figure 6.10: Pure, code-switching or translanguaging language use by teachers according to LoLT

It can be seen from Figure 6.10 that pure language use dominates in LoLT English schools in the sample (Grade 3 – 31%, Grade 4 – 36%). This means that the high pure language use shown in Figure 6.9 was predominantly found in English LoLT schools, which is not surprising in terms of policy compliance. Although pure language use is most common in English LoLT schools in the sample, what is interesting is that translanguaging is used a lot in these schools as well (Grade 3 – 26%, Grade 4 – 28%), as is code-switching although to a lesser extent (Grade 3 – 15%, Grade 4 – 10%). In the indigenous language LoLT schools, the difference between language use in the IsiZulu and Setswana LoLT schools is noteworthy. In IsiZulu LoLT schools, both in Grade 3 and Grade 4, pure language use is most common, there is no code-switching and very little translanguaging while in Setswana LoLT schools translanguaging is most common, some code-switching was evident and very little pure language use. Finally, if one again considers the overall totals, the higher percentage of language mixing is also seen in Figure 6.10. In LoLT English schools, mixed language use was observed for 41% and 38% of the time in Grades 3 and 4 respectively while pure language was observed for 31% and 36% of the time in Grades 3 and 4 respectively. Overall, in the indigenous LoLT schools, mixed language use was observed for 17% and 18% of the time in Grades 3 and 4 respectively while pure language was observed for 11% and 8% of the time in Grades 3 and 4 respectively.

The variation in language use that emerged from the quantitative analysis of the videos was followed up with a more fine-grained qualitative analysis of language use, using the transcriptions of the observed lessons. The more fine-grained analysis of these episodes sheds further light on language mixing in the observed lessons, except that in the qualitative analysis, utterances rather than time segments were coded. In the context of great variation in language use, the qualitative analysis shows how the variation looks. Four episodes were selected for this purpose. Using the transcripts of the observed lessons it was possible to see the manner in which language was mixed (e.g. using single terms/phrases/etc.) and the number of languages used when translanguaging (e.g. up to three languages used in one utterance and up to five languages in one lesson).[47]

Since the qualitative analysis goes into more detail, it is presented in five subsections that now follow. First, in Section 6.2.3.1 an overview of language use in the transcripts is presented.

[47] The selected episodes do not show the full extent of the variation shown in the RMFPM observation report (Sapire, 2018b) due to space constraints in this study where analysis across three data sets is presented.

This is followed by a closer analysis of the four episodes selected from the dataset to exemplify teachers using translanguaging and code-switching while teaching mathematics in Grade 3 and Grade 4 lessons.

6.2.3.1 Language use analysis – code-switching and translanguaging

An analysis of the transcripts enabled a more accurate description of the amount and nature of language mixing present in the lessons. Teachers and learners both used mixed language[48] and when they interacted language use was also mixed, with teachers and learners using different languages during interactions (for example learners responding in English during a dominant indigenous language lesson). Before presenting the four carefully selected episodes in Sections 6.2.3.2 – 6.2.3.5, based on the overall quantitative analysis of the videos, I give an overview of the language use in the full observation sample set. As stated earlier in the theoretical framework chapter, language use lies on a continuum between multilingualism and monolingualism (Section 3.2.1). The range of language mixing in the sample lessons was from pure to highly mixed. Each of the observed lessons was coded according to four levels of language mixing: pure, mixed (little), mixed (some) and mixed (lot). The three categories of mixing enable the distinction between lessons according to the amount of language mixing. The code "mixed (little)" was assigned when single (often monosyllabic) words were used in interactions, in a different language to the dominant language of the lesson. The code "mixed (some)" was assigned when interactions involved exchanges in more than one language, but pure language use still predominated during the lesson and the code "mixed (lot)" was assigned when, throughout the lesson, interactions involved exchanges in more than one language. Table 6.1 presents the spread of these codes across the sample lessons according to school, LoLT, grade and dominant language(s). In the table, each school is coded according to the level of mixing during the observed lesson and this is indicated by an "x" in the relevant column. The lessons are ordered in the table according to school number and grade.

[48] Although, as mentioned previously, learners spoke very little.

Table 6.1: Use of language mixing in the sample schools

School	LoLT	Teacher	Language(s)	Pure	Mixed (little)	Mixed (some)	Mixed (lot)
S1	English (IsiZulu/Sesotho)	Gr 3	Sesotho/English			x	
S1	English (IsiZulu/Sesotho)	Gr 4	English		x		
S2	English (IsiZulu/Sesotho)	Gr 3	IsiZulu/English				x
S2	English (IsiZulu/Sesotho)	Gr 4	IsiZulu/English				x
S5	IsiZulu	Gr 3 T1	IsiZulu/English		x		
S5	IsiZulu	Gr 3 T2	IsiZulu/English		x		
S5	IsiZulu	Gr 4	IsiZulu/English		x		
S6	Setswana	Gr 3 T1a	Setswana/English				x
S6	Setswana	Gr 3 T1b	Setswana/English				x
S7	English (IsiZulu)	Gr 3	English	x			
S7	English (IsiZulu)	Gr 4	English	x			
S8	Setswana	Gr 4 T1	Setswana/English		x		
S8	Setswana	Gr 4 T2	Setswana/English			x	
S10	IsiZulu	Gr 3	IsiZulu/English				x
S11	English (IsiZulu/Sesotho)	Gr 3 T1	Sesotho/English		x		
S11	English (IsiZulu/Sesotho)	Gr 3 T2	IsiZulu/English		x		
S11	English (IsiZulu/Sesotho)	Gr 4	English	x			
S12	English (IsiZulu)	Gr 4	English	x			
S17	English (Setswana)	Gr 3 T1	English	x			
S17	English (Setswana)	Gr 3 T2	English	x			
S17	English (Setswana)	Gr 3 T3	English	x			
S17	English (Setswana)	Gr 4	English		x		
S18	English (Setswana/Sesotho)	Gr 3	English	x			
S18	English (Setswana/Sesotho)	Gr 4	Sesotho/English		x		
S19	English (IsiZulu/Sesotho)	Gr 3	IsiZulu/English		x		
S19	English (IsiZulu/Sesotho)	Gr 4 T1	IsiZulu/English			x	
S19	English (IsiZulu/Sesotho)	Gr 4 T2	IsiZulu/English			x	
S20	English (IsiZulu/Setswana)	Gr 3 T1	Setswana/English				x
S20	English (IsiZulu/Setswana)	Gr 3 T2	Setswana/English				x
Total number of schools for each level of mixing				**8**	**10**	**4**	**7**

It can be seen from Table 6.1 that there were no pure indigenous language lessons in the sample while in approximately a third of the sample (eight lessons) teachers used pure English.

Teachers in another third of the sample (10 lessons) used very little mixing, just a few simple words that were interjected into essentially dominant (pure) language lessons. Thus, in almost two thirds of the observed lessons (18 lessons) teachers did not mix languages much. Compared to this, in just over one third of the sample (11 lessons – 4 lessons "some", 7 lessons "lot") teachers used mixed language. The findings presented in Table 6.1 confirm the findings of the quantitative time segment coding – pure language was used most in the English LoLT schools and less so in IsiZulu LoLT and Setswana LoLT schools (Figures 6.9 and 6.10).

The next table, Table 6.2, gives a more descriptive summary of the language use and languages used in the observed lessons, expanding on the assigned levels of language mixing given in Table 6.1. The table elaborates on the coding applied in Table 6.1 and the order of the schools is the same as in Table 6.1.

Table 6.2: Extent of language mixing in the sample schools

School	LoLT	Teacher	Language(s)	Notes
S1	English (IsiZulu/Sesotho)	Gr 3	Mixed - some	Lesson dominated by Sesotho, with little mixing of the English language. Lesson starts out as pure Sesotho, with number names also being said in Sesotho. The lesson continues in Sesotho with little English mixing, and number names uttered in English. Number operations are uttered in Sesotho for some parts and some in English (such as multiply, add, etc). The mixing is done as a form of translanguaging.
S1	English (IsiZulu/Sesotho)	Gr 4	Mixed - little	There is very little language mixing. For the most part language is pure, however, there are some words used such as wena and kana together with English, which do not contribute much to language use (they just mean, you and or).
S2	English (IsiZulu/Sesotho)	Gr 3	Mixed - lot	Language use is IsiZulu with the number names in English. Mathematical operations are in IsiZulu, e.g. susa (subtract), u bala (count), etc. There is a lot of translanguaging and no evidence of code-switching. Borrowed words such as jumpa, understande, practiza , eda, etc., are among some of the words used when translanguaging.
S2	English (IsiZulu/Sesotho)	Gr 4	Mixed - lot	The lesson starts out with the teacher code-switching when introducing the concept of number patterns. As the teacher code-switches there is also some translanguaging that presents itself in the switching (this is visible from minute 1 to minute 3). Language mixing is presented when the teacher wants to gauge if the learners understand or are still following the lesson (e.g. "Angithi kuyezwakala?" meaning "you can understand me, right?". All number names are said in English even in the cases of code-switching or translanguaging; however some of the mathematical operations are said in IsiZulu and some in English.
S5	IsiZulu	Gr 3 T1	Mixed – little	There is very little mixing of languages in this lesson. There is only one case of language mixing throughout the whole lesson ("Ayibhali iball pen?" meaning "your pen doesn't write?). This is an indication of translanguaging, with the teacher using an English word while speaking IsiZulu.

School	LoLT	Teacher	Language(s)	Notes
S5	IsiZulu	Gr 3 T2	Mixed – little	IsiZulu has been used in the case of reprimanding and when giving instructions (e.g. "...ngicele umunikeze" meaning "...please give him"). All number names have been uttered in IsiZulu, even in cases of translanguaging. Translanguaging has been used when giving instructions to learners (e.g. "Sebenzisa ichart lakho ubone ukuthi iyiphi inamba elandelayo") meaning "use your chart to find the next number".
S5	IsiZulu	Gr 4	Mixed – little	There is very little language mixing in this lesson. When trying to get learners to answer her questions, the teacher switches from English to IsiZulu (e.g. in minute 12 "yini into oyibonayo?" meaning "what is it that you see?"). This switch of languages is usually done when the learners are not responding. There is no evidence of code-switching in this lesson.
S6	Setswana	Gr 3 T1	Mixed - lot	There is evidence of translanguaging and code-switching all throughout the lesson. In some instances the learners are instructed to give their answers in Setswana then in English (and vice versa). Number names, math operations and colours are uttered in both Setswana and English. For reprimanding, the teacher generally uses Setswana, and also when giving out instructions.
S6	Setswana	Gr 3 T2	Mixed - lot	Translanguaging and code-switching is found throughout the lesson. Even in cases where the teacher seems to be code-switching, there is some evidence of translanguaging (for example, "what shape is this? Shape e ke e feng?"). Learners respond in English and in Setswana, sometimes as per Teacher's instructions and sometimes at their own choice. Lesson started out with a lot of language mix, and towards the end, there is little language mix, teacher uses mostly English.
S7	English (IsiZulu)	Gr 3	Pure	There is pure English language use.
S7	English (IsiZulu)	Gr 4	Pure	There is pure English language use.
S8	Setswana	Gr 4 T1	Mixed – little	When the teacher introduces the topic, there is code-switching involved (paterone to patterns). As the lesson goes on these two words are used interchangeably. Interrogative statements (such as akere and neh) are used throughout the lesson. The teacher also uses words such as mosemane (meaning young man) and ngwanyana (meaning young lady) when addressing the learners. The Teacher uses Setswana words mostly to reprimand the learners.
S8	Setswana	Gr 4 T2	Mixed - some	The teacher starts off the lesson in English, with the only mix being interrogative statements. The lesson then moves on to a little use of Setswana and then to the lesson being dominated by Setswana. Mathematical operations have been uttered in English e.g. (add, subtract, times) and as translanguaging (e.g. timesa, divida). Setswana has been used mostly to reprimand, to check if the learners understand, and also to explain some concepts to a learner or a group of learners. All number names have been uttered in English.
S10	IsiZulu	Gr 3	Mixed - lot	The lessons mostly dominated by IsiZulu. Number names have been uttered in English and IsiZulu. Number operations are uttered in IsiZulu. There is some evidence of translanguaging throughout the lesson, but it is very minimal.
S11	English (IsiZulu/Sesotho)	Gr 3 T1	Mixed - little	There is very little language mixing in this lesson. The dominant language is English, with very few Sesotho words used. The Sesotho words uses were in cases of exclamation (e.e aa, akere, neh and wena) and to reprimand the learners. There is only one case of translanguaging in the lesson; Sesotho mixed with an English number name (Akere le a tseba gore mona five ya kena and it leaves nothing).
S11	English (IsiZulu/Sesotho)	Gr 3 T2	Mixed - little	There is very little language mixing in this lesson. There is only one case of language mix, translanguaging (yini eza nga bo four).

School	LoLT	Teacher	Language(s)	Notes
S11	English (IsiZulu/Sesotho)	Gr 4	Pure	Language use is generally pure, with a few interrogative statements that present themselves as a mix of languages (e.g. neh, ae, angithi).
S12	English (IsiZulu)	Gr 4	Pure	Language use is generally pure, with a few interrogative statements that present themselves as a mix of languages (e.g. akere, neh).
S17	English (Setswana)	Gr 3 T1	Pure	Language use is generally pure, with a few interrogative statements that present themselves as a mix of languages (e.g. neh).
S17	English (Setswana)	Gr 3 T2	Pure	Language use is generally pure, with a few interrogative statements hat present themselves as a mix of languages (e.g. akere, neh).
S17	English (Setswana)	Gr 3 T3	Pure	Language use is generally pure, with a few interrogative statements that present themselves as a mix of languages (e.g. neh).
S17	English (Setswana)	Gr 4	Mixed - little	There is very little language mixing in this lesson. There are a few words used as for of interrogative statements (e.g. akere, ao) and words such as meneer (Afrikaans). There is only one case of code-switching throughout the whole lesson ("E ngwale mo tlase" meaning "Write down on the bottom." (minute 11)).
S18	English (Setswana/Sesotho)	Gr 3	Pure	There is pure English language use.
S18	English (Setswana/Sesotho)	Gr 4	Mixed - little	There is very little language mixing in this lesson. The mix has been used for the purposes of giving instructions or getting learners to respond (e.g. "ke mang omongwe" meaning, "who else". All math numbers are given in English, even in translanguaging instances.
S19	English (IsiZulu/Sesotho)	Gr 3	Mixed - little	There is very little mix of language in this lesson. IsiZulu has been used for cases of exclamations/emphasis e.g. "Akere". Otherwise the language use is pure.
S19	English (IsiZulu/Sesotho)	Gr 4 T1	Mixed - some	The lesson is carried out in with all mathematical terms/words uttered in English. IsiZulu is used in instances of reprimanding (e.g. at minute 9 "hhayi, angiwuthandi lowo msindo", meaning "No, I do not like "that" noise". Language mixing is also presented as translanguaging (minute 9 "yabona laphaya ku seventy-five" meaning "Do you see there at 75 (page)" . This lesson presents no case of code-switching; there is only some pure language use and translanguaging.
S19	English (IsiZulu/Sesotho)	Gr 4 T2	Mixed - some	The teacher uses IsiZulu to check if the learners understand. The teacher also uses interrogative statements (such as "angisho", "akere", "siyezwana", "neh") to check understanding from the learners. All number names and mathematical operations have been said in English.
S20	English (IsiZulu/Setswana)	Gr 3 T1	Mixed - lot	The lesson starts out with teacher code-switching when introducing the concept. There is evidence of translanguaging all throughout the lesson, even when the teacher seems to be code-switching. All number names have been uttered in English. Throughout the lesson, learners communicate in both English and Setswana. The teacher does the language switch when reprimanding and to check if the learners understand. As the lesson gets to the end, the teacher uses Setswana with some element of translanguaging.
S20	English (IsiZulu/Setswana)	Gr 3 T2	Mixed - lot	There is evidence of translanguaging and code-switching all throughout the lesson. The teacher is more controlled at the beginning of the lesson and uses less language mixing but as the lesson progresses, she starts to use more translanguaging and some code-switching. She uses Sepedi and Setswana when she mixes, and she mixes both maths and general terms.

It can be seen in Table 6.2 that teachers mix languages differently which is evidence of language mixing on the monolingual-multilingual continuum. Mixing languages involved single words and/or mathematical terms (closer to monolingual language use), phrases or whole sentences (closer to multilingual language use). The use of language mixing can be examined further by asking when, why and how teachers use it. In my study, I noted many examples of different kinds of language mixing. As noted in Section 4.9, a limitation of my study was that I was not able to take the analysis of these examples to the level of detail to which I would have liked. [49] I did follow up on the ways in which language mixing occurred to a small extent, as will be seen in Sections 6.2.3.2-6.2.3.5. The list given below in Section 6.2.3.1.1 provides a summary of the types of language mixing identified in the observed lessons.

6.2.3.1.1 Use of mixed language in observed lessons

1. When do teachers mix languages?
    a. When they want to give an instruction
    b. When learners don't understand a concept
    c. When they want to illustrate a concept
    d. When they say certain mathematical terminology
    e. When they want to explain an idea using concrete materials
    f. When they want to introduce a topic
    g. When they wrap up a topic
    h. When they want to reprimand a learner (non-mathematical)
    i. When they want to praise a learner (non- mathematical)
    j. As a natural manner of speech, for certain words (non-mathematical)

2. Why do teachers mix languages?
    a. To clarify ideas by giving explanations
    b. To ask probing questions
    c. To help learners use and get to know terminology (formal/informal)
    d. To help learners understand using their home language

[49] This is an aspect of further research I would like to carry out should this be possible.

3. How do teachers mix languages?
    a. Code-switching (choice)
    b. Translanguaging (fluid)

The list above is numbered to enable cross-referencing in the presentation of the episodes in Sections 6.2.3.2-6.2.3.5. While some variations in language use are referenced, not all of them are, since as discussed in the limitations to the study (Section 4.9), this analysis was not exhaustive.

The focus of the next four subsections is on four episodes in which there was richer language mixing, selected from the observed Grade 3 and Grade 4 lessons. All four of the episodes are examples of the code "mixed (lot)" used above in Tables 6.2 and 6.3 since the episodes were selected to give insight into mixed language use. In all of the observed lessons, fluid translanguaging was more common than code-switching, although there were some examples of code-switching found in the data. The episodes are now presented and discussed to show the ways in which teachers used mixed language when they were teaching mathematics, showing evidence of the subcategories in my analytical framework (Figure 4.2).

The first episode which is presented in Section 6.2.3.2 is from a Grade 3 lesson in a LoLT Setswana class.

6.2.3.2 Example 1 – Grade 3 lesson – LoLT Setswana class

In this episode, from a Grade 3 lesson on number patterns, the teacher is explaining the breakdown of the number 135 into hundreds, tens and units.[50] The language use in this episode is an example of a teacher interacting with learners to help them realise how numbers are spoken about in terms of hundreds, tens and ones (number concept) (Section 6.2.3.1.1, items 1c and d) and to become familiar with the mathematical terminology (number names) in their home language and English (Section 6.2.3.1.1, items 2c and d). The LoLT at the school is officially Setswana although at this school there was a very mixed population of learners in terms of language. In Grade 3, according to policy, mathematics is meant to be taught in the

[50] Place value (hundreds, tens and ones), is part of CAPS Topic 1, *Numbers, operations and relationships*. It is being applied by the teacher here as part of a lesson on CAPS Topic 2, *Patterns, Functions and Algebra*: Section 2.2 – Numeric patterns.

chosen LoLT of the school, but this teacher translanguages as can be seen in the episode in Table 6.3. In the table, learner utterances are coloured green to distinguish them, teacher utterances in the dominant language (Setswana) are in black with the colour red used where language mixing occurs. The colour purple is used for trans words both in the original and in the English translation (to maintain the link to the original version).

Table 6.3: Excerpt from O3S10

Speaker	Utterance	Translation
Teacher	Mo shapeleng matsogo... Ena (writes 135 on the board) ke mang? Ka English?	Clap hands for her. Ena (writes 135 on the board) Who is it? In English?
Chorus	One hundred and thirty-five...	One hundred and thirty-five...
Teacher	...one hundred and thirty-five, akere...Ka Setswana, are yeng ka Setswana...	... one hundred and thirty-five Right? In Setswana, Let's go in Setswana...
Chorus	Lekgolo le tharo tlhano...	One hundred and thirty-five...
Teacher	Kana wa re lekgolo, le tharo, le tlhano...tharo o o wela ka mo metsweng or ko masomeng?	So you say one hundred, and three, and five; this three, does it fall under units or tens?
Chorus	Mo masomeng	In Tens?
Teacher	Ke masome ka mo?	Is it tens here?
Chorus	No mam	No mam
Teacher	Ke di units, ke di ten, ke di one hundred akere? Wa re lekgolo le tharo le tlhano akere? Jaanong go raya gore o tlogetse tharo ko kae? Go raya gore o mo tlogetse ko kae? Ka fa ke eng ka fa?	They are units, its tens, it's hundreds, do you mean one hundred, and three, and five? Right? Now where did you leave the three? It means you left three and five?
Chorus	Metso	Units
Teacher	Jaanong a ke lekgolo tharo tlhano? A re bueng palo e ka Setswana, e bueng ka Setswana, lekgolo, tharo, tlhano, ka English go nale hundred, three, five?	Now is it one hundred and thirty-five? Let's say the number in Setswana, let's say it in Setswana, One hundred and three five. In English, there is hundred, three, five
Teacher	Re e bitsa yotlhe, ga e batle gore le e kgaole, don't break it.	We are calling all of it. We do not need to break it down, don't break it.
Learner	Lekgolo le masome....	One hundred and ten
Teacher	You have never said hundred, three five, o rile one hundred and thirty-five... E bue ka Setswana...	You have never said hundred, three five, you said one hundred and thirty-five... Say it in Setswana...
Learner	Lekgolo some tharo	One hundred and thirteen
Teacher	Sometharo ke e (writes 13 on the board), a ke lekgolo? Ka na wa re ke lekgolo akere?	Here is thirteen, (writes 13 on the board) is it a hundred? You guys are saying it's hundred, right?
Chorus	Yes mam	Yes Mam
Teacher	Jaanong ware, lekgolo, sometharo, tlhano. ... Ke gore ga le tlhaloganye gore sometharo e felela ko kae, o bua ka lekgolo, o bua ka sometharo, o bua ka tlhano...palo e le e di a tshwana? Ka English ra re ke mang?	Now you are saying one hundred, thirteen and five ... It seems you don't understand where thirteen ends; you speak about one hundred, you speak about thirty, you speak about five ... is this number the same as this number (pointing). In English, what would you call it??
Chorus	One hundred and thirty-five...	One hundred and thirty five
Teacher	Ka Setswana ke ... Kgolo some a mararo tlhano...eng? Lotlhe ...	In Setswana it's ... one hundred and thirty-five, what? All of you ...
Chorus	Kgolo some a mararo tlhano	One hundred and thirty-five.

In Table 6.3 there is evidence of translanguaging and code-switching (Section 6.2.3.1.1, items 3 a and b) which is now discussed. The teacher alternates between Setswana and English fluidly when saying the number names (translanguaging). She also explicitly asks learners to say the number names of the numbers in the sequences that they are counting at times in English and at times in Setswana (code-switching). In some instances the learners are instructed to give their answers in Setswana and then in English and they respond accordingly. This is evidence of a translanguaging pedagogy (Vaish, 2019). The teacher mostly translanguages, moving fluidly between Setswana and English. There is an example of code-switching: "gore le e kgaole, *don't break it*" (*do not need to break it down*, don't break it). This code-switching example is coloured using blue above, for easy identification and to distinguish it from the other colour coding. The explanation is a little confusing near the end when the teacher tries to clarify the difference between 130 and 13 but ultimately the learners are all able to read the number 135 in both English and Setswana. Finally, in this episode there is evidence of the teacher translanguaging using formal (pure) and appropriate trans words when speaking about numbers (number names are formal mathematical terminology in Grade 3) (Figure 4.2, subcategories 4 and 5). The trans words in this episode are all used to express number names, made using a combination of a Setswana prefix and an English number name.

The next episode which is presented in Section 6.2.3.3 is from a Grade 3 lesson in a LoLT IsiZulu class.

6.2.3.3 Example 2 – Grade 3 lesson – LoLT IsiZulu class

This Grade 3 episode is from a number patterns lesson in which the teacher works with numeric sequences.[51] The language use in this episode is an example of a teacher using mixed language for certain mathematical terminology (number names) and also as a natural manner of speech for certain interjections (Section 6.2.3.1.1, items 1d and j). The LoLT at the school is officially English although in this school the learners are predominantly IsiZulu. This could explain why the teacher mixes language as she does here – to help learners to understand using their home language (Section 6.2.3.1.1, item 2d) while still using some English. In this episode, given in Table 6.4, the teacher discusses the number sequence of 4s and how to generate this sequence by counting up in 4s.

[51] The pattern of 4s is part of CAPS Topic 2, *Patterns, Functions and Algebra*: Section 2.2 – Numeric patterns.

Table 6.4: Excerpt from O3S2

Speaker	Utterance	Translation
Teacher	Amaphethini ezinombolo esizowenza namhlanje amaphethini okubala ngobani?	Number patterns we will do today, which ones will we do?
Chorus	Four	Four
Teacher	Ngo four. [52] Lalelani ke … akuzukuphelela ekutheni sibala ngo four ngeba kade senza but okubalulekile ukuthi wazi ukuthi kune inamba ozoyinikezwa. Makuthiwa yeqa ka four then usuzokwazi ukubona inamba elandelayo. It's not that … iphethini lokubala ngo four, eight, twelve, sixteen kuphela … kuyezwakala yini?	Fours. Listen then … it's not going to end with you counting in fours the way we have been doing but what is important is to know is there is a number you will be given. When they say count in 4s then you will be able to see the next number. It's not that … simply a pattern of counting 4 8 12 16 only … Do you understand?
Chorus	Yes mam	Yes mam
Teacher	But ukuthi wazi ukuthi mawunikezwe lenamba bese kuthiwa jampa ka four bese ubona inamba enjani elandelayo. Kuyezwakala yini nah?	But so you should know that if you are given a number … then they say jump four times … then you can see which number come next. Are you getting it?
Chorus	Yes mam	Yes mam
Teacher	Alright ngicela sike sibheke lana ke bantwana bami? Nali I tshathi lethu. Siyabona lapho kulelo khona (pointing to learners in the corner)?	Alright … Can we please look here my children? Here is our chart. Can you see there in that corner (pointing to learners in the corner)?
Chorus	Yes mam	Yes mam
Teacher	Ake sibale nje la, siqale ngaleli phethini lezinamba ezila. Sibale la size sifike la ku fifty …	Let's just count here. Start with this number pattern. Count from here until we get to fifty.
Chorus	(Learners counting from 1-50 from the chart in front)	
Teacher	Good ake ngiqale ke ngibone ukuthi le maths le esiyenzile singakwazi yini ukuthi siyenze makuthiwa asiyenzeni. Ngifuna ukubona ukuthi niyayikhona yini na, niyayilandela lento esiyenzayo	Good. Let me start to see if this maths that we have done … but that we cannot do when we are told to do it … I want to see if you can do it. If you are following.
Teacher	Ake ngininikeze nangu u three. Siyawubona u three?	Let me give you … here is three. Can we see three?
Chorus	Yes mam	Yes mam
Teacher	U three wethu (writes it on the board). Then mawusuka ku three lyiphi inamba ezolandela?	Our three (writes it on the board). Then from three which number will follow?
Chorus	(Learners shout different numbers)	
Teacher	Wait wait wait neh. Nazi izinamba siyazibona neh.Ngifuna ukuthi mangabe ubuka eshathini, ukwazi futhi ukusebenzisa izandla zakho neh. Yikho ngithi asiqale ngalezi zinamba ezincane.khona sizothi masifika kwezinkulu uzoba usuyi understanda kancono lento.	Wait wait wait …Here we can all see the numbers right. I want you to look at the chart and be able to use your hands as well. That's why I say you must start with the small numbers first so that when we get to big numbers then you understand this better.
Teacher	Njengamanje ngikunikeze bani? U three angithi? Okay emva ka three ngifuna u jampe kangaki?	Right now, what number have I given you? Three, right? Okay, after three I want you to jump how many times?
Chorus	Kawu four	Four times
Teacher	Ngifuna u jampe kangaki?	I want you to jump how many times?
Chorus	Kawu four	Four times

[52] As before, learner utterances are coloured green to distinguish them, teacher utterances in the dominant language (IsiZulu) are in black with the colour red used where language mixing occurs. Where the teacher used the English number word with an IsiZulu prefix this is also coloured red. Trans words are coloured purple both in the original and in the English translation.

Speaker	Utterance	Translation
Teacher	Alright siyaqala ku three, siyamusho u three emoyeni singakabali la. Sithi three and then	Alright let's call out three before we start here . We say three and then …
Chorus	Four, five, six, seven	Four, five, six, seven
Teacher	Which means sithola bani?	Which means … what do we get?
Chorus	Seven	Seven
Teacher	Kusho ukuthi masisuka la ku three ,masijampa kayi 4 siza lana angithi. One, two, three, four (referring to the number chart on the board and writes 7 on the pattern). Okay masiphinde siqhubeka futhi ngephethini lika four, sothola bani?	Which means starting from from three and we jump four times we get here One, two, three, four (referring to the number chart on the board and writes 7 on the pattern). Okay. If we repeat and continue with the pattern of four, what will we get?

In the episode given in Table 6.4 there is evidence of a lot of translanguaging (no code-switching identified here) with IsiZulu as the dominant language (Section 6.2.3.1.1, item 3b). The learners say very little. Their responses are mostly in English (with some mixed responses). The teacher starts the lesson using very formal mathematical terminology in IsiZulu (Figure 4.2, subcategory 4, formal). She continues to use predominantly IsiZulu, but her speech is infused with some English (she translanguages) and she uses some trans terms (Figure 4.2, subcategory 4, informal). During the lesson the teacher speaks about the mathematical operations in IsiZulu, for example susa (subtract), u bala (count).[53] The teacher also uses many trans words such as inamba/lenamba, jumpa, understanda, etc. (number, jump, understand, etc).[54] She and the learners consistently say the number names in English or using mixing with English (ngo-4, ka-3). In this episode, there is evidence of the teacher (and the learners) translanguaging when expressing the number name words, using formal (pure) and trans words, similarly to the language use in the episode in Section 6.2.3.2. Finally, the teacher uses a few pure English words when she speaks as part of full sentences which are predominantly pure IsiZulu (okay, good, alright, which means, etc.). This is evidence of translanguaging using non-mathematical expressions (Figure 4.2, subcategory 1).

The next example which is presented in Section 6.2.3.4 is from a Grade 4 lesson in a LoLT Setswana class.

[53] Not visible in this short episode but found in other parts of the lesson.
[54] In other parts of the lesson she use other (different) trans words as well.

6.2.3.4 Example 3 – Grade 4 lesson – LoLT Setswana class

In this episode, from a Grade 4 number patterns lesson, the teacher explains the use of flow diagrams.[55] This is another example of a teacher using mixed language for certain mathematical terminology (operation names) (Section 6.2.3.1.1, item 1d) however, he might be translanguaging in this way because this is a Grade 4 lesson and the LoLT (according to policy) should be English. He translanguaged throughout the lesson. The LoLT at the school is officially Setswana although at this school there were also many Sepedi learners. In Grade 4, according to policy, mathematics should be taught in English, so this teacher is making a choice to use translanguaging to facilitate the discussion in spite of that (Section 6.2.3.1.1, item 2d). In this episode, given in Table 6.5, which is taken from near the end of the lesson, the teacher is recapping how the numbers are found using the input and output numbers given in the flow diagram.[56]

Table 6.5: Excerpt from O4S8.2

Speaker	Utterance	Translation
Teacher	A re etse dilo di be easier akere? Akere mo ge re ya pele, re etsang?	Let us make things easier, Okay? Right, here, when we go forward, what do we do?
Chorus	Re a timesa	We times
Teacher	Mo re ya morago	Here we go backwards
Chorus	Divide	Divide
Teacher	Divide, mo (points at another flow diagram on the board) re ya pele	Divide here, (points at another flow diagram on the board) we are going forward
Chorus	Times	Times
Teacher	Ke times, le divide akere?	It is times, and divide, right?
Chorus	Yes	Yes
Teacher	Then mo ga di tshwane akere? (Pointing at a double flow diagram)	Then, here, they are not the same, right?
Chorus	Yes	Yes
Teacher	Ge re ya pele re etsang?	When we go forward, what do we do?
Chorus	Ra divida	We divide
Teacher	Mo ge re ya pele?	Here, when we go forward?
Chorus	Timesa	Times
Teacher	Mo, ge re ya morago?	Here when we go backwards?
Chorus	Re a divida	We divide
Teacher	Mo, ge re ya morago?	Here, when we go backwards?
Chorus	Ra timesa	We times
Teacher	To make things easy for you akere?	To make things easy for you okay?
Chorus	Yes, Maam	Yes, Maam

55 Flow diagrams are part of CAPS Topic 2, *Patterns, Functions and Algebra*: Section 2.2 – Numeric patterns. They present pattern rules in a diagrammatic manner.
56 In the table, teacher utterances in the dominant language (Setswana) are in red and the colour black is used where language mixing occurs. Learner utterances are coloured green and purple, to show language mixing in their utterances. When teachers also use trans words, these are also coloured purple.

Speaker	Utterance	Translation
Teacher	Mara o ska baiza, ke di inverse, akere?	But do not make a mistake; these are inverses, okay?
Chorus	Yes	Yes
Teacher	Ke visa versa, akere?	It is vice versa, okay
Chorus	Yes	Yes
Teacher	Ge o sa multiply o etsang?	If you are not multiplying, what are you doing?
Learner	Wa divida	You are dividing
Teacher	Wa divida, akere? Ge o sa divide, o etsang?	You are dividing, right? If you are not dividing, what are you doing?
Chorus	Ra timesa	We times
Teacher	Wa timesa.Ge o sa plase o etsang?	You are multiplying. If you are not adding, what are you doing?
Chorus	Minasa	Minusing
Teacher	Ge o sa minase o etsang?	If you are not minusing, what are you doing?
Chorus	Wa plasa	You add
Teacher	Okay ngwala ka speed, ge	Okay, Write quickly then.
	(Learners continue with class activity, as the teacher walks around checking their work)	

The teacher translanguages fluidly (Section 6.2.3.1.1, item 3b) in the episode shown in Table 6.5 between Setswana and English (no code-switching identified here). The language use is predominantly mixed with slightly more Setswana than English. The learners followed and participated in the discussion also alternating in their use of language like their teacher. In this episode, there is evidence of the teacher and the learners translanguaging when speaking about the operations. They speak about the operations using formal English words (e.g. *divide* and *multiply*) but they also use informal words (e.g. *times*) (Figure 4.2, subcategory 4 formal/informal). They also both use trans words to speak about the operations (e.g. *divida, timsa, minusa, plasa – divide, times, minus, plus*) (Figure 4.2, subcategory 5, appropriate). The teacher refers to the inverse (formal mathematical terminology) nature of the operations multiplication and division in one interaction (Figure 4.2, subcategory 4, formal) – there were not many instances when this occurred during the observed lessons. The use of English and trans words alternates as the lesson progresses, with the learners following the teachers' lead on this.

The next episode which is presented in Section 6.2.3.5 is from a Grade 4 lesson in a LoLT IsiZulu class.

6.2.3.5 Example 4 – Grade 4 lesson – LoLT IsiZulu class

In this episode, from a Grade 4 lesson, the teacher is teaching the class how to complete number sentences[57] the teacher uses a lot of translanguaging and there is also one example of code-switching. This episode illustrates a teacher using mixed language (translanguaging) to illustrate a concept and to say the number names (Section 6.2.3.1.1, items 1c and d). The teacher also does this to ask probing questions[58] (Section 6.2.3.1.1, 2b) and to help learners understand the patterning concept using their home language (Section 6.2.3.1.1, item 2d). The teacher moves fluidly between IsiZulu and English in this episode, given below in Table 6.6, even though according to policy he should be using LoLT English (since this is another Grade 4 episode). [59]

Table 6.6: Excerpt from O4S2

Speaker	Utterance	Translation
Teacher	If you add here, if you put a plus here. In order to get eight, what will be the number? *Nathi*?	If you add here, if you put a plus here. In order to get eight, what will be the number? *Nathi*?
Chorus	Six	Six
Teacher	Yes, six. *Kwezi*? Here we get six. So here on this sum we said, u four; mawumuphindaphinda ngo two uthola u eight angithi?	Yes, six. *Kwezi*? Here we get six. So here on this sum we said, u four; if you multiply 4 two you get eight, isn't it?
Teacher	Bese kuthiwa la u two mawumuhlanganisa nobani, no six uthola u eight. That proves ukuthi ama numbers singawasebenzisa manje bese asinikeze one and the same answer. So if they say maybe three plus space la equals to twelve. Bese kuzothiwa three times kuzobekwa I space la equals to twelve. (Writes them both on the board, space is an empty box).	Then here if you add two and how much, and six, you get eight. That proves that you can use numbers to give you one and the same answer. So if they say maybe three plus space here equals twelve. Then they say three times space here will equal twelve. (Writes them both on the board, space is an empty box)
Teacher	So here, you must also know, kufanele wazi ukuthi, which rule that you must use. Which number is needed here in order to get the same answer? Which number do we have la?	So here, you must also know, you must know, which rule that you must use. Which number is needed here in order to get the same answer? Which number do we have here?
Chorus	(Learners shouting different numbers to him)	
Teacher	Ngibuza ukuthi u three ngingamuhlanhanisa nobani ukuze ukhiphe u twelve?	I am asking which number can I add to three to get twelve?
Learner	Nine (One learner shouts the number 9)	Nine
Teacher	U nine angithi?	Nine, right?
Chorus	Yes sir.	Yes sir.

[57] Number sentences are part of CAPS Topic 2, *Patterns, Functions and Algebra*: Section 2.2 – Numeric patterns. Completing number sentences is part of early algebraic thinking.
[58] For example, "I am asking which number can I add to three to get 12?" (translation).
[59] In the table, teacher utterances in the dominant language (English) are in black with the colour red used where language mixing occurs. Learner utterances are green to distinguish them. When teachers also use trans words, these are coloured purple.

Speaker	Utterance	Translation
Teacher	Okusho ukuthi lana sizothi ubani, u nine. (He fills in the empty box with 9) Then lana sizothi, u three sizomuphindaphinda nobani ukuze sithole u twelve?	Which means that here we will say what, nine. (He fills in the empty box with 9) Then here we will say, we will multiply three by what to get twelve?
	(Three learners get it wrong)	
Teacher	Yah, Thanda?	Yah, Thanda?
Learner	Four	Four
Teacher	Yes, three times four equals to twelve. (He fills in the empty box with 4.)	Yes, three times four equals to twelve. (He fills in the empty box with 4.)
Teacher	So lokhu kusitshela ukuthini? Kusitshela ukuthi all the numbers that we have, izinamba zonke esinazo. Singazihlanganisa, sizophindaphinde kodwa zisinike I answer eyodwa efanayo. Kuyezwakala angithi?	So what does this tell us? It tells us that all the numbers that we have, we can add them or multiply them, and they give us the same answer. Do you understand?
Chorus	Yes sir.	Yes sir.
Teacher	Okay, so ke manje ake sibuke ukuthi what is happening if we multiply these numbers. Let's say if we multiply these numbers what is happening? Let's say u three times 3. U three mawuphindaphinda ngo 3 sithola bani?	Okay, so now let's look at what is happening if we multiply these numbers. Let's say if we multiply these numbers what is happening? Let's say u three times three. Three multiply by three what do we get?
Chorus	Nine	Nine

In the episode in Table 6.6, the teacher, in a class with predominantly IsiZulu learners, has chosen to translanguage, but there is one example of code-switching (Section 6.2.3.1.1, items 3b and 3a). In this episode, the learners' responses are only single word utterances of number names (four, nine, six) or affirmatives (Yes Sir). The utterance "you must also know *kufanele wazi ukuthi*", (you must also know, *you must know*) is an example of code-switching, the teacher is using repetition (in translation) to reinforce what he is saying.[60] In this episode, there is more evidence of the teacher translanguaging when expressing the number name words, using formal (pure) and appropriate trans words (Figure 4.2, subcategories 4 and 5), similarly to the language use in the episode in Section 6.2.3.2 and 6.2.3.3 (in contrast, here the learners only use formal English number names).

Set against the backdrop of the quantitative findings from the observed lessons presented in Section 6.2.3.1, the qualitative analysis of the language use in the four episodes selected from the observed lessons in Sections 6.2.3.2 to 6.2.3.5 shows that although pure language was used to a large extent, language mixing was varied and complex across the sample. Language mixing was used more often than pure language in some lessons. This stands in contrast to the overall finding across the full sample set of observations that in almost two thirds of the observed lessons (18 out of 29 lessons), teachers used almost entirely pure language (Section 6.2.3.1).

[60] This is also coloured in blue (as in the code-switching example in 6.2.3.2) for easy identification and to distinguish it from the other colour coding.

The selected episodes also give examples of teachers using language mixing in different ways and for different purposes.

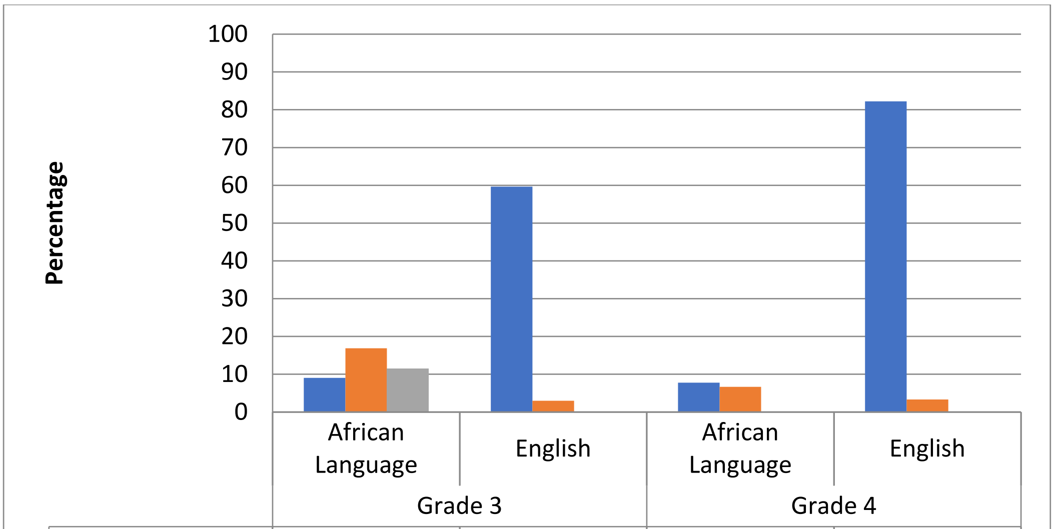
In the teaching of mathematics in the multilingual context, language use for mathematical/non-mathematical words is of particular interest, as captured in the first subcategory of my analytical framework (Figure 4.2). The descriptive findings from the quantitative analysis of the variables related to teachers' use of mathematical and/or non-mathematical language during a mathematics lesson are presented next in Section 6.2.4.

6.2.4 Mathematical language and non-mathematical language

In this section, the descriptive findings from the quantitative analysis of the observed lessons are presented to give an overview of mathematical and non-mathematical language according to the dominant spoken language in the lesson. This is the first step[61] taken in the description of mathematical/non-mathematical language use (Subcategory 1, Figure 4.2) in the observed lessons.

The quantitative analysis of the observed lessons coded for the use of mathematical language (terms such as *numbers, shapes, pattern*, etc. and phrases such as *counting in 3s, count on, count backwards* etc.) used by speakers during time segments (*Appendix 7.2*, code O). Mathematical language is used in different ways and for different purposes (Section 6.2.3.1.1) but in this section the focus is on which language is used when "speaking mathematically". Mapping this code according to dominant language gives nuanced insight into variation in language use since it shows language mixing specifically of mathematical language in the observed lessons. Figure 6.11 shows the variation in languages used to express mathematical terms/phrases in the sample according to dominant language.

[61] In Chapter 7, Section 7.4, I present a second analysis of mathematical language use based on a detailed word count of mathematical terms used in the observed lesson. In this chapter variation of language use is the focus.



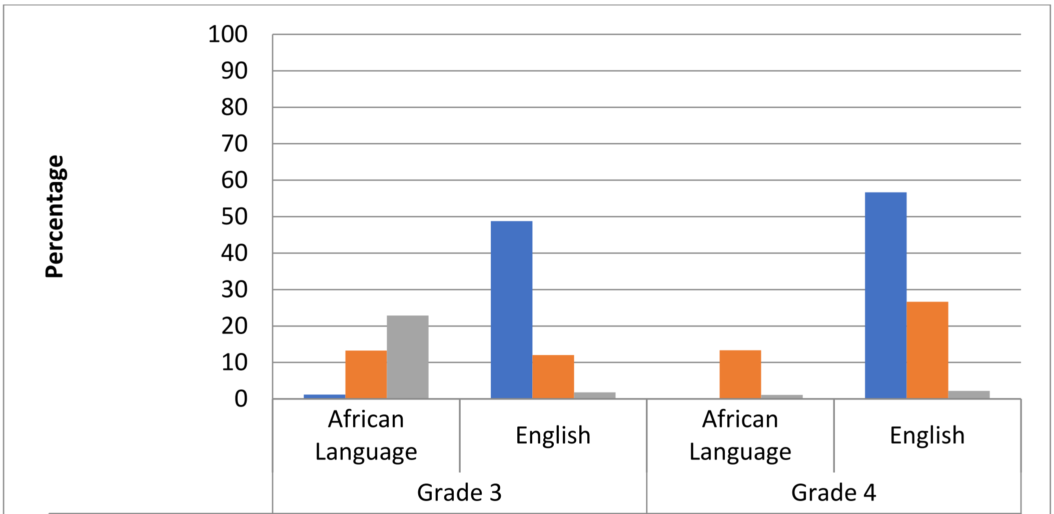
	Grade 3 African Language	Grade 3 English	Grade 4 African Language	Grade 4 English
English	9	60	8	82
Both	17	3	7	3
African Language	11	0	0	0

Figure 6.11: Mathematical language according to dominant language

From Figure 6.11 it can be seen that in lessons where English is the dominant language of the lesson, it is used far more than indigenous languages to express mathematical terms. This is the case in both Grades 3 and 4 (60% and 82% respectively). In Grade 3 lessons where indigenous languages are the dominant languages spoken during teaching, there is more of a balance between the use of English only, a mix of English and indigenous languages, and indigenous language only to express mathematical terms (9%, 17% and 11% respectively). In Grade 4 lessons where indigenous languages are the dominant spoken languages during teaching, there is a balance between English only and a mix of English and indigenous languages to express mathematical terms (and no time segments when only indigenous languages were used to express mathematical terms). While the dominance of English in Grade 3 is not in accordance with CAPS home language policy, the dominance of English in Grade 4 is not surprising since in Grade 4 the LoLT is English and so teachers are either using English (in accordance with the LoLT) or using a mix with indigenous language to support the use of English. Overall, this finding shows that mathematical language use is predominantly in English.

The quantitative analysis also coded for the use of non-mathematical language (e.g. general instructions such as *good, take out your books, choose the blocks you like, alright, stop misbehaving, take out your pen, sit, start working*, etc.) used by speakers during time segments

(*Appendix 7.2*, code P).[62] Figure 6.12 shows the variation in languages used to express non-mathematical words/phrases in the sample according to dominant language.



	Grade 3 African Language	Grade 3 English	Grade 4 African Language	Grade 4 English
English	1	49	0	57
Both	13	12	13	27
African Language	23	2	1	2

Figure 6.12: Non-mathematical language according to dominant language

It can be seen from Figure 6.12 that English is less markedly the dominant language of expression for non-mathematical words (than it was for mathematical terms) in both Grade 3 and Grade 4 lessons. The percentages for use of English to express non-mathematical language in English dominant segments are 49% and 57% (Grade 3 and 4 respectively). This is lower compared to 60% and 82% (Grades 3 and 4 respectively, mathematical language use) as seen in Figure 6.11 above. In Grade 3 lessons where indigenous languages are the dominant languages spoken during teaching, very little English is used to express non-mathematical words. More often indigenous languages are used, but a mix of languages is also used. In Grade 4 lessons where (despite policy) indigenous languages are the dominant spoken languages during teaching, a mix of languages is used more often than pure indigenous languages to express non-mathematical words. A mix of languages is also used to express non-mathematical words, more so in Grade 4 than in Grade 3 lessons (12% in Grade 3 compared to 27% in Grade 4). Overall, this finding shows that non-mathematical language use is also predominantly in English, although less strongly so than for mathematical language use.

[62] Section 6.2.3.1.1 lists three identified examples of non-mathematical language use.

The analysis of the subcategory mathematical/non-mathematical language use in the observed lessons showed that for both variables, English language use predominated. This is not surprising in the light of the finding that English was the dominant language during the observed lessons (Section 6.2.2) but it is nuanced by the other findings presented in Section 6.2.

Section 6.2 has shown that there is variation in language use in the multilingual context. Although it was shown that pure language use was dominant (Sections 6.2.1 and 6.2.2) there was also variation. While pure language use is predominant for speaking and writing mathematics (more so in English than in the indigenous languages), mixed language is also used. It was also shown that there is variation in mixed language use. There was variation in the language used to give mathematical explanations given in the survey (Section 6.2.1) and in the language used in the observed lessons (Sections 6.2.2, 6.2.3 and 6.2.4). Although there was no observable pattern, there was variation in relation to the variables for the subcategories verbal/symbolic (Figure 6.6), formal/informal and appropriate/inappropriate (Tables 6.4-6.7). Some teachers used translanguaging more commonly for certain mathematical terms (Sections 6.2.3.2-6.2.3.5) and others used translanguaging for non-mathematical expressions (Section 6.2.3.3). Teachers also used mixed language for various reasons, such as to help learners use and become familiar with mathematical terminology, to understand ideas using their home language, to ask probing questions and clarify ideas. This was demonstrated in the analysis of the episodes, where some of the uses of mixed language according to the list (Section 6.2.3.1.1) were noted. As it was discussed, this variation is present in spite of policy which pushes for pure language use.[63] The findings presented in Section 6.2 thus show that teachers are making choices about language use when they teach mathematics.

Teachers' perceptions about language use confirm the choices they make in practice. These perceptions are the focus of the findings presented next in Section 6.3, where findings in relation to my third research question, based on survey and focus group discussion data, are presented and discussed.

[63] This is evidence that teachers' heteroglossic language ideologies (at times) motivate them to go against the prevailing monoglossic language ideology embodied in policy. The discussion of language ideologies and variation in language use is given in Section 6.4 of this chapter.

6.3 Perceptions about language use vary – some teachers comply with policy while others defy it

Two of the datasets (the survey and focus group discussions) were used to analyse the teachers' perceptions about language use in order to answer my third research question: *What are teachers' perceptions of the "best practice" in relation to language use in mathematics teaching?* The teaching of mathematics in South Africa receives a lot of publicity, much of it negative, since learning outcomes in mathematics are so poor (McCarthy & Oliphant, 2019). Teachers are at the centre of this discussion and many of them feel wrongly criticised for the poor outcomes. Language was seen as hugely problematic and many teachers blamed poor achievement in mathematics on language. At several schools, teachers pointed to the demographics of the school feeding areas which are highly diverse. Teachers contend that the diverse demographics have led to a learner population that speaks mixed languages. In this context they make a call to be allowed to teach in a common language (English) in conjunction with the home languages of the learners, that is, to be allowed to use mixed language. Some teachers showed an awareness of the idea that mathematics has a language of its own, knowledge of which is essential for the learning of mathematics. As one teacher put it, "Okay, if I can say, let the teachers teach them the language of mathematics, … there's a language for English, neh, but there's a language for mathematics, if we don't let the child to understand this language obvious, she or he cannot even try." (FG4S15)

When I spoke to the teachers about language use as an issue in mathematics education, there was a sense of relief that one of the root issues linked to poor learner achievement in mathematics was being touched on. Several teachers (24% according to the focus group discussion analysis) felt that mathematics is not the problem, language is.[64] A teacher in one of the focus group discussions explained it in this way:

> You find that these learners they understand maths; they know the maths, but they don't know the language that we are using to teach. Maybe I am using Sepedi for example as my home language, those learners will end up failing maths, you find that they don't fail maths, they are failing the language. Next week you find that I'm teaching in

[64] This teacher is referring to language itself, not the language of mathematics.

another language[65] and these learners pass maths. So you see that the only barrier there was language and not maths as a subject. (FG3S20)

Teacher perceptions about language use were evidenced in the survey and focus group discussion data. As explained in the discussion of my methodology (Section 4.4.2) the survey was carried out first and followed up in the focus group discussions. I first present a summary of the written responses.[66] The responses were coded using the categories in my analytical framework (Figure 4.2), and percentages were assigned according to the number of teachers expressing similar ideas. The summary of these findings is given in Table 6.7. Also shown in the table is the alignment with the list of observed mixed language use (Section 6.2.3.1.1).

Table 6.7: Grade 3 and Grade 4 teachers' language use preferences expressed in the survey with reasons (n=62)

Theme	Percentage
I use mostly English. *Reason:* It is the common learner language (experience), or it is the LoLT (policy).	85
I code-switch. *Reason:* To support learners' understanding (research and experience). Section 3.2.1.1 items 1a, 2d, 3a and 3b	52
English is better for the teaching of mathematics. *Reason:* Terminology advantage (experience). Section 3.2.1.1 item 1d	30
I use mostly IsiZulu/Setswana. *Reason:* It is the LoLT (policy).	26
IsiZulu/Setswana is better. *Reason:* It is the home language and better understood by learners (research and experience). Section 3.2.1.1 item 2d	24
English should be used. *Reason:* Because of the policy switch to English in Grade 4 (policy).	17
Teaching mathematics in IsiZulu/Setswana is difficult. *Reason:* Terminology disadvantage (experience). Section 3.2.1.1 item 1d	9

The findings in Table 6.7 align with findings from the lesson observations (Section 6.2.3), where it was shown that English is the dominant language but that teachers also used mixed language when they are teaching mathematics. In this summary of teachers' responses to

[65] Here the teacher does not name English as the other language. This is a sign of the constraint imposed by policy – fear of speaking in a way that is perceived as "against" policy is rife. Although there are teachers who address it head on, many do not, as teachers have learnt to be highly compliant in the current system.
[66] There were 62 teachers (37 Grade 3 and 25 Grade 4) who participated in the survey on language use (Section 4.5.1).

questions about language use choices, the teachers' reasons for these language use choices are included.[67] The reasons they gave align with items on the list of observed use of mixed language (Section 6.2.3.1.1) as is also shown in the table. The links to the observed use of language highlight teachers' use of language mixing to support learners' understanding and the way in which they use mathematical terminology. It can be seen that there is a general tendency towards curriculum compliance (using the language because it is the LoLT) but that teachers are also driven by their knowledge of the common language of the learners.

Findings from the analysis of the focus group discussions[68] were also aligned to those shown in Table 6.7. Since answers given in the discussions were more extensive they enabled a richer and more nuanced insight into teachers' perceptions about language use. Percentages were again assigned according to the number of teachers expressing similar ideas, but these are not tabulated, rather they are noted in relation to the five key findings in relation to language use that emerged from the focus group discussion. These findings are discussed in the next five subsections of this chapter, building on and enriching the survey findings by drawing on the perceptions expressed by teachers in the focus group discussions. The first finding, in Section 6.3.1 relates to the CAPS language policy.

6.3.1 Teachers would like the LoLT for mathematics to be English, but they would like to be allowed greater flexibility in language use

Many teachers expressed their concerns and criticisms of the CAPS LoLT policy: the preference for English (vs. indigenous language) as the LoLT for mathematics was expressed by 67% of the teachers in the focus group discussions (compared to 85% in the survey). As one teacher put it, "I don't see any problem in teaching Mathematics in English, actually I think it is best" (FG3S4) and another said, "Starting from Grade 1, I think it's best for them to learn mathematics in English" (FG3S14). Another put it in a different way, bringing in not just the issue of home language, the multilingual context and English, but also the issue of the mathematical language or register: "And the big, big problem is that we are not teaching only

[67] Note that the categories are not mutually exclusive and so a teacher might have said she prefers English because it is the common language and because it is the LoLT. In the survey teachers were asked to give reasons for their responses which could therefore be summarised here as well.
[68] There were 74 (47 Grade 3 and 27 Grade 4) teachers that participated in the focus group discussions, more than in the survey, since the invitation was made to all FP and Grade 4 teachers as explained in Section 4.5.2 (methodology).

the Zulu learners; it's mixed. The Tsonga, the what what, the what what. So it is very difficult too, and a ... it's struggling to a language; to a home language, it's also struggling to mathematics by the way." (FG3S13).

The use of code-switching was emphasised alongside a strong emphasis on the need to use English as the LoLT for mathematics because it helps learners to understand better. The practicality of English vs. home language seemed to make sense to teachers. There were two teachers who said that code-switching does not help, but that it confuses learners. They felt this way because they said that learning in one language will in the end enable stronger learning and they based this on their personal experience of being taught mathematics, not on their experience as mathematics teachers. Interestingly, one was a teacher who had learnt in English from the start and felt this was better while the other was one who had learnt in her home language.

Teachers expressed the perception that learners struggle to use the home language but that when they spoke in English, they were understood, as one teacher put it, "It's much better, like I said it's better, if I say it's *green,* they understand because if you talk that language they just look, other learners will say *iphi leyo* and I'll say a *green* and they'll say ohooo!" (FG3S14). Teachers also said that learners enjoy learning mathematics in English. There was also a perception that home language mathematics terminology is difficult for the learners because it is not a terminology that they use in everyday interactions. One teacher gave the following example: "Like numbers, in Setswana twenty is *masume a ma bedi*. At home when they are being sent to the shop, they just say twenty cents or go and buy twenty apples they won't say *masume a ma bedi a di apula"* (FG3S18).

For some, the LoLT could be the third or fourth additional language for the learner and this creates difficulties for both teachers and learners. One teacher said that if the LoLT of a school is IsiZulu, it would be better if they only admit IsiZulu learners or it gets complicated. As it was shown above, teachers are aware that language provision for a multilingual learner population requires something other than a single LoLT.

The second finding, presented in Section 6.3.2, extends the discussion on the use of English in the teaching of mathematics. The perception is that teachers want to be allowed to use mixed language from a base of teaching mathematics in English in the early grades, which they feel is the common language and equips learners for the future.

6.3.2 Teachers place particular value on English as the common language and the language which will be used after the FP

Linked to the first finding, but with a focus on common language, teachers also expressed little confidence in the practicality of home language policy. In the focus group discussions, many teachers (61%) said they would like to use English to teach mathematics (even if they do not use it as a pure language) because it is the common spoken language. The general sense of it is expressed in this comment by a teacher who said, "Others were doing Zulu, others Sotho, others Pedi. So the common language that they all understand it's English, yeah, so and it's ... especially with maths" (FG1/2S3). Their comments pointed to different aspects of diverse learner populations that could create language use issues. Some comments from teachers spoke about the disadvantage to South African language speakers whose home language did not coincide with that of the schools – this happened in both IsiZulu and Setswana LoLT schools:

> There are some learners who come here only speaking Zulu[69], not English only Zulu, as a teacher you have to explain in Zulu or Xhosa, or Venda and you are teaching maths in Tswana. Even Shona, we have Zimbabweans here who have permits, study permits, who are studying here. There are Zulus, there are Tswanas, there are whatever, there are whatever, so the common language is what? English. I wish this thing they should keep it in mind. (FG3S6)
>
> Yes, you know it's a problem, but the department said they must learn all subjects with their languages. OK, it's fine "with their languages", but what about here? Who's favouring if I'm speaking Zulu[70] then there is a Tsonga here, and a Sotho? Then who is getting a favour? It means the Zulu one is favourable, but what about the others? (FG3S13)

Teachers generally agreed that the current multi-cultural and multi-ethnic composition of learners would be best served by a heightened use of English, as it is the one language most

[69] This was said by a teacher from a Setswana LoLT school.
[70] This was said by a teacher from an IsiZulu LoLT school.

learners would understand. The situation of richly multilingual classes is highly complex. There are learners who speak languages other than the official languages of South Africa in the schools. The issue of foreigners in classes was also raised with one teacher saying, “Also for us teachers because these learners are from different environments, most of them are not Tswanas. So I can’t speak Shona, but they can understand when I speak English” (FG3/4S17). Another said, “Mostly bana ba mo a se ba mo ke ba from outside. A se ba Tswana, a se baPedi, a se baVenda, a seMachangane. Ke Zimbabwean, Nigerian so wa bona go re sometimes bona ba ba tswang from there ba understanda better ge o bolela ka English.” (*Mostly the learners who are at this school aren’t from here they are from outside. They are not Tswana, Pedi, Venda nor Tsonga, they are Zimbabweans, Nigerians. So you see that sometimes those who come from there understand better when you speak in English.*) (FG4S6) This teacher went on to explain that using English was not always a solution in a mulitlingual class – because certain learners in the class do not understand it well enough: “Ba ke ba explainelang ka Setswana e be le ho re le kgale they have their own problems but ko re majority ge ke explainile in English they understand, nkase re the whole class ge ke explainile in English ba understanda better. No! No!” (*The ones I’m explaining to in Setswana already have their own problems but it’s just that the majority if I explained in English they understand, I won’t say it’s the whole class who understands better after I explained in English. No! NO!*) (FG4S6)

Teachers also expressed the view that learning mathematics in English in the FP would facilitate the transition from Grade 3 to Grade 4 (55% of teachers expressed this view in the focus group discussions). Some of them said this simply in a positive way: “I think it is important from FP when it comes to mathematics let them teach in English so that when they get to Grade 4, 5, 6 and 7 they no longer have to be in this transitional phase, let it start from the beginning that way it will be easier for teachers to just add on and not start afresh like starting with a new child from Grade R” (FG4S19). Others added a negative about the home language to enforce the view: “I think for Grade 3 it is not good because in Grade 4 they are going to learn mathematics in English therefore I think mathematics it should be suitable to be taught in English from Grade 1 up to higher level. I don’t think mother tongue is good for the learners.” (FG3S14)

Teachers said that teaching in English prepares learners for Grade 4 and expressed the idea that using the home language could create barriers for learners going forward because English becomes the LoLT. The terminology of numbers was mentioned a lot: “When it comes to numbers, it's difficult for them. So I think it's easy to use English and I think that's the best way because if you...you are confusing learners if they start with mother tongue and at the... later on stage they use English, it is difficult for them to relate to" (FG3S18). Shape names were also mentioned by many teachers, for example one said, "It becomes a huge problem, especially in term one when they get to Grade 4, we have a huge number of learners that are under performing mostly because of the language. They were used to calling a circle *sikadike* and now it's a *circle* so it's like starting from afresh in Grade 4" (FG4S1). Finally another Grade 4 teacher summarised the problem of transitioning from home language to English and the pressure it puts on teachers in the following way:

> I think I am pressurised to teach because of they write the common papers so when the common papers come we don't have an option to choose whether we want to write in English or Sepedi so you are obliged to teach in English and the learners are obliged to understand English language, without considering the fact that they were taught in their mother tongue from Grade 1 to Grade 3, we have to just make a miracle, they don't teach us the magic but they want us to perform miracles that is the problem, I mean you can't ... The child cannot spend 36 months learning in home language then they expect the child to adjust within 3 months, actually for 2 months, they expect the learner to adjust in 2 months because in the 3rd month they write the test, so there's no way we are achieving the good results. (FG4S8)

Another aspect of preparation for the future links to the importance of learners' confidence in English, as the language to be used after school (42% of teachers expressed this view). This perception of the value of English is also felt on the part of the School Governing Body committees who make the choice of LoLT for schools. In my sample, 12 of the 20 schools had changed to English as LoLT in spite of a majority of the learners in these schools speaking indigenous languages. In the literature, it is referred to as going "straight for English" (Badenhorst & van der Merwe, 2016; Dixon & Peake, 2008; Mohohlwane, 2020). As one teacher put it:

> So I think the way we are doing, it's better, because firstly they have self-confidence. We need to build that; the outside world needs someone who can express him or herself in English. So it's good also to maybe for the learners to know their mother tongue and to be able to speak it but, in the reality, English it's the language that we need to know because going to an interview, you will be asked in English. (FG4S7)

The finding here is that teachers think English should be given preference because it is the common language of the learner population. It is also the language which teachers feel more confident using when they teach mathematics because they are more familiar with using English in the context of mathematics. According to the teachers, learners are also more familiar with mathematical terminology, such as number names, in English. Finally teachers expressed a belief in the value of learning mathematics in English in the FP in order to build the foundational knowledge of the terminology for Grade 4 (and beyond).

The next finding, presented in Section 6.3.3, relates to the pressure experienced by teachers as a result of policy monitoring and the imperative to comply.

6.3.3 Teachers feel pressured by department officials to use more pure language

Many teachers in the survey expressed the view that they use a particular language because it is the LoLT, indicating that their language use choices result at least in some way due to the pressure of policy (Table 6.7). In the focus group discussions, 64% of teachers expressed the view that they felt pressure from policy to use the LoLT and to use pure language. At one school, teachers did not just perceive this pressure, they had been instructed directly not to code-switch.

> So coming here I was told no English, you are not supposed to teach learners in English, learners are not supposed to write anything in English in the next grade… so me at first, my first year it was hard, it was very hard, like I had to think before I can present to the learners so that they can be able to understand, cause sometimes even if it is my language it is not that easier for me. (FG3S1).

The discussion about planned/unplanned code-switching revealed teachers' response to this pressure to teach in pure language in an interesting way – many teachers said that they did not plan to code-switch. Number names, which have been mentioned in other contexts, were the reference point in this teacher's example of this "unplanned" code-switching: "It happens, you can't plan that it … just happens. Sometimes we start to "OK, count", then you start out, *one … two* and then oh, we are not supposed to do that, let's go back … *kunye … kubili* ... We don't plan, because we know we must follow policy" (FG3S10,). In this quote it is clear that the code-switching **was** intuitive, but this was explained as "unplanned" because strictly speaking, it should not have happened.

Several teachers mentioned that learners learn things like the names of shapes and how to count in English in crèche or Grade R. One said, "… in Grade R, where they are taught shapes in English. When they go to Grade 1, they go back to home language which is more difficult for them to understand what the teacher is trying to say to them" (FG3S4). Another said, "I'm a Grade 1 teacher. Our learners are coming from Grade R, you know Grade R is using English. My learners know the shapes in English, and they can count from one to 50 in English. They don't use IsiZulu and so when they come to Grade 1, they come across this difficult language." (FG3S14) Teachers spoke specifically about number names creating problems for young learners because the numbers are very long and confusing in the home language, especially when learners have to write the number names:

> Even in counting, when they count in LoLT in Sesotho it's very hard for them because now they have to count, like the number it's very long in terms of saying ... Uhm ... one hundred and forty (140) they have to say *lekgolo mashome a mane le metsoe e me kae kae* (140 and couple of digits), so it's very long for them to say, but in English it's easier for them to say one hundred and forty. (FG3S1)
>
> IsiZulu language has got these long names, for instance when you are counting from 1 to 10 and like for instance *eight* is *isishiyakalumbili*. It becomes a long word for them. Whereas in English we just say eight. Nine is *isishakalonunye* and in English it is *nine*. (FG3S14)

Teachers thus raised many points in favour of the use of English (not necessarily pure English, but English in a mix). English is used in everyday life, at home and in play, for learners to say shape names and to count. This makes it easier for them to use these words in class when learning mathematics. In a multilingual community, learners use English when they play and interact, when it is the common language. English is often the language that learners are exposed to in the media, for example on television, in advertising, shop names and posters. Learners do use English mixed with the home language – yet pressure comes from the department to use pure home language rather than mixed language.

The fourth finding, presented in Section 6.3.4, is that in spite of policy, teachers say they prefer mixed language use, which they refer to most often as code-switching, since they were not familiar with the term translanguaging. They state this preference even though they know they should be using pure language.

6.3.4 Teachers prefer using mixed language at times although they use pure language more often

In the survey, 52% of teachers said that they use code-switching (Table 6.7) compared to 65% in the focus group discussions. This finding could be more nuanced by virtue of the discussion and it was clear that there was a sense of hesitancy about speaking about the amount of code-switching used because of an awareness that it was against policy. Thus while 50% of the teachers said that they use code-switching, but they do not use it a lot, 15% of teachers said that they use a lot of code-switching. Teachers said things like: "As Mam A said *...a gekho* comfortable *neh*... I think when we mix... if there's a Zulu class we mix the IsiZulu and English for learners to understand easy, if they don't understand you speak *Ihome language* from *Ekhaya* ... *Imother tongue* ... so that to understand easy" (FG4S12) and "I do not think it is much of a problem because sometimes I switch, I translate, when I say I *add* then I must say *hlanganisa*. And then maybe after two weeks to a month they get familiar with the terminology" (FG4S14). Another teacher said, "As a Grade 3 teacher I even try to code-switch because they are going to Grade 4 and it's a problem in maths addition *ukuhlanganisa* I try to code-switch I don't know if it's the right thing or not" (FG3S14). The comment made by the teacher at the end of this quote was expressed by many teachers in conversation about code-switching – this might have been an expression of uncertainty or it could be a way of softening the opinion given because the action of code-switching was understood by the teachers as "illegal".[71]

The fifth finding, presented in Section 6.3.5, is linked to the activity of code-switching. It is the most commonly expressed reason for the use of code-switching – to support learner understanding.

6.3.5 Teachers believe that giving explanations in the home languages aids understanding of mathematical concepts

In the focus group discussions, many teachers (42%) expressed the perception that code-switching helps learners to understand. This aligns with the commonly expressed reason for

[71] At the time the focus group discussions were carried out teachers from one school reported that they had very recently been issued a directive from the district office to stop all code-switching and use pure-language only.

using code-switching given in the survey (Table 6.7). Grade 4 teachers in particular spoke about the ad-hoc nature of their code-switching, emphasising that it was generally unplanned, but used to support learner understanding. As mentioned above (Section 6.3.3) the emphasis on the lack of planning might be because teachers are aware that, according to policy, they should be teaching in pure English. Several teachers spoke about using code-switching in spite of it not strictly being allowed because they had seen the need for it in their classes. A Grade 4 teacher mentioned the fear of not complying with policy by code-switching rather than using pure language but none-the-less going against it, because of a desire to explain in a way that the learners can understand. She said:

> I know that you are recording me, but I just, I need to be honest with you, because you find that some of the learners can't read. And if you can't read ... if you can't read, you won't be able to write. So just a little, just to explain to them in their mother tongue; this is what I mean, then you will just code-switch, but not right through. It's not allowed … the department doesn't want it. (FG4S7)

Another teacher said:

> We do switch because, remember they are coming from those Grade 3s and then now they are in Grade 4. So for you to make sure that they understand, you, you use bilingual language, you go this way then ... trans it to go the other language. So that's how we work. We use both languages. (FG3S3)

Many teachers spoke about code-switching to enable learners to know and use the mathematical terminology in both English and the home language. Number names were spoken about by many of the teachers, particularly those in Grade 3. Teachers seemed to feel strongly that number names are more easily spoken about in English. As one teacher put it, "You code-switch. *Mina*, in most cases if they don't know, and I want them to know that 60 plus 3, they know it's 63. But they don't know if I can ask them in Setswana *matharo hlakanya le hlano*, they even confuse *thataro le tharo, hlano le tharo* but if you can say 63 …" (FG3S6). This is in spite of research that has shown the value of using the linguistic structure of number names in indigenous languages (Mostert, 2019, Poo & Venkat, 2021) but it seems that the hands-on knowledge of the teachers is that it is easier (and thus better) for learners simply to use English number names at times. As teachers see it, code-switching enables better learning of both languages and transitioning between the use of the two. They also want to equip learners to deal with both languages in spite of pressure from the department to use pure language and this extends beyond the use of number names to other mathematics terminology. As one teacher said,

> When I use it [code-switching] I use it consciously because there are words that they have to understand in both languages for instance minus sign I have to tell them that this is a *minus* sign and also tell them in IsiZulu is *susa* they must understand that most especially what is important let me say so, so I emphasise on the issues that I see he or she must understand in both Sizulu and English. (FG3S2)

The findings in Section 6.3 are evidence that teachers generally expressed their views freely in the focus group discussions although at times they made it clear that they could not say certain things directly, because they knew they would be speaking against policy. The findings that teachers expressed views in favour of English as LoLT for mathematics teaching and of code-switching are both essentially against policy. The finding that they feel pressurised by policy to use pure language show teachers' policy compliance while at the same time an awareness that this is not necessarily what they would like to be doing. The finding that they prefer to use mixed language because they believe it aids learner understanding shows teachers drawing on their experience to justify an action that goes against policy.

As discussed in my theoretical framework (Section 3.2.1), when teachers make choices about language use, language ideology is at play, whether they are aware of it or not. The focus of Section 6.4 that now follows, is on the way in which teachers' language use and their perceptions about it are influenced by their language ideologies.

6.4 Monoglossic and heteroglossic (embodied and articulated) ideologies drive language use

My analytical framework presents an interplay between drivers of language use and language use itself (Figure 4.2). The framework suggests that ideology together with research and policy (which are seen as sources of authority and which are themselves influenced by ideology) drive language use. Since research and policy are more "visible", they may more often be acknowledged as drivers of language use, but I have positioned them in the framework in a way to suggest that they too are influenced by ideology. My theoretical framework (Table 3.1) expands on the concepts related to the drivers of language use. In the table I give a diagrammatic illustration of how ideology may influence language use directly or it could also do so through the sources of authority (research and policy). As was discussed in Chapter 3, language ideology may be embodied or articulated (Section 3.2.1). In this final section of Chapter 6, findings from Section 6.2 about variation in language use are used to speak (by inference) about embodied ideologies. Findings from Section 6.3 about teachers' perceptions of language use are used to speak about their articulated ideologies (also inferred, but from reasons for language use expressed directly in answer to survey and focus group discussion questions).

Two different language ideologies are identified in the literature – monoglossic (or purist, favouring the use of pure language) and heteroglossic (or pluralist, favouring the use of mixed language), as discussed in in more detail in Chapter 3 and operationalised in Chapter 4. The findings in relation to teachers' language use show evidence of both embodied monoglossic and heteroglossic ideologies in the written explanations (survey) and spoken utterances (lesson observations).

In the survey (Section 6.2), as it was shown in Figure 6.6, the majority of the written explanations were written in pure language, and English was the most commonly-used language (83% teachers, 38% Grade 3 learners and 53% Grade 4 learners). This is evidence of an embodied monoglossic ideology. In the survey explanations there was very little evidence of mixed language use, although there was some. Also shown in Figure 6.6, learners used more mixed language (20% combined overall) than teachers did (4% combined overall). Although these percentages are low, they are evidence that language mixing is used and of an embodied heteroglossic ideology. This weighting in favour of an embodied monoglossic ideology may be determined due to the pressure of policy, which calls for pure language use. It could be that the monoglossic ideology embodied in the CAPS influences teachers (who in turn influence learners) in this pure language use because as it was discussed, the CAPS policy is favours pure language use and only provides monolingual materials for learners (Section 2.3).

Although the perception data (survey and focus group discussion) revealed that teachers do not always agree with policy and did speak out against it (Section 6.3.1), they also spoke about pressure to comply with policy which is enforced by officials who monitor teachers for compliance (Section 6.3.3). The officials are authority figures who are strong drivers of language use. In spite of this, evidence from the lesson observations (Section 6.3) showed slightly greater variation in language use (than in the survey) and a larger percentage of teachers using mixed language then pure language in their lessons. As it was shown in Figure 6.9, translanguaging and code-switching (mixed language use) were observed for 58% and 55% cumulatively in Grade 3 and Grade 4 lessons respectively. In terms of ideology, this is evidence of embodied heteroglossic ideologies (mixed language use). Translanguaging was highest in Grade 4 classes when English was the dominant language (Figure 6.9, 37%). This evidence of an embodied heteroglossic ideology is particularly noteworthy, since in Grade 4 English is the LoLT which is the language teachers expressed a preference for as the LoLT for mathematics teaching (Section 6.3.2). Pure language was observed for 42% and 45% cumulatively in Grade 3 and Grade 4 respectively (Figure 6.9). Although these percentages are lower than those for mixed language (cited above), they are not negligible and they are evidence of the embodied monoglossic ideologies or compliance on the part of teachers, to the embodied monoglossic ideology of the CAPS.

Findings of teacher perceptions about language use show that many teachers expressed an articulated heteroglossic ideology. This was seen in both the survey and the focus group discussions where 52% (Section 6.3) and 65% (Section 6.3.4) of teachers respectively expressed the view that they used code-switching in their teaching. Although teachers spoke strongly in favour of English as the LoLT – 85% in the survey and 67% of teachers held this view (Section 6.3 and 6.3.1 respectively), this was with the proviso that they be allowed to code-switch. The reasons teachers gave for code-switching aligned with the uses of mixed language observed in the lessons (Section 6.2.3.1.1). The main one they spoke about was to support learners' understanding (Section 6.3.5, aligning with Section 6.2.3.1.1 items 1c and 2d). Here the heteroglossic ideology underlies a professional choice, based on experience that mixing languages helps learners to understand better.

When teachers spoke about using pure language in the survey (specifically IsiZulu, Setswana or English) this was generally related to the pressure of policy (Table 6.7). This was the case in the focus group discussions as well – 64% of teachers said that they felt pressured by the department to use pure language (Section 6.3.3). There were two teachers who spoke about the value of pure language (monoglossic ideology) based on their own experience (Section 6.3.1) – one in favour of English and one in favour of home language. Teachers were thus aware of pressure of departmental policy and that it pushed them towards using a particular language when they teach mathematics. The more detailed responses in the focus group discussion added substance to this view of the teachers, showing how deeply it affected them, to feel pushed in one way or another, at the whim of policy (Section 6.3.3). Several teachers spoke about the mixed (or sometimes changing) messages they receive from the district/head office in relation to language use (Section 6.3.3) which they found confusing. One teacher expressed a view that showed awareness of the influence of language ideology saying, "Well the department, you know, I don't know about the department, because you know these departments, they are actually driven by politics. So now if they are driven by politics, you find that some of the officials are actually want the learners to speak the vernacular, and the others want them to speak in English" (FG4S18). This comment shows that the teacher perceives that policy is not necessarily based on research or educational reasons, but rather on what she calls "politics" which is essentially ideological.

Findings thus show that the embodied ideologies evident in teachers' writing were predominantly monoglossic, while the embodied ideologies evident in their language use when teaching were predominantly heteroglossic. Their articulated ideologies show cognisance of tension between monoglossic and heteroglossic ideologies. Teachers expressed the view that they think that mixed language is supportive of learner understanding (heteroglossic) and so they would like to be allowed to code-switch (Section 6.3.5). At the same time they express the view that while they would like to code-switch, they feel pressured by policy to use pure language (Sections 6.3.3 and 6.3.4). The conclusion is that there is variation in teachers' language use and it is influenced by language ideologies.

6.5 Conclusion

The findings in this chapter show that teachers are making language use choices in relation to the teaching of mathematics, but they feel pressure from external factors when they do this and that language ideologies play a role in this. The quantitative findings provided a synopsis of language use while the qualitative findings zoomed in and gave examples of use. The CAPS policy appears to be influencing teachers' language use and creating a system that favours multiple monolingualism rather than multilingualism. Teachers are not necessarily in favour of this policy although for the best part they comply with it, which they must do, because they are held accountable to do so by officials who monitor CAPS compliance (Section 6.3.3). They were very pleased to have participated in the research and to share their ideas and it appeared that they were hungry to speak about the multilingual context. One teacher used the opportunity to make the following comment, which captures an idea expressed by many participants in the study:

And whoever, who introduced the policy should come and ask teachers, teachers know best because they are with the learners … day and day in. So I suggest that next time if they want to do something, they must start … come and do the surveys at schools to find the teacher's view, before they do anything, or before they jot anything down and call it a policy. So they must first consult teachers." (FG1/2S3)

In this chapter it has been shown that, aligned with the finding in relation to pure language use being more common in written explanations and very common in classroom teaching, teachers said, in both the survey responses and the focus group discussions, that they use pure language more often when they teach (Sections 6.3.1 and 6.3.2). They qualified this view (also in both the survey and focus group discussion) by saying that they use code-switching to support teaching for understanding (Section 6.3.4). In the observations, this was seen to be the case. While teachers spoke more about code-switching, what they did in the observed lessons is use both forms of mixed language – translanguaging and code-switching. The ways in which they use mixed language vary as was shown in the episodes presented (Sections 6.2.3.2-6.2.3.1). Thus what teachers say they do (use more pure language) in relation to what they do (as observed in the classroom) is not entirely aligned. It was shown in the quantitative analysis of the observation data that mixed language use was more common than pure language use (Figures 6.9 and 6.10). This finding aligns with the view expressed by the majority of teachers (in both the survey responses and the focus group discussions) – that they would like to be allowed to use mixed language but they feel pressured by policy not to do so (Sections 6.3.4 and 6.3.3).

Pure language use aligns with a monoglossic ideology and mixed language use aligns with a heteroglossic ideology. The misalignment between teachers' expressed preferred language use (mixed) and actual language use (more pure in written work and more mixed in teaching) is indicative of an ideological clash. At least for some teachers, heteroglossic ideologies are being challenged by monoglossic ideologies. This situation is compounded by the embodied monoglossic language ideology of the CAPS and it may explain the discomfort many teachers feel in relation to the question of best practice for language use when teaching mathematics. They may experience internal tension resulting from a clash between their own embodied and articulated ideologies. They also feel the tension created by making decisions based on their professional judgement, which, guided by the authority of research, leans towards heteroglossia and pressured by policy, another source of authority, leans towards monoglossia. The monolingual/multilingual, monoglossic/heteroglossic tension indicates that the standardisation debate is the analytical level which shows where the ideological debate is constrained.

In Chapter 7 I present the findings in relation to the language standardisation debate and teachers' perceptions of this debate.

Chapter 7 Findings – The language standardisation debate

7.1 Introduction

The final set of findings that I present relates to the language standardisation debate and teachers' perceptions of the language standardisation debate. This will be used as the second basis for the discussion of my overarching research question: *What factors drive the language use of multilingual Grade 3 and Grade 4 mathematics teachers and learners on the topic of patterns?* The second and fourth sub-questions yielded data that is presented in this chapter. The chapter is divided into four main sections. Firstly, in Section 7.2, following on from the findings on teachers' perceptions on variation in language in Section 6.4 of Chapter 6, I present the findings on teachers' perceptions of the language standardisation debate. This is in relation to my fourth research question: *What are teachers' perceptions of the language standardisation debate in relation to mathematical register of patterns?* After that, in Sections 7.3 and 7.4, I present further findings that add to the discussion on variation in language use presented in Chapter 6, in relation to my second research question: *What variation in language use is evident when teachers and learners write and speak mathematics?* The findings presented extend the discussion to variation in relation to standardisation and are discussed according to the subcategories in my analytical framework (Figure 4.2). Finally, in Section 7.5, in another step towards answering my broad research question, I discuss the anomaly of the language ideology embodied in the CAPS.

While analysing and thinking about variation in language use, the issue of standardisation was ever present. Questions in relation to standardisation came to mind, or were asked by participants in the study, such as – is it necessary? is it possible? is it in place? how could it be achieved? Hence, I realised that in a study of language use the tension between variation and standardisation had to be considered and addressed and that is the focus of this chapter. The tension I observed is evidence of the tension Barwell (2014) notes between "unitary language" and "heteroglossia". The idea of unitary language speaks to the language that is imposed by policy as the language of learning and teaching (LoLT). Heteroglossia, on the other hand, speaks to language as resource, used by the diverse teacher and learner population present in the multilingual context (Barwell, 2014).

I once again use key findings to structure the chapter, and data from the three data sources that informed my study (survey, focus group discussions and observations) are used in this chapter. There are choices which teachers need to make because of the limits set by standardisation on which I will elaborate in the three sections of this chapter. The variation presented in this chapter is more directly related to the use of mathematics terminology, with a view to thinking whether this terminology is/is not/should be standardised. These findings are important because they bring to light evidence of the lack of standardisation of the terminology which has only been reported anecdotally to date or in more general writing about language development (Lafon & Webb, 2008; Mafela, 2010; Mojela, 2008; Schäfer, 2010). The findings are presented in detail in this chapter since the lack of standardisation is often glossed over and it needs to be brought under the spotlight. However, it must be noted that standardisation is not necessarily presented as the goal or the ideal, although elements of standardisation may be seen as useful in the support of language use in the teaching of mathematics. The argument is put forward that while a single-minded drive for standardisation of languages is not going to solve the problem of teaching mathematics for understanding, a lack of standardisation creates some tension in the system.

I interviewed five professional translators with whom I have worked on bilingual materials in mathematics projects since 2012 and comments made by two of them were pertinent:

> I would like though to comment about Xitsonga. Some of the new grammatical rules implemented lately are not meeting the actual grammatical rules, as expected for a standardised language. It seems like the majority of members of PanSALB in Xitsonga are from the same geographical area and use the same dialect, hence their decisions with regard to grammatical rules are not accommodative of other dialects. This has resulted in promoting a regional dialect, compromising quality and progress. (NR)

> Tshivenḓa translators are mainly guided by the standardised terminology registers referred to above. Tshivenḓa, like other languages, has one standard dialect and a number of other dialects. The standard dialect in Tshivenḓa is Tshiphani. The dialect is spoken in the areas of Tshivhase and Mphaphuli. Most Tshivenḓa dictionary entries are in Tshiphani. Many Tshivenḓa dictionaries lexicographers support the idea that only from the standard dialect lexical entries should be entered in the dictionaries. (MN)

These two professional linguists are referring to issues they encounter in relation to standardisation of indigenous languages which affect them when they work on educational materials. Teachers in multilingual classes are also affected by issues of standardisation. The first set of findings presented now in Section 7.2 relates to teachers' perceptions of language standardisation. This follows the discussion of teachers' perceptions on variation in language use discussed in Chapter 6, since their perceptions emphasise the lack of standardisation of the mathematical register.

7.2 Teachers' perceptions emphasise the lack of standardisation of the mathematical register

The findings in this section pertain to my fourth research question: *What are teachers' perceptions of the language standardisation debate in relation to mathematical register of patterns?* Teachers must teach in classrooms daily, following policy directives in terms of both content and language use – what to teach and how to teach it. Under such conditions, teachers understandably feel controlled. Although for the most part they are compliant, they valued the focus group discussions as an opportunity to air some of their views in relation to the issue of language standardisation.

In Chapter 6 (Section 6.3) it was shown that there is variation in teachers' perceptions in relation to language use. Their perceptions about language standardisation (or lack thereof) also vary, but all teachers are aware of the complex set of problems that arise due to the lack of standardisation of the indigenous languages. The analytical subcategories correct/incorrect, formal/informal and appropriate/inappropriate (Figure 4.2) are applicable in this discussion. In Section 7.2.1 I present my findings in relation to teachers' perceptions about language standardisation.

7.2.1 Teachers are aware of a complex set of problems linked to the versions of mathematical terms in the indigenous languages

Teachers raised many issues related to the standardisation debate in the focus group discussions. The first one was that teachers noticed inconsistencies and errors in language use in the indigenous language versions of materials that are issued to them (such as the DBE workbooks) which they find offensive. These errors indicate to them a lack of professionalism and respect for the indigenous languages for which they are prepared (Section 7.2.1.1). Related to this, the second issue was that teachers noticed that certain words appear to have been invented by materials developers. They were critical of choices made by the inventors, particularly in relation to anglicisations (Section 7.2.1.2). The third issue about which teachers felt strongly was that they want the job of inventing terms for use in the indigenous languages done for them. They do not want it to be left up to them (Section 7.2.1.3). The fourth issue relates to the tension between pure forms of language and the languages spoken in urban areas (Section 7.2.1.4). The fifth issue teachers raised was that they felt that they did not know the terms in the indigenous language well enough. They often spoke about this in conjunction with the idea that using English might be preferable because at least they know the English terms (Section 7.2.1.5). Linked to this, the sixth issue, aligned with findings from the survey and classroom observations, was that teachers feel that English is standardised, and mathematics should be taught in English. They say that English is well developed and does not present terminology problems that plague them in the indigenous languages (Section 7.2.1.6). Finally, in response to the issues raised, teachers made the point that the use of mixed language offers a way of addressing the problem of a lack of standardisation, since it allows for the use of both the indigenous languages and English (Section 7.2.1.7). This suggestion sits well in the multilingual context.

The first finding, discussed in Section 7.2.1.1, is that teachers noticed language use errors in indigenous language versions of materials that are issued to them.

7.2.1.1 Teachers have observed inconsistencies and errors in indigenous language versions

Teachers were quite critical about some of the terms used in materials given to them. They referred directly to the lack of standardisation of language, saying that it leads to inconsistencies and errors in written material coming from the department – both in the DBE workbooks and in common assessments (such as the ANA in the past). There were some teachers who said they had not noticed any inconsistencies in versions in terms of language. Subcategories 3 and 5 from my analytical framework (Figure 4.2, appropriate/inappropriate and correct/incorrect) apply here.

Firstly, teachers questioned the appropriateness of the choices of some words in the published texts they are given. Comments were made such as:

> Let me tell you about the DBE [workbook] there are some errors there, like… Uhm... I was raised in a Zulu community, I was taught in Zulu, even at school from Grade 1 to Grade 12 but then with the DBE [workbook] there certain words which I have never seen in my life ... some of them are in Xhosa, some of them are in Zulu so I think at times the people who are writing it they are mixing the terms. (FG3S1)

One specific choice of terms that caused confusion was given by a teacher who said, "It depends on which ... the teachers, which language they use. They say *indilinga* and others *isiyingi*, you see? And when you come to somebody who knows *isiyingi*, who don't know *indilinga*, they mark you wrong" (FG3S13). Here the teacher shows that two words which she considers are appropriate are not always accepted as such. Another teacher referred to four different ways one could say the word small, "*Ncephisa*, maybe someone else will come and say, *ukuncani* … *okuncani* – small – and *ukuncephisa*" (FG3S10), evidently accepting that all of them should be considered appropriate. There were also comments made about the use of inappropriate words. A teacher made a comment about the language use in a common assessment, in which she identified inappropriate words which, she said, caused confusion, saying:

> There was a question in the task that we wrote I just couldn't understand. It's written in Setswana. I even said to my learners, it's the last question. I told my learners forget about that question because even myself, I couldn't even explain it. (FG3S6)

Secondly, not just the choice of word but the spelling of words was criticised. Teachers call these mistakes, saying, "DBE in English is good but the DBE [workbook] in IsiZulu has got lots of mistakes. I have seen it, we are correcting all the time" (FG3S11). These differences in word use choices and inconsistencies in spelling in indigenous language versions that crop up because of the lack of standardisation thus create tension. Teachers did not only speak about general inconsistencies and errors, they were particularly concerned about anglicisations, inventions created at the whim of materials developers in the absence of standardisation. This is now discussed in Section 7.2.1.2.

7.2.1.2 Teachers find some invented words problematic especially when they are anglicisations

Inconsistencies do not only arise because of poor spelling or varying choices of words, they also arise in the form of anglicisations. Teachers noticed that materials developers borrow directly from English, since there is not sufficient mathematical terminology for them to use. Here teachers are raising issues related to my analytical subcategory formal/informal (Figure 4.2, subcategory 4). They recognise the need for borrowing from English, but teachers feel at a bit of a loss because of the arbitrary or non-standard way in which this is done. This view, expressed by many teachers, comes across strongly in the following teacher's comment from a focus group discussion.

> Again one other thing eh there are some words that are there in English but in our home language you have to think … by the way sometimes we have to create words of our own it's like "okay what can we say this is?" … Just like sometimes they use borrowed words tally ke *tali tali* but come on guys you are wasting a lot of time. (FG3S6)

As discussed in Section 6.3, at the time I carried out the data collection for this study, teachers were aware that the department did not want them to use mixed language (or anglicisations). They felt pressure to use pure language (Section 6.3.3), yet they noticed the use of anglicisations in published materials, being used due to a lack in language standardisation. This was of particular concern to them in common assessments, where they felt their teaching was undermined by the language use in the assessments. They felt that if they used pure language (which they were pressured to do) their learners may be disadvantaged. One teacher pointed a finger back at the department in a criticism of the anglicisations used in a national systemic test saying, "Now I remember in that ANA, they usually did it when it comes to the month, they are the ones who were the culprit of writing the month in English form like saying *Januari* or *Februari* or *uMarch*" (FG3S2).

The observations made by teachers about errors, inconsistencies and problematic anglicisations was followed up with a wish they expressed, that they should be provided with standardised terminology. This is now discussed in Section 7.2.1.3.

7.2.1.3 Teachers would like the standardised words to be invented for them

Many teachers said that the terminology of the indigenous language is not fully developed for use in mathematics. One teacher spoke about the problem quite explicitly and expressed a wish for standardised language:

> And it has to be the same for everyone. It must not be different. Teacher from school A will explain it her way and even if they write, they don't know ... They write common exams and they don't even understand what the question wants, only to find that they know the answer but the question they don't understand, because I've explained it in my way. Maybe if they can just use one language and prescribe it for all schools. Yes standardised. (FG3S5)

Teachers want clarity on the language they should use when teaching especially since they are given clear instructions about pure language use. This was put quite bluntly by one teacher who said, "If the Grade 1 and 2 are doing maths in their mother tongue, those who are doing those policies must make sure that the terms that are not there in our mother tongue, they must go and find them and give us those terms" (FG4S8). This teacher is making the point (expressed by several teachers in the focus group discussions) that they would like it if the mathematical terms that they need to use when teaching mathematics were developed for them. This cuts across the subcategories appropriate/inappropriate (Figure 4.2, subcategory 5) and formal/informal (Figure 4.2, subcategory 4) as shown in Section 7.2.1.1 and Section 7.2.1.2 respectively.

Language is not static, it is always in a state of flux and development and variations in language use will arise. This happens more in urban areas, where although the language spoken by many may not be pure, speakers identify themselves as speakers of a particular language. The desire for a more standardised language was raised but it was also questioned by teachers in the urban multilingual context, where they are aware of differences between "home" language versions (of indigenous languages) spoken by different speakers. This is discussed in 7.2.1.4.

7.2.1.4 There is a clash between pure indigenous languages and "home" languages in urban areas – the pure language is another language

The problem was raised that the "standard" language teachers are expected to use at school (found in some materials and common assessments) is not the same as the "home language" spoken by learners. This problem is more applicable in urban areas. It is touched on in the following three quotes:

> What is the obstacle, then we suggested that, because our learners are not speaking the Setswana at home they are mixed with other children, even the mothers. Other children the mother is Motswana the father is MoZulu and the child accommodates both parents. So when the child comes to school, then it is this Setswana, pro-Setswana for the home learned children then it's like a third language into the child. (FG3S18)

> Now it's home language… like they are talking about deep Sesotho, not the Sesotho which we know, which is common to the learners. So it takes time for them to process the language as well, so writing the ANA is a little bit official to them. … It's the language that is written there that they don't understand, that's where the problem is. (FG3S1)

> It is the pure Zulu, the one that is used in KZN and yet here at the location we've got multilingual neighbours, so you find that our children are not speaking the proper Zulu. So when we going to teach them the proper Zulu at the lower level, it becomes a bit difficult the ... the maths content, yes, it is a bit difficult. (FG3S7)

This point links to Mojela's (2008) point about standardisation of indigenous languages and dialects. The teachers are referring to the "standard" used in the DBE workbook as something foreign, that causes confusion, that is "not the same" as the indigenous language the learners speak at home. This again relates to the subcategories appropriate/inappropriate (standardised dialects) and formal/informal (standardised mathematical terms) (Figure 4.2, subcategories 5 and 4). It begs the question of when/if "standardisation" can be achieved in order to overcome the issues that arise. The issue about dialects and a standard dialect is a long way from being resolved.

Aligned to this, the fifth issue that teachers raised was that not everyone knows all of the terminology that exists in the indigenous language and that as a result of this, English might be preferable for the teaching of mathematics. This is discussed in 7.2.1.5.

7.2.1.5 Rather teach mathematics in English – there is uncertainty about indigenous languages

Many teachers mentioned the stability of the standardisation of English and their familiarity with standard English mathematical terminology. In contrast to this they spoke about their own familiarity (or lack thereof) with mathematical terms in the indigenous language (as discussed in Section 7.2.1.4). One teacher said:

> I do feel comfortable teaching in English, because I find it easier to teach in English than it is in my home language. Because imagine if I were to teach these learners maybe shapes in Sepedi, it means I will have to do more research than I have to do now, like maybe solve the name circle in Sepedi; for now I can't even remember what circle is in Sepedi. (FG3S20)

This again links to the subcategories formal/informal and appropriate/inappropriate (Figure 4.2, subcategories 4 and 5) with teachers expressing their uncertainty and therefore lack of confidence to make the right choices about which terminology to use when teaching mathematics in the indigenous languages. Other comments that related to this were, "When we become specific, really certain concepts are difficult to teaching the concept in Zulu so that is why I also agree with her. I'll also teach time with English because I can't even do it in Zulu myself." (FG3S2); "Square ke *sekwere* you see, yah, that's it. So you see what it is, even the teachers themselves don't know those words in Setswana, I don't want to lie." (FG3S6) and "What I can say, because IsiZulu sometimes it's more complex, sometimes the word is even hard for me as a teacher, I have to go to another teacher and ask what does this word mean? More especially in the DBE [workbook], there are certain words which are written in Zulu which I don't even understand myself." (FG3S1).

This leads to the next perception that was expressed and is discussed in Section 7.2.1.6, that a better alternative might be to use English when teaching mathematics since it is more standardised.

7.2.1.6 Rather teach mathematics in English – English is standardised

This perception was discussed in Chapter 6 (Section 6.3.2) when teachers' perceptions on language use were discussed, but it is relevant here as well, since teachers position it as a solution to the problem of a lack of standardisation of terminology in the indigenous languages. Several teachers said they prefer to use English for the teaching of mathematics because the English language has the standardised terms. Teachers expressed the idea that formal, appropriate words for some of the mathematics terms they need to use do not exist in the indigenous languages in which they teach, while they do exist in English (Figure 4.2, subcategories 4 and 5). They say that know the terms in English, so this is a logical language to use when teaching mathematics. Teachers said things such as:

> So it is much easier and many … err ... most of the maths concepts are in English. In our language, we don't have the concepts of maths language; therefore it is much easier to teach the terminology of maths in English than in our language. (FG3S20)

> However if I may add, it's very difficult as well to teach the vocab on its own in English transferring it to IsiZulu, because some of the words we don't even have in IsiZulu. So in my opinion maths, the language should be taught in English. … We don't even have the proper language to explain to the kids whatever the concept we are trying to explain to them, because we don't have in IsiZulu. (FG3S5)

> But I prefer to teach in English, most of the time. I don't like to code-switch. Why? Because they are not asking about their language; the question is not about their language, they are using what? Mathematics. (FG4S4)

This final comment raises the question about what is being taught – language or maths? This point touches on a key issue raised in the literature, which is that in a mathematics lesson, language should be a resource, the tool used to reach the goal of mathematics learning (Planas & Setati-Phakeng, 2014). As it has been seen, many of the teachers struggle with language use issues.

Although the final comment above suggests favouring English for the teaching of mathematics, one of the suggestions made (and enacted) by teachers is that mixed language is useful in the multilingual context. This is discussed next in Section 7.2.1.7.

7.2.1.7 In the absence of standardisation, teachers acknowledge the value of mixed language use in multilingual contexts

As it has been shown, teachers' perceptions are that there is a lack of standardised language and they speak about the value of code-switching to overcome the difficulty of explaining some concepts in the indigenous language. One teacher put it like this:

> Ok actually [using code-switching] it's benefiting because teaching in our mother tongue concepts like three dimensional shapes and other concepts, it's difficult to switch them to our own mother tongue. There are concepts in maths whereby it's difficult for one to teach in our mother tongue. Explanations in home language are longer because of the lack of terminology in the home language. (FG3/4S17)

The quotation above shows an awareness of issues in relation to formal, appropriate terminology in the indigenous languages (Figure 4.2, subcategories 4 and 5). The usefulness of code-switching in multilingual contexts was mentioned by many teachers (Sections 6.3.3 and 6.3.4) as beneficial for the teaching of mathematics in that it supports learners' understanding. The point made here is more specific – that code-switching is supportive because it enables mixing languages when there is a lack of terminology (or lack of knowledge of the terminology) in one language that can be supported by another language.

The many findings discussed above (Sections 7.2.1.1-7.2.1.7) show that the language standardisation debate is not yet resolved and it is creating issues for teachers on a day-to-day basis. The final point made in Section 7.2.1.7, about knowledge of and familiarity with terms and the value of using language mixing to overcome the lack of appropriate words, leads to the next finding which is discussed in 7.2.2. Teachers spoke about the value of bilingual materials in multilingual contexts as means of mitigating issues arising from a lack of standardisation.

7.2.2 Teachers say that bilingual materials are useful in multilingual contexts because they mitigate issues of standardisation

In the light of all the issues that arise in relation to standardisation and the lack of standardisation, teachers spoke strongly in favour of bilingual materials, noting some of the different benefits such materials offer. Firstly, the bilingual format offers alternatives, as one teacher said, "That would be better [bilingual material] in case they do not understand even

Sesotho, they can read in English and then maybe they will understand it better" (FG3S1). There are at least two points of access to the tasks being given if they are given in two languages. Multiple access points could support understanding in multilingual contexts. Another teacher referred to bilingual material she had used, indicating the value of these materials.

> I think it's so much better with both languages, it's so much better. I remember at one stage we had this GPLMS program that was implemented in schools and the material that they gave us had both languages because the child who cannot understand. English could at the bottom, look at the material in Zulu and understand what is … No, it didn't confuse the learners. It's used to make the learners understand better when using both languages. (FG3S5)

The use of a bilingual format not just for workbooks and activities but also for assessment was suggested. As one teacher said, "I would say they should combine all the languages, bilingual material and bilingual tests. Depending on the languages spoken by learners in a school" (FG4S11).

As it was shown in 7.2.1, there was a strong sense of discomfort and confusion in relation to language standardisation – the confusion around missing formal, appropriate terms was evident and teachers showed a desire to get clarity on which terms they should use. The points they raised showed that they were grappling with issues relating to formal/informal and appropriate/inappropriate terminology (Figure 4.2, subcategories 4 and 5). During the focus group discussions we shared a bilingual dictionary[72] with the teachers. The dictionary was seen as very useful in the multilingual context and teachers spoke about ways in which it could support them to clarify uncertainties about mathematical terms in indigenous languages. Teachers were openly excited about the dictionary and could see how it could be useful to them, as the following three comments show:

> Or if we can get maybe booklets like these [pointing to a bilingual dictionary] maybe other side is English, other side is Zulu, so that when they say *ukuhlanganisa – addition* this side. Yes. (FG4S10)

[72] The version of the dictionary that was shared was a combined FP (Grades 1,2,3) dictionary that was compiled during the GPLMS project. This dictionary has been edited and revised since then and is now in its fourth iteration. It is an open source resource and is being used in the Teaching Mathematics for Understanding (TMU) pilot and other mathematics interventions in the FP.

> I think what you brought today [bilingual dictionaries] is much better. If you look at the vocabulary, I have seen it in even in high schools if you look at the maths, there is a vocabulary maybe index or something, at the back, or glossary. Maybe if they can do that, to say this word in Zulu says this. And it has to be the same for everyone. It must not be different. (FG3S5)

> I think it could have been better if we had a mathematics dictionary to explain certain concepts for learners who are English home speakers or whatever. Even in Sesotho we should have a certain dictionary, that will explain the concept of terms, how we are supposed to teach them. For instance *molapalo* (number line), for me I don't get it *molapalo* – so you have to try to say you know… to try to divide the word along. *Mola* meaning it's a line, *palo* it's numbers, so that's when they can get to understand it. But if you say *molapalo* they don't understand it, so it will be easier if teachers would have, to have a mathematics dictionary, so that when they can be able to, if they are teaching, they should be teaching whatever that is … you know what they understand according to the dictionary. (FG3S1)

Teachers also mentioned the usefulness of the dictionaries in preparation for common assessments, to help them know and understand the terminology used in the assessments. They spoke about needing the dictionaries, since the dictionaries could give them information on the formal, appropriate terms in use which would help them to be better able to prepare their learners for common assessments. One teacher captured this view in relation to the pressure created by common assessments in the following comment:

> Because now we are in an exit class, the movement to intermediate and the whole nation, they are looking at us. They expect us to do one common paper provincially you see, that is why I say we do need those dictionaries, they could help us a lot. (FG3S11)

Related to issues of commonly understood terminology (or lack thereof), teachers spoke about the versions of the DBE workbook that they liked to use and versions of common assessments they preferred (they referred back to the ANA, even though it had been discontinued). As mentioned in the background and introduction to my study (Section 1.1), the DBE workbooks are provided in all eleven official languages of South Africa but they are all monolingual. The point teachers made was that they found it useful to receive the DBE workbook and common assessments in English, because it is more commonly understood. At one school, the teachers spoke explicitly about having recently attended a departmental briefing (FG3S5) where they had heard that they were no longer going to be allowed to receive English DBE workbooks for mathematics because the LoLT of their school was IsiZulu and that they should stop all code-switching when teaching mathematics. [73] They had been allowed this dispensation (English material for mathematics in an IsiZulu LoLT school) for several years and were now considering what to do about it. They did not want to take the drastic step of changing the school LoLT to English, as they did not think the learners would cope with home language English but at the same time, they did not want to have to teach mathematics in pure IsiZulu. The teachers were left to solve this conundrum created by an authoritarian directive which they saw as a challenge to the functional routine they had established at their school.

Teachers picked up the idea of bilingualism readily as a response to the problems they faced in the multilingual context. For teachers, the use of mixed languages came to mind while they grappled with issues of a lack of standardisation and how to overcome these issues, in the context of teaching mathematics for understanding. As discussed in this section, they recognised the value of bilingual materials in the context. One teacher made the connection between bilingual materials and the LoLT, making the following suggestion:

> Yes, the policy should be the mother tongue together with English. Let's say the book on this side is Zulu and on the back is then English, that will be the best because if you open this side its Zulu and English the other side. … No, we need both languages from now maybe till Grade 7. After Grade 7 they will be matured, their brains will be matured enough to take other things like different languages. (FG4S2)

Perceptions about variation in language use (Section 6.3) are linked to perceptions in relation to the standardisation of language (Section 7.2). The constraint of standardisation is evident in both sets of perceptions. The translation activity, which is discussed next in Section 7.3, gives further insight into variation in mathematical language use in the context of the standardisation debate and sheds light on the value of language proficiency in support of teaching mathematics for understanding (Barwell, 2018; Planas, 2018).

[73] Note made in discussion prior to a focus group discussion at a sample school (2018).

7.3 Teachers and learners working with mathematical terminology: flexibility is key

The survey translation activity was used to investigate the flexibility with which teachers and learners were able to move between languages (home language[74] and English) in a written activity. I used the term flexibility to speak about the ease with which teachers and learners could move between languages in the translation activity. I contend that a high level of flexibility can be seen as evidence of a high level of language proficiency. As discussed in Section 4.1.1, the activity was limited to the translation of 20 terms from the mathematical register of patterns that ranged in difficulty and familiarity. [75] The four subcategories verbal/symbolic; correct/incorrect, formal/informal and appropriate/inappropriate in my analytical framework (Figure 4.2, subcategories 2, 3, 4 and 5) were applied in the analysis of the survey translation activity. I first discuss and further exemplify the different types of responses that were accepted as correct in the translation activity (Section 4.6.1.2).

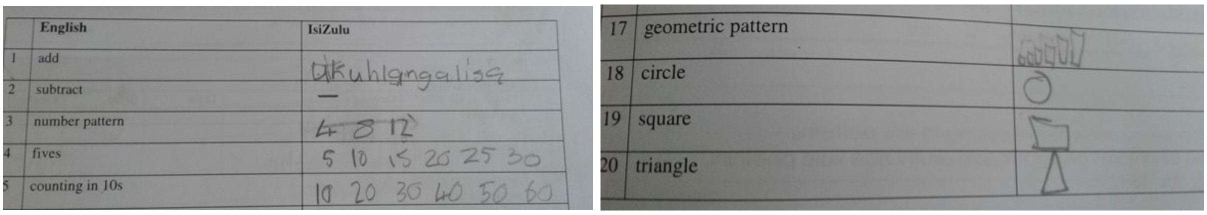
The full mathematical register consists of more than just words (e.g. Barwell, Barton & Setati, 2009; Barwell, Leung, Morgan & Street, 2005; Setati, 2002) and some of the terms could be "translated" using other than a verbal response.[76] There were three such types of terms. The first type are terms used to name operations which are used when finding rules for numerical patterns e.g. add (+). The second type are terms that name specific counts which could be explained using numeric examples e.g. fives or counting in 10s. The third type are terms related to mathematical shapes which could be visualised or drawn, since geometric patterns involve shapes. In the translation activity, some learners showed their understanding of a term by giving a symbol (e.g. a plus sign) or an illustration (e.g. a square), evidence that they understand the meaning of the term but are unable (or did not choose) to translate the term using language. This variation in mathematical language use is represented in my analytical framework as subcategory 2, verbal/symbolic (Figure 4.2) where symbolic includes symbols as well as

[74] This assumes that the home language of the teachers and learners is the LoLT (or ex-LoLT for schools that have adopted English as LoLT). As was shown in Chapter 5, the schools are highly multilingual and this assumption is actually not valid, however, in schools, learners are expected to work in the LoLT and findings in this regard are taken to speak to the policy assumptions. As mentioned previously, I refer to home language in the sense of the CAPS LoLT assumption, otherwise I refer to indigenous languages when not speaking about English.

[75] See Appendix 3 for the full list of CAPS patterns related terminology and Appendix 4 for the 20 terms selected for inclusion in the survey questionnaires.

[76] In this section, where the survey translation activity is discussed, the word translation is used often. This is not to be confused with the "translation" that is involved in code-switching, as discussed in the definitions of the categories in my analytical framework. But language proficiency facilitates both translation activities.

diagrammatic illustrations presented as alternatives to verbal expressions. Correct symbols/diagrams were accepted as correct translations since this is evidence that the learner knows the mathematical meaning of the term and is able to “translate” it using the broader mathematical register. Examples of these are shown in Figure 7.1.



	English	IsiZulu
1	add	[illegible]
2	subtract	—
3	number pattern	4 8 12
4	fives	5 10 15 20 25 30
5	counting in 10s	10 20 30 40 50 60

17	geometric pattern	
18	circle	
19	square	
20	triangle	

Figure 7.1: Examples of symbolic variations for translations

In Figure 7.1 examples of the three types of symbolic translations are shown. [77] In the snapshot on the left, although the learner gave a verbal translation for the word *add*, the translation for *subtract* was given using the operation sign for subtraction (–). This was accepted as correct. This learner also gave symbolic examples by way of “translation” of other terms shown here. *Number pattern* was “translated” as 4, 8, 12; the term *fives* was “translated” as 5, 10, 15, 20, 25, 30 and *counting in 10s* was “translated” as 10, 20, 30, 40, 50, 60. All of these were also accepted as correct. In the snapshot on the right, another learner also gave symbolic translations. The term *Geometric pattern* was expressed as a drawing of a geometric pattern of increasing rectangles. This was accepted as correct. The terms *circle*, *square* and *triangle* were all expressed using diagrammatic examples by way of “translation” which were also accepted as correct. Thus, included in the variety of translations that were accepted as correct, were the symbols, numeric examples and diagrams that gave appropriate “translations” of the given terms.

There were also some terms which learners translated correctly, where clearly, they did know the meaning of the term, but they did not use the anticipated spelling in their translation (expected translation). This variation in mathematical language use is captured in my analytical framework as correct/incorrect (Figure 4.2, subcategory 3) where the expected translation stands for the “correct” spelling and “incorrect” includes translations that were accepted as correct in spite of variations in or incorrect spelling. There were two other types of translation,

[77] The two snapshots in Figure 1 are taken from two different learners’ work. The one on the left is a Grade 4 learner and the one on the right is a Grade 3 learner.

again where learners clearly knew the meaning of the term, but they did not give the anticipated response by way of translation that were accepted as correct. These variations in mathematical language use are captured in my analytical framework as formal/informal or appropriate/inappropriate (Figure 4.2, subcategories 4 and 5). Acceptable but informal expressions for terms were accepted as correct in spite deviating from the list of expected translations (Section 4.6.1.2, formal/informal). Certain differences in word choice, or spellings of words, could be attributable to dialectical differences. Responses where learners used appropriate terms in indigenous languages that are not in the DAC dictionary lists of terms for versioning [78] were accepted as correct (Section 4.6.1.2, appropriate/inappropriate). Examples of variation according to these subcategories are shown in Table 7.1.

Table 7.1 Examples of the subcategories correct/incorrect, formal/informal and appropriate/inappropriate

No.	Direction	Term	Expected translation	Variations in spelling accepted as correct: formal (informal) versions
1	English/Setswana	add	tlhakanyo (oketsa, tsenya, tsennya)	tlhakanya, tlhakantsha, go tlakansa, go tlakantsa, go tlhakantsha, ke go tlakantsha, hlakantsha
1	Setswana/English	tlhakanyo	add (plus)	ad, ed, edd, edishine; adshen; edsane; adition, edition, adshin, assitchan puls, polase, polas, pluse, ples, plers, plass, plase, plas, pas
9	English/IsiZulu	between	phakathi nendawo (phakathi)	mmphakathini, maphakathi, pakati, phakathi ne ndawo, emaphakathini, ngaphakathi, pakathi, emabakathini, ngaphakathi
9	IsiZulu/English	phakathi nendawo	between (middle)	betneer, betwee, betweet, bitween, inbetween, betwewen mindle, in the middle, in the milhili, in the meagle, in the milhili, on a middle, writein mihleli, midlel esayd the way, insad

Table 7.1 shows examples of responses accepted as correct using two terms from the translation activity, *add* and *between* (terms 1 and 9 in the activity respectively). Examples of variation, in both directions of translation are shown. The term *add* is shown for English/Setswana and the term *between* is shown for English/IsiZulu. The last column in the table gives the responses that were accepted as correct in the activity. It can be seen that there was rich variation in

[78] As explained in the methodology, the list (with translations) for the translation activity was compiled using the DAC dictionary. The DAC dictionary does not provide adequate variation in terms but it was used as the "standard" since it is provided as the standard reference for translators doing translation of CAPS related material in the FP.

spelling observed in the translations of the terms. The coding did not penalise the many examples of incorrect spelling and so "correct translations" included translations (in all languages) with correct and incorrect variations of spelling. As it can be seen in the first row of the table, many alternative spellings/forms of the word *tlhakanyo* were accepted as correct translations of the term *add* (from English to Setwsana). The fourth row of the table shows that the term *middle* (and many alternative spellings and expressions for the word) was accepted as an informal term for *between* (from IsiZulu to English).

Translanguaging examples (mixed language expressions or trans words) were also included in subcategory 5, since they were accepted as correct (appropriate) translations (Section 4.6.1.2, appropriate/inappropriate), even though they were not the anticipated 'correct' responses in terms of the activity (this happened more often from English into an indigenous language). Further examples of variation according to the subcategories formal/informal and appropriate/inappropriate are shown in Table 7.2.

Table 7.2 Examples of the subcategories formal/informal and appropriate/inappropriate

No.	Direction	Term	Expected formal translation	Informal/appropriate translations accepted as correct
3	English/Setswana	number pattern	popegopalo	nomoro ya pattern
5	English/IsiZulu	counting in 10s	ukubala ngawo 10	bala ngabo ten; bala ngama tens; bala ngama ten.
10	English/IsiZulu	flow diagram	ishadi lokulandelayo	ukulandelana diagram
10	IsiZulu/English	ishadi lokulandelayo	flow diagram	flow chart
16	Setswana/English	tatelanopalo	number sequence	number pattern
18	English/IsiZulu	circle	isiyingi	indingiliza
19	English/Setswana	square	sekwere	khutlo nne

Table 7.2 shows a few more examples (in the last column of the table) of informal or appropriate expressions accepted as correct for some of the different terms in the translation activity. The coding did not penalise the use of informal/appropriate terms or expressions and so these were included as "correct translations" (in all languages). The translation *flow chart* was accepted as correct for the anticipated response *flow diagram* and *khutlo nne* (4-cornered shape) was accepted for *sekwere* (*square*). Dialectical differences, for example *indingiliza* for *isiyingi* (*circle*), were also accepted as correct. Translanguaging was accepted as correct (for example *nomoro ya pattern* for *number pattern* and *bala ngama ten* for *counting in 10s*). If I had not been prepared to accept variation in the translation activity, "success" rates would have

been much lower and they would also not have been a fair representation of correct translations provided by learners. We do need to prepare learners and teach them to spell correctly, but awareness and acceptance of more varied possibilities (including dialectal differences in spelling and translanguaging) is critical in multilingual contexts. Accepting as correct, incorrect alternative spellings, and acknowledging correct informal/appropriate terms maintains the focus on the concept.

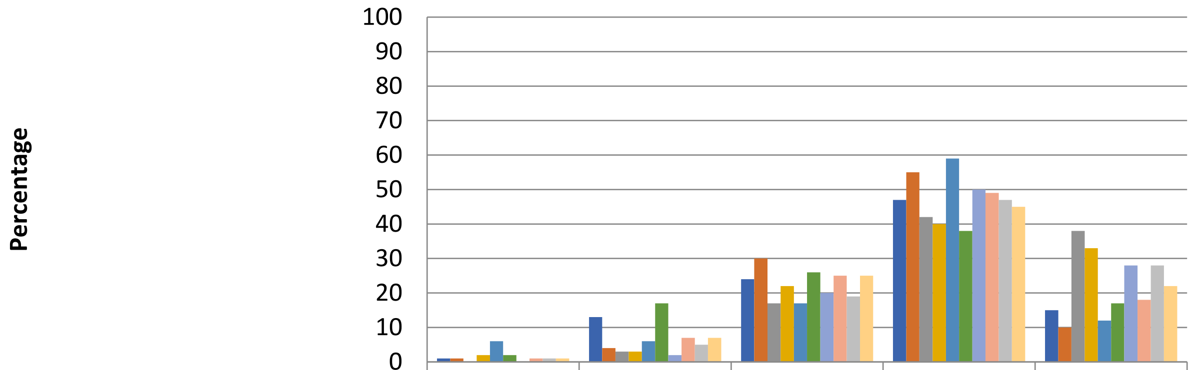
The examples shown above form the basis for the discussion in the two subsections that now follow. Section 7.3.1 presents findings from the learner sample while Section 7.3.2 presents the teacher findings on the translation activity in the survey. The first finding from the translation activity, discussed in Section 7.3.1, is that learners are severely limited in terms of flexible use of language.

7.3.1 Learners are severely limited in terms of flexible use of language

The learners who participated in the study were all young (Grade 3 and Grade 4). Although this is an age at which they could already be using language in the process of learning, it is well known that in South Africa the reading and writing skills of such learners is still well below international benchmarks (Howie & Van Staden, 2012). While Bertram, Christiansen and Makurdi (2015) found that Foundation Phase teachers' low subject content and pedagogic content knowledge was a cause of poor learner performance in mathematics, issues of language impacting on their achievement has not been sufficiently researched to date. The findings in this section of Chapter 7 are further evidence of general weakness in the learner population in relation to reading (Spaull, 2016a) and vocabulary development which has been written about by Pretorius and Stoffelsma (2017).

It is of interest to study the findings of the translations done by the Grade 3s and Grade 4s separately and to compare them, since according to policy, learners should be using their home language in Grade 3 (an indigenous language) and English from Grade 4 onwards. Figure 7.2 presents the summary of correct[79] learner translations per grade and direction of translation.

[79] According to my subcategories (Figure 4.2 and Section 4.6.1.2) and coding which, as it has been explained, accepted a wider than normal range of correct responses in order to acknowledge variation in spelling, word choice and representation.



	16-20 terms correct	11-15 terms correct	6-10 terms correct	1-5 terms correct	0 terms correct
English/Setswana Grade 3 learners	1	13	24	47	15
English/Setswana Grade 4 learners	1	4	30	55	10
English/IsiZulu Grade 3 learners	0	3	17	42	38
English/IsiZulu Grade 4 learners	2	3	22	40	33
Setswana/English Grade 3 learners	6	6	17	59	12
Setswana/English Grade 4 learners	2	17	26	38	17
IsiZulu/English Grade 3 learners	0	2	20	50	28
IsiZulu/English Grade 4 learners	1	7	25	49	18
Total Grade 3 learners	1	5	19	47	28
Total Grade 4 learners	1	7	25	45	22

Figure 7.2: Correct learner translations by grade and direction of translation

In Figure 7.2, it can be seen that learners in both grades did not fare well in the translation activity. Only 6% of Grade 3 and 8% of Grade 4 learners could translate more than 10 of the 20 terms correctly. On average across all groups, 47% and 45% of Grade 3 and Grade 4 learners respectively were able to translate between 1 and 5 terms correctly and 19% and 25% of Grade 3 and Grade 4 learners respectively were able to translate between 6 and 10 terms correctly. There were 28% and 22% of Grade 3 and Grade 4 learners respectively who were not able to translate any words at all. These figures show that, very slightly, Grade 4 learners did fare better on the activity than their Grade 3 counterparts. Since this was not a test of ability but rather of familiarity with mathematical terminology, and the ability to move flexibly between languages, the achievement results are not so much of interest as the opportunity the activity gives for a closer look at which terms were more familiar ("easier" for learners to translate) and which terms were less familiar ("more difficult" for learners to translate).

A closer examination of the translation responses was carried out using the summary tables[80] in which all the detail of the terms translated by the learners was recorded (one table per grade for each of the directions of translation). Detailed observations about the nature of the translations in terms of the subcategories of my analytical framework were possible using the summary tables for the translation data. An extract for the term *describe*[81] (the seventh term on the translation activity list) from the Setswana/English (tlhalosa) and the IsiZulu/English (chaza) from learner summary tables is shown in Table 7.3.

Table 7.3 Counts for learner translations of the term *describe* from the translation activity

No.	Term (Language)	Translations -expected term and variations in spelling	Translations – other acceptable translations with variations in spelling	Numeric/Symbolic "translations"
7	tlhalosa (Setswana)	describe	explain	n/a
	50/128		50 variations were noted e.g. alxplan, aspain, axbin, eecipain. One learner wrote extend.	
7	chaza (IsiZulu)	describe	explain tell (not exactly correct but acceptable)	n/a
	67/197		62 Variations were noted e.g. axplain, axmplaning, axplein, ecplain, explane, explayini, xplam, xplani 2 interesting variations were noted e.g. talk, tell me. The learners understood it to mean "talk about" which is correct.	

It can be seen in Table 7.3 that no learners used the word *describe* in their translations. They all used an informal alternative, *explain,* which was accepted as correct (Figure 4.2 subcategory 4). The counts in the second and the fourth rows of Table 7.3 indicate variation and number of correct responses. For example, 50/128 indicates that there were 50 different correct translation alternatives of the term (including those with incorrect spelling) out of a total of 128 correct translations given for that term (Figure 4.2, subcategory 3). This excerpt thus shows further evidence of findings of my analytical subcategories correct/incorrect and formal/informal (Figure 4.2, subcategories 2 and 4) as exemplified in Tables 7.1 and 7.2. It can be seen that both in Setswana and IsiZulu there were many alternative "correct" spellings. The examples of correct translations given in the table show the extent to which alternatives were identified which take into consideration any phonetic record of the term sounded out in the mind of a

[80] Two full exemplar summary tables of learner translations can be found in *Appendices 5.1* and *5.2.*
[81] This word (describe) was chosen as an example because the words thlalosa (Setswana) and chaza (IsiZulu) were used as translations for the word "explain" in the mathematics questionnaire which was the second part of the survey. It is the seventh word on the activity list.

young learner. The way (at times) in which learners write the English words phonetically can be linked to the activity of translanguaging – in this case the words *explayini* and *xplani* can be seen to have IsiXulu roots. This finding has bearing on the drive for standardisation and use of pure standard language as discussed in Section 2.3. In the translation activity, if only the pure, correct standard forms of terms had been counted as correct (both in English and in the indigenous languages) the percentages of correct translations would have been close to zero. Young learners need to be taught in a way that will lead to correct knowledge and use of terminology but along the way, correct knowledge and understanding needs to be acknowledged and built on in order to develop conceptual understanding (meaning) at the same time as procedural knowledge (spelling).

In Table 7.3, other examples of translanguaging which produced appropriate alternatives were found. [82] For example, one learner translated the term describe as *ho chaza*, which is a mixture of Sesotho and IsiZulu and another learner translated *extend* into *go extenda* borrowing from English and mixing with Setswana. Thus the translation activity revealed that learners used synonyms for terms, some of which they invented for themselves (creating synonyms at times using creative translanguaging techniques). These examples are further evidence of findings of the analytical subcategory appropriate/inappropriate as exemplified in Table 7.2. This shows learners making meaning with words and also needs to be considered in the light of the standardisation debate (Section 2.3). At this level, conceptual understanding needs to be prioritised and correct spelling (procedural knowledge), can and will be developed over time. As was discussed in Section 7.2, teachers perceive that knowledge of the mathematical terminology would be improved if it were more standardised (Sections 7.2.1.5 and 7.2.1.6) but this view should be tempered by the manner in which non-standard terminology can be used in meaning making discussions in mathematics.

The findings for the learners' translations in the different directions and for the different languages give an indication of the flexibility with which learners can move between using mathematical terminology in the home language (either IsiZulu or Setswana in the case of this study) and English. Figures 7.3, 7.4, 7.5 and 7.6 represent these findings graphically and enable comparisons between learner translations for both grades, in both directions of translation.

[82] The translanguaging examples given here are from translation tables that are not included in the appendices because the full set of eight tables could not be included due to space constraints.

These four graphs are presented on one page in such a way that a visual impression of the variation across the four directions of translation is possible.

Figure 7.3 Percentages of correct *English-Setswana* translations for Grade 3 and 4 learners in the sample

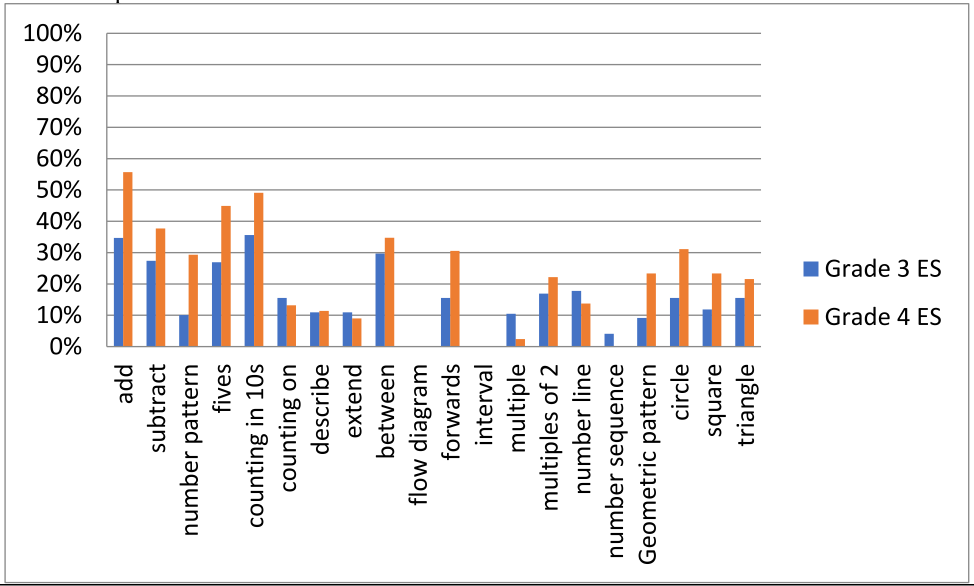


Figure 7.4 Percentages of correct *English-IsiZulu* translations for Grade 3 and 4 learners in the sample

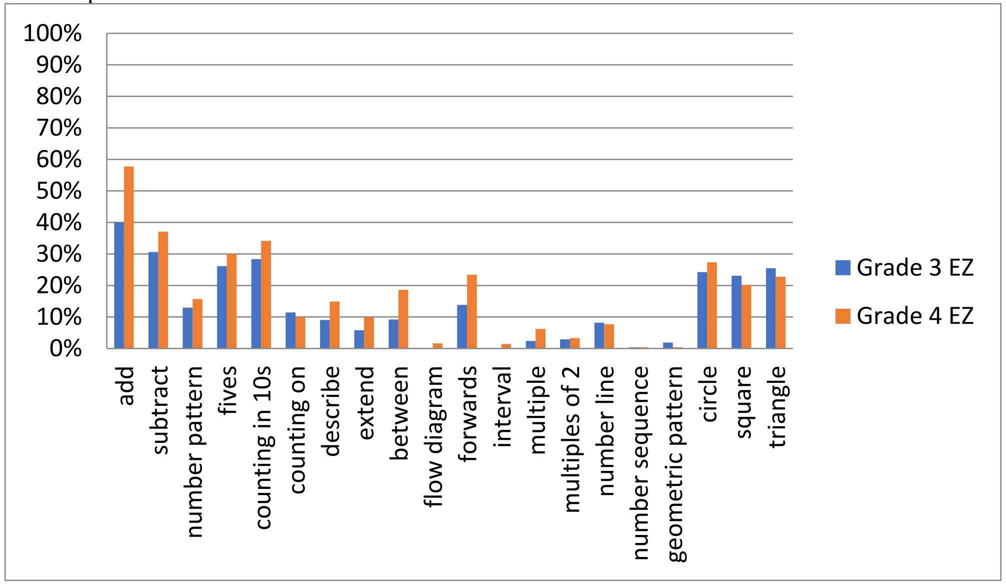


Figure 7.5 Percentages of correct *Setswana-English* translations for Grade 3 and 4 learners in the sample

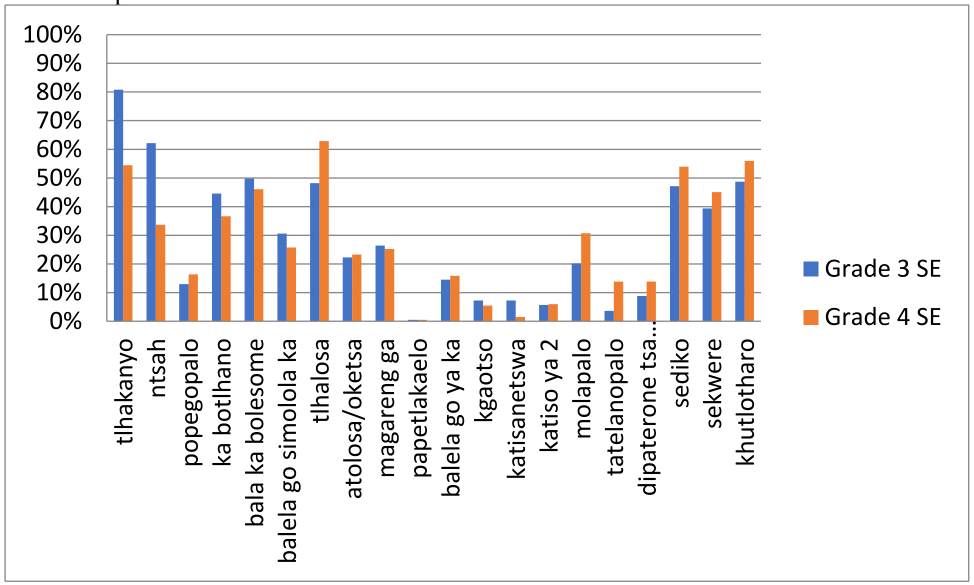
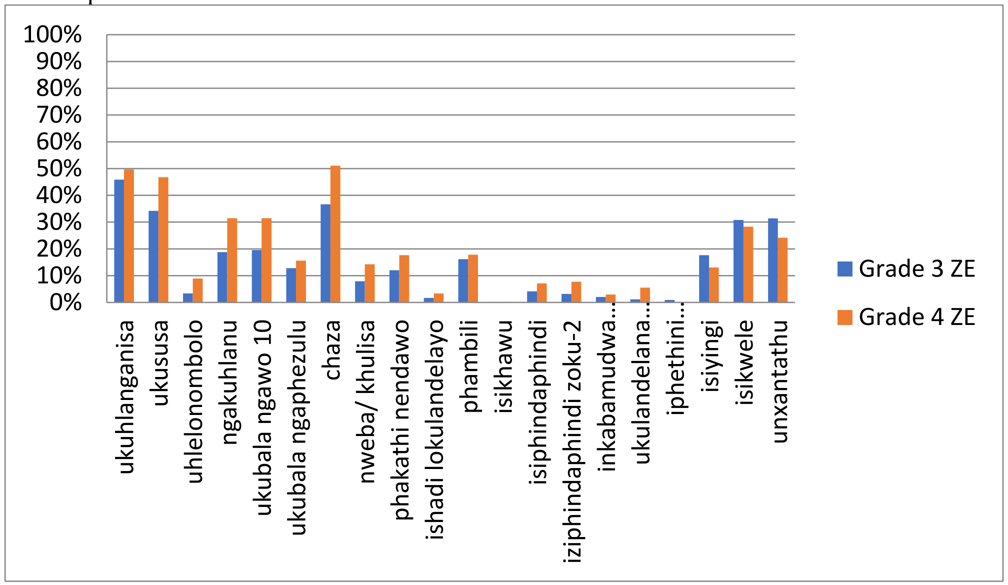


Figure 7.6 Percentages of correct *IsiZulu-English* translations for Grade 3 and 4 learners in the sample



It can be seen in Figures 7.3, 7.4, 7.5 and 7.6 that in both directions and for the majority of the terms, Grade 4 learners were stronger than Grade 3 learners in the translation activity. The pattern in Figures 7.3 and 7.4 are not much different from those in Figures 7.5 and 7.6 – showing that for many terms there are similar levels of ease/difficulty with which learners were able to move from English to IsiZulu/Setswana. In these figures it is again clear (as seen in Figure 7.2) that translations were done better in Setswana (Figures 7.3 and 7.5) than in IsiZulu (Figure 7.4 and 7.6).

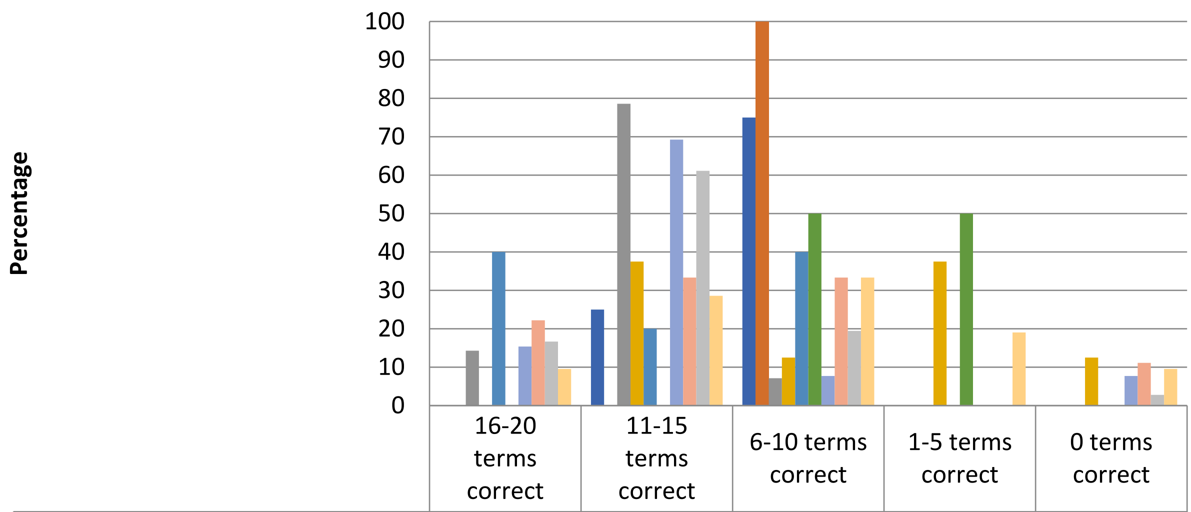
The findings in relation to particular terms are highly varied and the fine detail of achievement is not discussed here, since that was not the purpose of this activity, but certain comparisons are made to highlight the terminology for which they occur. In both directions the terms interval, geometric pattern, flow diagram and number sequence were translated the worst and generally the learners who got these terms correct also got the spellings correct. These could be learners who are proficient in both language (English/IsiZulu/Setswana) and in mathematics, showing the value of language proficiency. Very few learners knew how to translate these terms (which must show at least for some that they did not know the meaning of these terms) even though the terms are in the curriculum. This is taken as indicative that the terminology in the CAPS, which is considered the standardised terminology of patterns, is not necessarily well known by learners.

I now extend the earlier discussion of the term *describe/thlalosa/chaza* for the learner activity (Table 7.3). It can be seen in Figures 7.3 and 7.4 that just near to 10% of learners were able to translate the term *describe* into an indigenous language. Figures 7.5 and 7.6 however show that closer to 50% of learners were able to translate it from the indigenous languages to English. The discussion after Table 7.3 showed that the translation to English was mostly done using a synonym for the term, *explain,* spelled in many different ways. In looking for an explanation for this, I considered that it could be linked to the fact that the mathematical questions in the earlier part of the survey may have been read/explained to learners, and the term *explain* (linked in the bilingual presentation of the questions to the terms *thlalosa* and *chaza*) would have been brought to the attention of learners in this way.

The next finding from the translation activity, discussed in Section 7.3.2, is that teachers' language proficiency is better than that of learners', and teachers are able to move flexibly between languages.

7.3.2 Teachers' language proficiency is better and they are able to move flexibly between languages

Teachers did the translations in the same directions as the learners in their classes – hence the same four directions of translation are reported on and for the same grades. Before the discussion on the detail of the teacher translations, a summary of the number of correct translations is given in Figure 7.7 which summarises the overall number of terms translated correctly by the teachers.



	16-20 terms correct	11-15 terms correct	6-10 terms correct	1-5 terms correct	0 terms correct
English/Setswana Grade 3 teachers	0	25	75	0	0
English/Setswana Grade 4 teachers	0	0	100	0	0
English/IsiZulu Grade 3 teachers	14	79	7	0	0
English/IsiZulu Grade 4 teachers	0	38	13	38	13
Setswana/English Grade 3 teachers	40	20	40	0	0
Setswana/English Grade 4 teachers	0	0	50	50	0
IsiZulu/English Grade 3 teachers	15	69	8	0	8
IsiZulu/English Grade 4 teachers	22	33	33	0	11
Total Grade 3 teachers	17	61	19	0	3
Total Grade 4 teachers	10	29	33	19	10

Figure 7.7: Correct teacher translations by grade and direction of translation (n=62)

It can be seen from Figure 7.7 that the teachers, as is to be expected, fared better than the learners in the translation activity. Overall, the Grade 3 teachers were stronger in the activity than the Grade 4 teachers, which is not surprising since Grade 3 teachers are expected to teach in the indigenous languages. However, the overall percentages across the board are still fairly low – 19% and 33% of Grade 3 and Grade 4 teachers respectively translated between 6-10 terms correctly and 61% and 29% of Grade 3 and Grade 4 teachers respectively translated between 11-15 terms correctly. Only 17% and 10% of Grade 3 and Grade 4 teachers respectively translated between 15-20 terms correctly.[83]

The teachers' responses to the translation activity were recorded into the same eight summary tables[84] as for the learner data. Observations about the nature of the teachers' translations in terms of the subcategories of my analytical framework could thus also be made. The teachers' responses were far more standard and there was very little variation in the translations given by teachers. An example of this is shown in Table 7.4 which contains extracts from the teacher tables for the term *describe/thlalosa/chaza*.[85] This data is presented in comparison to the findings for the same terms translated by learners, shown in Table 7.3. Table 7.4 shows that teachers know the standard terminology to a greater extent than learners do.

Table 7.4 Counts for teacher translations of the term *describe* from the translation activity

No.	Term (Language)	Translations (Language) - expected term and variations in spelling	Translations – other acceptable translations with variations in spelling	Numeric/Symbolic "translations"
7	tlhalosa (Setswana)	describe		None
	1/3			
7	describe	chaza (IsiZulu)		None
	3/11	Other spellings the phrases e.g. ukuchaza, ukuchaza kabanzi		

In Table 7.4 the counts are given in the same way as in the learner tables. For example, 3/11 in the fourth row, means there were three different correct translations of the term out of 11 correct translations given. It can be seen in the table that there are very few alternative spellings in the teachers' work. In Setswana three (out of four) teachers translated the term *tlhalosa* correctly and used the standard English spelling. In IsiZulu 11 out of 13 teachers translated the term *describe* correctly and there were three variations in their responses. These variations, linked to the term *chaza,* are further examples of my analytical subcategory appropriate/inappropriate

[83] There were some teachers in the sample who chose not to do the translation activity (1 IsiZulu Grade 3 teacher and 2 IsiZulu Grade 4 teachers). This data is reflected in the percentages given in Figure 7.7 as "0 correct" since the tables were produced for the full sample of teachers that participated in the activity. It is not likely to be a correct representation of the knowledge of the terminology on the part of these three teachers.
[84] Two full exemplar tables of teacher translations can be found in *Appendices 5.3 and 5.4*.
[85] This is the seventh term on the translation activity list.

(Figure 4.2, subcategory 5) as exemplified in Tables 7.1 and 7.2. It is worth noting that in the translations to indigenous languages, there was greater variation in the spelling, which again speaks to the standardisation debate.

The findings for the teachers' translations in the different directions and for the different languages give an indication of the flexibility with which teachers can move between using mathematical terminology in the home language (either IsiZulu or Setswana in the case of this study) and English. Once again, as with the learner findings, Figures 7.8, 7.9, 7.10 and 7.11 graphically represent these findings and enable comparisons between teacher translations for both grades, in both directions of translation. The four graphs are again presented on one page in such a way that a visual impression of the variation across the four directions of translation is possible.

Figure 7.8 Percentages of correct *English-Setswana* translations for teachers of Grades 3 and 4

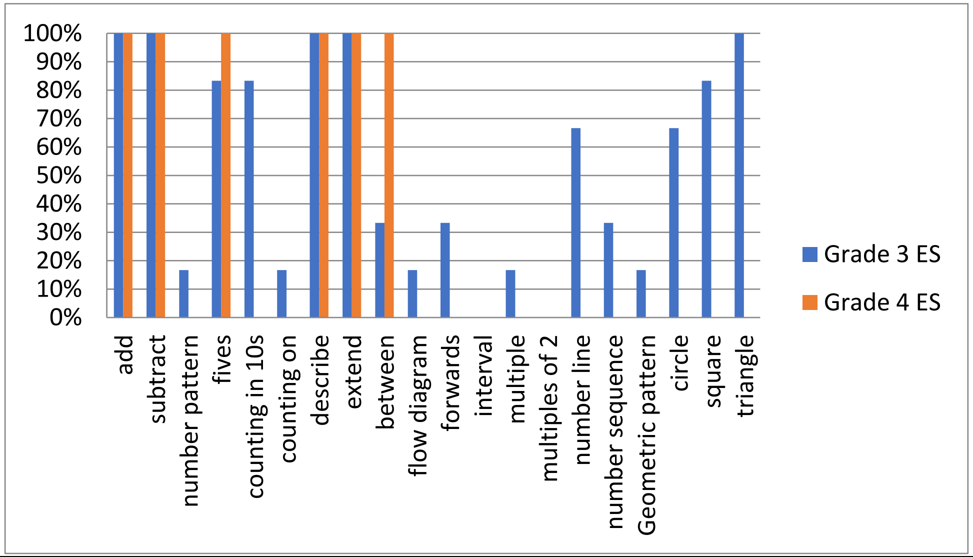


Figure 7.9 Percentages of correct *English-IsiZulu* translations for teachers of Grades 3 and 4

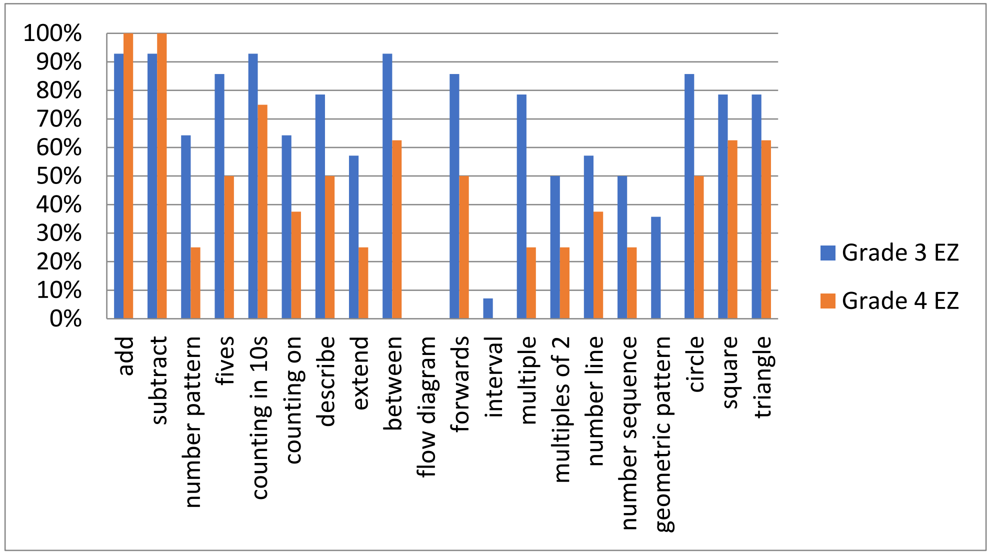


Figure 7.10 Percentages of correct *Setswana-English* translations for teachers of Grades 3 and 4

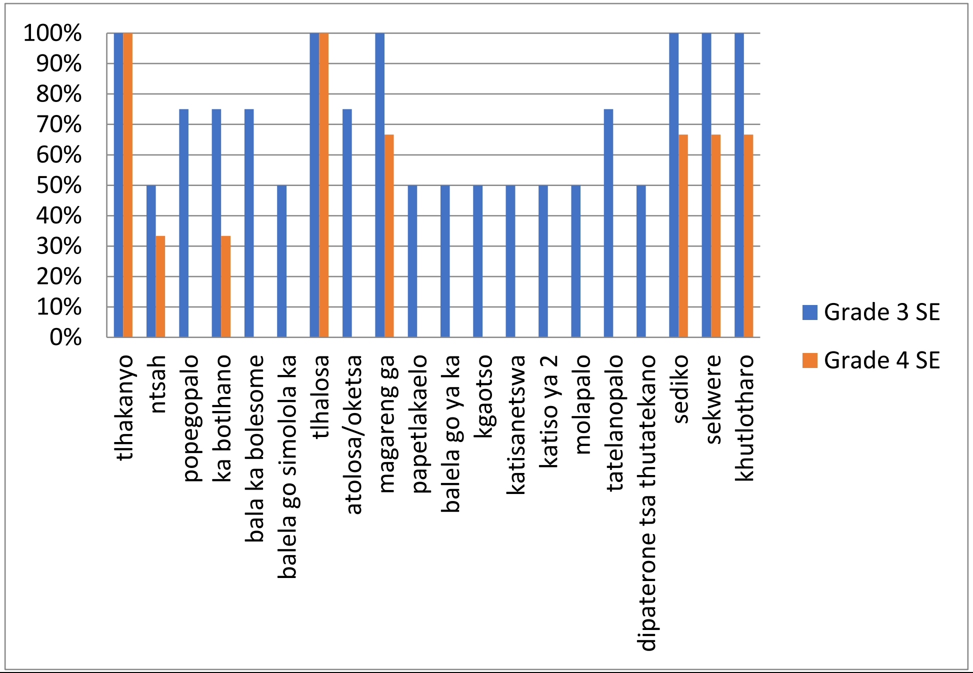
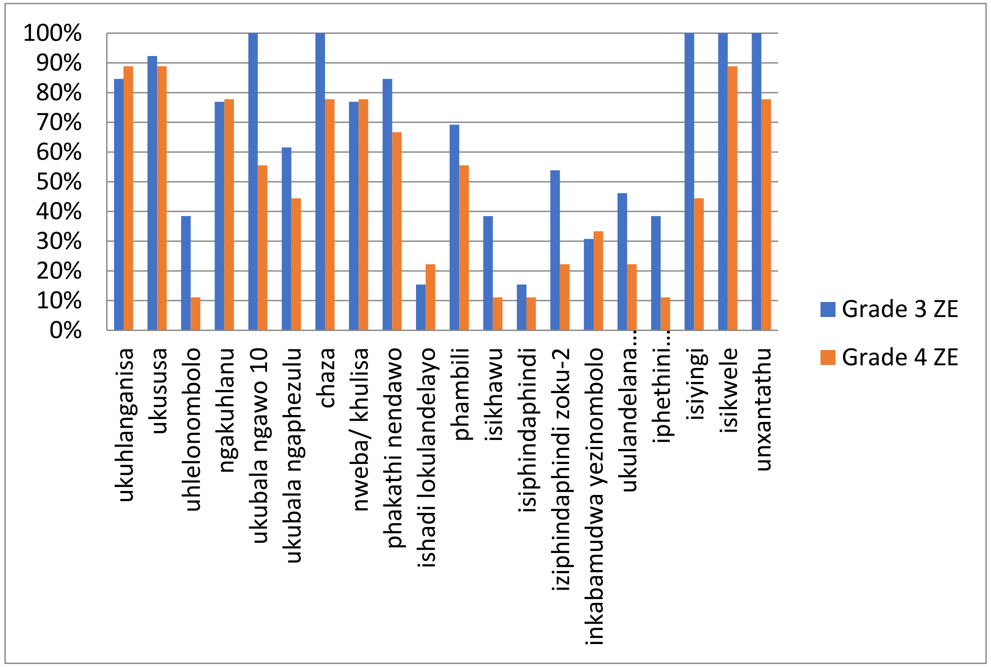


Figure 7.11 Percentages of correct *IsiZulu-English* translations for teachers of Grades 3 and 4



It can be seen in Figures 7.8, 7.9, 7.10 and 7.11 that the teacher translations do not show the same patterns seen in the learner pattern for terms translated correctly/not. It could be expected that teachers would fare better in such an activity. Unlike in the case of the learners, there were some terms that all teachers translated correctly. However, there were some terms that several teachers did not translate correctly. Interestingly, the terms which were problematic in the learner set (Figures 7.3, 7.4, 7.5 and 7.6) were also not so well done by the teachers (for example the terms interval, geometric pattern, flow diagram and number sequence) in both directions. It may be that learners did not know these terms because their teachers were not using them.

The findings in relation to particular terms are again highly varied but in different ways and the patterns in the teacher graphs are more erratic. As before, the fine detail of achievement is not discussed here since that was not the purpose of this activity, but in the teacher sample, the quality of the teacher translation activity was concerning. Many teachers spoke about using code-switching (Section 6.3.4) and one would assume a better knowledge of the core terminology in both languages on the part of the teachers. The findings show that teachers are also not 100% comfortable with the CAPS terminology in both English and the indigenous languages of the study. What this might reveal is the reason why some teachers prefer to use mixed language, particularly when using mathematical terminology. It may be that they do not know all of the terminology in both English and the indigenous language and they prefer to use English for some of the terminology. This aligns with teachers' perceptions on variation in language use discussed in Sections 6.3.1 and 6.3.2 and their perceptions of the language standardisation debate, discussed in Section 7.2.

I now extend the discussion of the term *describe/thlalosa/chaza* (Table 7.4) to the teacher translation activity. It can be seen in Figures 7.8 and 7.10 that all Grade 3 and Grade 4 teachers in the Setswana LoLT schools translated the term correctly, in both directions. Figures 7.9 and 7.11 show at the IsiZulu LoLT schools not all but between 50% and 100% of teachers translated the term correctly (the percentages varied for the different Grades and directions of translation). These findings show greater knowledge of the standard terminology on the part of the teachers but not 100% knowledge, [86] which bears weight on the findings about teachers' perceptions in

[86] I note as a reminder that some of the "incorrect" translations were missing translations.

relation to the use of mixed language (Sections 6.3.1 and 6.3.2) and the standardisation debate (Section 7.2).

There were only three teachers (one IsiZulu and two Setswana) who translated all 20 terms correctly – all of these were Grade 3 teachers. The findings presented in Figures 7.8, 7.9, 7.10 and 7.11 also show that generally (although more strongly for the Setswana LoLT teachers), the Grade 3 teachers' knowledge of the terminology was stronger than that of the Grade 4 teachers (also noted in the comments on Figure 7.7). What is concerning about this finding is that in Section 6.2.4.1, Grade 4 teachers were seen to use more mixed language than Grade 3 teachers, but it could be that they are not mixing for mathematical terminology.[87]

It is not surprising, but it is important, that teachers showed greater flexibility in the survey translation activity than learners (Figures 7.2 and 7.7). It is important since Barwell (2018) and Planas (2018) emphasise the value of language proficiency in support of teaching mathematics for understanding. However, although their language proficiency was better than that of learners, it was still relatively poor – only 17% and 10% of Grade 3 and Grade 4 teachers respectively translated between 15-20 terms correctly (Figure 7.7). Teacher facility with the mathematical terminology may be one reason why learners struggle with it, but the nature of the terminology and the manner in which it is used may also be one of the determinants of this problem. Sections 7.3.1 and 7.3.2 showed that there was variation in the verbal, symbolic and diagrammatic alternatives given as translations for mathematical terms. These were representative of the broader mathematical register of patterns and used by both teachers and learners in the translation activity. It was also shown that variations in language use are linked to "standardised" terminology although there is not consensus on standardised terminology or whether it is even desirable to establish standardisation.[88]

The survey translation activity discussed in this section revealed that many learners and even some teachers were not able to translate, or move flexibly between languages, for some of the basic terminology of patterns. The mathematical terms on the activity list were written using the formal language prescribed by the DAC dictionary. As explained in my literature review,

[87] A more fine-grained analysis of the use of mathematical and non-mathematical language is given in Section 7.4.
[88] This debate is influenced by language ideologies. It will be discussed in Chapter 8 drawing on findings from Chapters 6 and 7.

this dictionary sets a standard for translations for all CAPS support material in the system (DAC, 2008). It is limited and has been criticised for this, but it still is held as the standard to be adhered to for professional translations.[89] This should be borne in mind when considering the variation of terminology found in the translation activity and the observed lessons. One of the questions foremost in my mind is: *Why are the learners not learning the language of mathematics?* Of interest in my study was the language of patterns.

The subcategories in my analytical framework (Figure 4.2) were also applied in a quantitative analysis of the observation transcripts (Section 4.6.4.3). This is presented next in Section 7.4 to give further insight into variation in teachers' mathematical language use in relation to standard terminology.

7.4 Teachers (and learners) using mathematical terminology in observed lessons

In the early grades, the core work on the topic *Patterns, Functions and Algebra* focuses on patterns (recognition, description and extension) and pre-algebraic thinking.[90] The mathematical language used in the learning and teaching of patterns includes number and shape names, operations, the language of pattern representation (pattern, term, number line, number table, flow diagram, etc.) and the language of pattern rule generation (sequence, next, comes after, comes before, comes next, forwards, backwards, rule, etc.). What came to the fore in the observed lessons was that the language of mathematics is not much spoken and if it is spoken, this happens more so on the part of teachers (Sapire, 2018a), so learners are not being given much chance to develop the language. In this section I delve more deeply into the use of mathematical language in the lessons. This section is presented in two parts – the first part exemplifies mathematical language use in the observed lessons (Section 7.4.1) and the second part presents the findings of the quantitative word count analysis of mathematical language use in the lessons (Section 7.4.2).

Section 7.4.1 which follows now, exemplifies a transcription of the observed lessons and gives a snapshot of the language use in the observed Grade 3 and Grade 4 lessons.

[89] My interview with five professional translators confirms this view.
[90] Geometric and numeric patterns are covered. The full overview of the topic can be found in the FP and IP CAPS documents, DBE, 2011a, p.9 (Grade 3) and DBE, 2011b, p.10 (Grade 4).

7.4.1 The reality in the classrooms – teachers using the language of patterns

In the Grade 3 lessons I observed, the teaching on patterns was mostly reduced to counting and skip counting (the first bullet in the FP CAPS descriptors). The mathematical language that surfaced was predominantly the number names. Learning about number concept and number names is part of the FP curriculum, and the teaching on patterns should consolidate this learning. It should, however, also extend and further consolidate mathematical learning by introducing more strongly the notion of patterns and rules, allowing opportunities for learners to reason mathematically. This would enable deeper learning and the teaching of mathematics for understanding. In the Grade 4 lessons I observed, the teaching of patterns included working with tables and identifying missing terms for given number sequences (tabulated, in flow diagrams or simply written out as sequences) which meant that some other mathematical language was noticed in the Grade 4 lessons. Before the quantitative analysis is shown, an excerpt from a Grade 3 lesson is given, to exemplify the type of mathematical language use in the observed lessons.[91]

The episode in Table 7.5 is an excerpt from a Grade 3 lesson where the teachers and learners counted a sequence of fours (skip counting) from 204 to 300 in Sesotho.

Table 7.5: Excerpt from a Grade 3 lesson on counting in 4s (O3S1)

Time	Speaker	Transcription	Translation
3:00	Learners (chorus)	Makgolo a mabedi le metswe e mene, makgolo a mabedi le metswe e robedi, makgolo a mabedi leshome le metswe e mepedi…	Two hundred and four, two hundred and eight, two hundred and twelve. (204, 208, 212)
	Learners (chorus)	Makgolo a mabedi leshome le metswe e tshelela, Makgolo a mabedi le mashome a mabedi, Makgolo a mabedi le mashome a mabedi le metswe e mene	Two hundred and sixteen, two hundred and twenty, two hundred and twenty-four. (216, 220, 224)
	Learners (chorus)	Makgolo a mabedi le mashome a mabedi le metswe e robedi, makgolo a mabedi le mashome a mararo le metswe e mepedi, makgolo a mabedi le mashome a mararo le metswe e tshelela…	Two hundred and twenty-eight, two hundred and thirty-two, two hundred and thirty-six. (228, 232, 236)
	Learners (chorus)	Makgolo a mabedi le mashome a mane, makgolo a mabedi le mashome a mane le metswe e mepedi , makgolo a mabedi mashome a mane le metswe e robedi…	Two hundred and fourty, two hundred and fourty-two, two hundred and fourty-eight. (240, 242, 248) *(teacher makes a mistake in counting with class)*
4:00	Learners (chorus)	Makgolo a mabedi le mashome a mahlano le metswe e mepedi, makgolo a mabedi le mashome a mahlano le metswe e tshelela, makgolo a	252, 256, 258 *(teacher makes a mistake in counting with class)*

[91] The episodes in Sections 6.2.3.2-6.2.3.5 also exemplify language use, with a focus on language mixing.

Time	Speaker	Transcription	Translation
		mabedi le mashome a mahlano le metswe e robedi…	
	Learners (chorus)	Makgolo a mabedi le mashome a tshelela le metswe e mepedi, makgolo a mabedi le mashome a tshelela le metswe e tshelela, makgolo a mabedi le mashome a supa…	Two hundred and sixty-two, two hundred and sixty-six, two hundred and seventy. (262, 266, 270)
	Learners (chorus)	Makgolo a mabedi le mashome a supa le metswe e mene, makgolo a mabedi le mashome a supa le metswe e robedi…	Two hundred and sixty-two, two hundred and sixty-six, two hundred and seventy. (274, 278/276) *(teacher says 278 and learners are saying 276)*
	Learners (chorus)	Makgolo a mabedi le mashome a robedi, makgolo a mabedi le mashome a robedi le metswe e mene, makgolo a mabedi le mashome a robedi le metswe e robedi…	Two hundred and eighty, two hundred and eighty-four, two hundred and eighty-eight. (280, 284, 288) *(teacher and learners continue from the mistake)*
5:00	Learners (chorus)	Makgolo a mabedi le mashome a robonngwe le metswe e mebedi, makgolo a mabedi le mashome a robonngwe le metswe e tshelela, makgolo a mararo	Two hundred and ninety-two, two hundred and ninety-six, three hundred. (292, 296, 300)
	Teacher	Ka Sesotho ke a tseba hore e sule e ya le baeziza, jwale he mamela re tlo qala ho makgolo a makae, a mane akere, ke four hundred akere?	**I can see that in Sesotho it's giving you problems, let's do it in English**, we are going to count from 400 right?

The episode shown in Table 7.5 graphically illustrates the manner in which counting (in this case skip counting in 4s) is sometimes carried out in mathematics lessons. Many teachers in the focus group discussions spoke about the difficulty they (and the learners) have saying the number names in indigenous languages and said that they would prefer to say number names in English, at least some of the time (Sections 6.2.2, 6.2.3, 6.3.3). The teacher in this episode began to make mistakes herself towards the end and suggested to the class that, "I can see that in Sesotho it's giving you problems, let's do it in English". The teacher whose lesson this extract is taken from was focusing on counting rather than patterns, which reduces the cognitive level of the lesson. Number names and counting dominated in this way in my observation sample. In the focus group discussion this teacher commented that, "Even in counting, when they count in LoLT in Sesotho it's very hard for them because now they have to count, like the number, it's very long" (FG3S1), showing no recognition that in the indigenous languages there are various forms of the numbers which can be exploited advantageously (Mostert, 2019, Poo &Venkat, 2021).

The excerpt in Table 5 also serves as an example of the observation transcription style.[92] The transcriptions of the observed lessons on patterns were used to do a word count analysis which is the focus of Section 7.4.2.

7.4.2 Teachers use standard mathematical terminology, but they use other appropriate terminology as well

The terms/phrases in the survey translation activity (exemplars can be found in *Appendix 4.1 and 4.2*) included selected terms related to the topic of patterns. The terms included operation names that are used to generate patterns and find rules for patterns (e.g. add, subtract), terms related to counting sequences that form patterns (e.g. counting in 10s), formal terms related to patterns (e.g. interval, number pattern, geometric pattern) and some shape names (e.g. circle, square, triangle) since shapes are used to generate geometric patterns and number patterns (counts of shapes can be used for this purpose). The terms on the list were in the standard or unitary (Barwell, 2014) form from the DAC dictionary. The word counts based on the search for the 20 terms on the translation list were very low – showing minimal mathematical language use of these specific words. [93] These findings explain (at least in part) why many teachers were not able to translate all of the terms on the list correctly and why learners were not able to translate most of the terms: teachers are not using this precise terminology much and learners have most likely not heard them very often. [94]

Aligning with the survey, where synonyms were accepted as correct (Section 7.4.1), a fuller set of words for the observation word count was created. The set was generated in table form rather than as a linear list in order to show groupings of terms related to the concepts linked to the teaching of patterns. They were identified based partially on the frequency of occurrence in the observation sample (and cross referenced to the survey translation activity) and partly on their importance as mathematical terms related to the concept of patterns. Formal/informal

[92] See *Appendix 7.4* for a full exemplar of an observation transcript.

[93] In the word count analysis the distinction between teachers' and learners' voices was not made. This was a pragmatic decision, as there was so little learner speech noted in the observed lessons. The observation was made in Section 6.2.4 in the analysis of episodes from the observed lessons that in many lessons learners only answered by saying *yes/no/yes sir/yes mam/no sir/no mam* and "mathematical" responses constituted primarily number names. An analysis that separates teacher and learner voices could be carried out but was not within the scope of this study.

[94] Learners may not have seen them in writing either, apart from when teachers may have written the word on the board since the second RMFPM project task which analysed mathematical texts (Sapire, 2017a) showed that the print materials do not include many mathematical terms.

(synonyms/appropriate alternatives) and other appropriate words/phrases (dialectical variation) were included for the second search (Table 4.2, subcategories 4 and 5). Table 7.6 shows the fuller set of terms used for the second word count.[95]

Table 7.6: Mathematical language use in the observed lessons on patterns according to dominant language

Concept/term	Isizulu	Setswana/Sesotho[96]	English
Patterns	amaphethini, iphethini, amaphethini ezinombolo, amaphethini esamubhalomdweb0	popegopalo, paterone, dipaterone, dipaterone tsa thutatekano	number pattern, pattern(s), geometric pattern
Counting	bala, ukubala, bala uqhube, ukubala uqhube, bala zonke, bala usuke, bala ngo	bala, balela, bala go simolola ka, balela go simolola ka, bala tsotlhe, balela go ya ka, bala ka	count, counting, count on, counting on, counting in, count all, count from, count with
Position (in pattern)	inombolo elandelayo, elandelayo	nomoro e latelang, e latelang	next number, next one
Moving/position	phambili, emumva, yeqa , weqa	ko pele, ko morago, tlola	forward(s), backward(s), jump, jumps
Growth (of pattern)	yandisa, ukwandisa, yehlisa, ukwehlisa	oketsa paterone, koketsego: atolosa, oketsa, go oketsa, fokotsa	increase, increasing, decrease, decreasing
Growth/size (or pattern/pattern terms)	khulisa iphethini, nciphisa iphethini	atolosa paterone, popegopalo: kgolo, kgologolo, e nnye, e nyenyane	big, bigger, small, smaller
Addition	hlanganisa, ukuhlanganisa, uhlanganise	tlhakanya, tlhakanyo, go tlhakanya, tlhakanya mo	add, addition, adding, add on, added, plus
Subtraction	susa, ususa, ukususa, khipha	ntsha, go ntsha,	subtract, subtracting, subtraction, minus, minusing, take away
Multiplication and division	phindaphinda, isiphindaphindi, uphindaphinde, hlukanisa, uhlukanisa, ukuhlukanisa,	katiso, aroganya, katisanetswa, atisa, go aroganya,	multiply, multiple, multiplied, times, divide, dividing, division
Shapes	indilinga, isikwele, unxantathu, isimo, umfanekiso womdwebo	dipopego, sediko, sekwere	circle, square, triangle, shape, diagram
Quantification	mangaki? kangaki?	tse kae? bokae?	how many? how much?
Odd/even numbers	izinombolo eziwugweje, izinombolo ezijwayelekile	sekgalatekanyi, palomafeta, palomaleka	even, even number(s), odd, odd number(s)
Equality	ilingana, ilingana no	lekana, lekana le	equal, equal to

[95] The formal terms on the survey translation list were also included in the table.
[96] Because Sesotho was used in some lessons, these words were included in the Setswana search list. These languages are from the same group of indigenous languages.

Table 7.6 shows the variation of terms linked to the concepts related to the teaching of patterns. Word counts for all of the terms shown in Table 7.6 were found using the compiled set of observation transcripts (Section 4.6.4.3).[97] As it can be seen in Table 7.6, the English, IsiZulu and Setswana mathematical terms included some standard terminology but also some synonyms for these terms. For example, in the first row, the possible terms that could be used to talk about patterns are given. In the Setswana examples, *popegopalo* (the word used in the DAC dictionary and one of the survey translation activity terms) is taken as the formal word for number pattern (Figure 4.2, subcategory 4). The words *paterone* and *dipaterone* were identified as appropriate alternatives (Figure 4.2, subcategory 5) that were used in the observed lessons. Counts for these terms were found. The word *popegopalo* was not used at all in the observed lessons, while the word *paterone* was used 22 times in the Grade 3 lessons and 15 times in the Grade 4 lessons. The word *dipaterone* was used 4 times in the Grade 3 lessons and 0 times in the Grade 4 lessons (Appendix 7.5.3).

The counts thus represent findings for the subcategory formal/informal (Figure 4.2, subcategory 4) and the subcategory appropriate/inappropriate (Figure 4.2, subcategory 5) since appropriate dialectical or informal alternatives in the indigenous languages were also included. The word counts based on the table demonstrated the uneven manner in which teachers use mathematical terms in their lessons. It seems as if teachers avoid (or forget) to use the full range of terms to speak about the mathematical content they are teaching.[98] This oversimplification of language use does not benefit the learners. Some findings from the word count analysis are given as illustrations of the use of mathematical terms in the observed lessons, since "terms used" is a part of mathematics language use in lessons.[99] Findings are discussed for the English, IsiZulu and Setswana term counts separately.[100]

The counts presented in Sections 7.4.2.1-7.4.2.3 are all from the full word count tables in *Appendices 7.5.1-7.5.3*. The counts need to be considered in respect of the sample size (25 lessons) of the observed lessons used in this analysis.

---

[97] Full tables of these counts are provided in *Appendices 7.5.1-7.5.4*.

[98] I did not do counts for the number names/numbers in the transcripts, since as alluded to in Section 7.4.1 and demonstrated in the excerpt in Table 7.5, number names predominated. There was no doubt these words were being used. This search was done to look at greater variation in the language use of patterns.

[99] Mathematical language is more than just words, as has been discussed. This is just a part of the language use analysis.

[100] The search was done across the full set of 25 observation transcriptions for all languages. A finer analysis according to LoLT could also be done but was not done in this study. This was a pragmatic choice related to the constraints of the study. It would be of interest in further analysis.

Since English was the dominant language of expression for the mathematical terms in spite of the LoLT (Figure 6.11), this is presented first.

7.4.2.1 Use of English mathematical terms in the observed lessons

The English mathematical terms included examples of formal/informal standard terminology (Figure 4.2, subcategory 4) as it can be seen in Table 7.6. The broader English word count (*Appendix 7.5.1*) showed that teachers in Grade 3 and Grade 4 used the term *pattern* a lot during the lessons (264 and 284 times respectively) and the term *number patterns* was also used in Grade 3 and Grade 4 (57 and 80 times respectively). There were some differences noted between Grade 3 and Grade 4. Notably, in Grade 3 lessons the terms *count* and *counting* (related to counting patterns) were used less frequently in Grade 3 than in Grade 4 lessons (160 and 26 compared to 445 and 72 times respectively). In the Grade 3 lessons the operations (*addition, subtraction, multiplication* and *division*) were referred to less frequently in discussions on pattern rules than in Grade 4 (144, 90, 52, and 22 times compared to 215, 57, 293 and 76 times respectively). Grade 3 teachers spoke a fair amount about *jumps* and going *forwards* and *backwards*, while Grade 4 teachers did not (34, 69 and 98 compared to 3, 7 and 19 times respectively), again showing a difference in approach to the teaching of patterns. *Odd* and *even* number sequences were referred to less often in Grade 3 than in Grade 4 lessons (3 and 22 times compared to 22 and 47 respectively) which shows the more advanced content being covered at the Grade 4 level, aligned with CAPS specifications. The term *diagram* was used relatively frequently in Grade 4 lessons (60 times), linked to the teaching of flow diagrams, part of the patterns content for the grade, but not at all in Grade 3. These findings confirm that teachers are essentially complying with CAPS specifications and they are using some of the mathematical language expected when teaching this content.

It is of interest, in the multilingual context, to note the observed language use in the indigenous languages. The terms that were used broadly aligned to the terms used in the English lessons, which not surprising since the same content was under discussion. The IsiZulu and Setswana mathematical terms included not only formal/informal standard terminology but also appropriate alternative dialectical terminology (Figure 4.2, subcategories 4 and 5) as it can be seen in Table 7.6.

IsiZulu counts are discussed first (Section 7.4.2.2) and the counts for Setswana (Section 7.4.2.3) follow.

7.4.2.2 Use of IsiZulu mathematical terms in the observed lessons

Mathematical terms were not used in IsiZulu as much as they were in English. Grade 3 IsiZulu teachers (*Appendix 7.5.2*) used more mathematical terms in IsiZulu than Grade 4 teachers did. This is to be expected since according to policy the LoLT is an indigenous language in Grade 3 and English in Grade 4. In Grade 3 lessons, terms relating to counting were more commonly used than in Grade 4. The terms *bala* (count), *bala ngo* (count with) and *elandelayo* (next number) (89, 18 and 19 times compared to 5, 0 and 0 times respectively). Operation terms were also used. In Grade 3 lessons the term *susa* (subtract) was used more frequently (11 times) than in Grade 4 (2 times). The terms *hlanganisa* (add) and *phindaphinda* (multiply) were used less in Grade 3 than in Grade 4 (0 and 14 compared to 4 and 23 times respectively). Other word counts were negligible.

7.4.2.3 Use of Setswana mathematical terms in the observed lessons

Mathematical terms were not used in Setswana as much as they were in English, similarly to IsiZulu. Grade 3 Setswana teachers also used more mathematical terms in Setswana than Grade 4 teachers did (*Appendix 7.5.3*), also similarly to IsiZulu. Again, this is to be expected since according to policy the LoLT is English in Grade 4. In Grade 3 lessons, the most highly used maths-term in Setswana was *kgolo* (big) (124 times) but this word was not used at all in Grade 4. *Ko pele* /*pele* (next number) was also used fairly frequently in Grade 3 (55 times compared to 5 times in Grade 4). Finally the counting terms, such as *bala* (count) and *bala ka* (count with) were used more often in Grade 3 than in Grade 4 (28 and 14 compared to 5 and 3 times respectively). Terms that were used more in Grade 3 than in Grade 4 lessons were *karabo* (equal), *paterone* (pattern) and *morago* (position) (15, 22 and 36 compared to 14, 15 and 12 times respectively). Other word counts were negligible.

Finally, the trans word count was analysed. Trans words were not included in Table 7.6 since they are highly varied and often individualised. The transcriptions were searched for trans words and a table was drawn up and used as a basis for the count (*Appendix 7.5.4*). The findings of the trans word count are presented next in Section 7.4.2.4.

7.4.2.4 Use of trans mathematical terms in the observed lessons

Trans word forms of mathematical terminology are evidence of the appropriate/inappropriate subcategory in my analytical framework (Figure 4.2, subcategory 5). This term was introduced in Section 6.2.1, where it was explained that the term *trans* was introduced to refer to words made up by the teachers/learners drawing on more than one "code" of expression. They are not standard, yet they are being used (*Appendix 7.5.4*). There is a wide range of these words – they do not all get used repeatedly but some of them do recur. For example, the term *jump* (used in connection with number line activities in pattern work) appeared as *jampa, siyajampa, ujampa, masijampa* in the IsiZulu lessons (17 times). The Setswana equivalent of this was *di-jumps* which was used less often (5 times). If the word count had been done using only the term *jump* this would not have given a fair representation of the extent to which the term was used in the observation set. The term *phethene/di pattern* was used in the Setswana lessons (38/2 times) while in the IsiZulu lessons the equivalent *i-pattern* was used, but only once. There is a mix of mathematical and non-mathematical terms in this list and they appear in different clusters. The use of trans words speaks directly to the standardisation debate – raising the question as to what terms should form part of the formal standard register. Other counts are minimal and thus are not all discussed, but it is worth noting that there were 90 different trans words counted in the sample.

The word count analysis of the observed lesson transcripts discussed in this section revealed that mathematical language use in the lessons was limited. There were 25 lessons which formed the sample of this analysis but only five of the word counts went over 200 (all in English) – an average of 8 times in a lesson. That being said there was a range of mathematical terminology used and it incorporated formal, informal and appropriate (dialectical and trans alternatives) mathematical terms (Figure 4.2, subcategories 4 and 5). Very little formal terminology was used in any of the lessons in any of the observed languages (*Appendices 7.5.1-7.5.4*). This sheds further light on my question: *Why are the learners not learning the language of mathematics?* It appears that the use of and exposure to this mathematical language is highly limited. Section 7.3 showed that learners and even some teachers exhibited limited flexibility with the terminology in the survey. Section 7.4, in showing how little this language is used in the lessons they teach, might in part explain this limited flexibility. In the indigenous languages, the formal, standard (DAC) forms of the terms were hardly used at all in the lessons, which begs the question: *Why not?* The scope of my study precluded a full investigation of this language use (see limitations discussed in Section 4.9) but one of the factors that I considered might impact on this was the issue of language standardisation.

The language standardisation debate is ideological by its very nature. The findings from my study in relation to this are presented next in Section 7.5.

7.5 The language ideology embodied in the CAPS clashes with the reality of multilingual schools - standardisation is the constraining factor

In this section I draw together findings that highlight the tension created by clashing ideologies (monoglossic and heteroglossic) driving language use, based on issues raised by teachers in relation to standardisation. The findings on teachers' perceptions from the focus group discussions show that teachers grapple with the issues that the standardisation debate raises in their classes in the multilingual context (Section 7.2). In spite of the prevailing monoglossic ideology embodied in the policy, teachers' ideologies varied (Section 6.4). In response to pressure from the monoglossic policy, teachers favoured the use of pure language (Sections 6.2.1, 7.2.1.4 and 7.2.1.5) – evidence of restricted language use. But teachers also used language creatively and favoured mixed language use (Sections 6.2.3, 7.2.1.7, 7.3.and 7.4), evidence of embodied heteroglossic ideologies. This creates multiple levels of tension experienced by teachers, which they expressed in terms of a complex set of problems linked to the versions of mathematical terms in the indigenous languages (Section 7.2). These are now discussed to demonstrate the constraining effect of standardisation on ideology which is more often seen as a restricting (constraining) factor but at times it is seen as a creative driver.

The contradiction between the founding policy documents (Department of Education, 1997) and the application of the policy represents the first level of tension in the system. This tension is evidence of the first constraining effect of standardisation, in the implementation of policy at the school level. The language policy on which the CAPS draws was designed to support multilingualism, but as discussed in my conceptual framework (Table 3.1) and supported by findings in Chapter 6, the language ideology embodied in the CAPS is monoglossic (Section 6.4). Implementation of the policy is monitored by district officials who, according to teachers, push for the use of pure language in teaching (Section 6.3.3). Teachers receive monolingual materials and are required to teach using pure language because of the embodied monoglossic ideology of policy, although they are teaching in a multilingual context. In this context, standardisation (or lack thereof) constrains teachers' ideologies. A teacher whose ideology is heteroglossic and wants to use mixed language is constrained by the monoglossic ideology of policy. Because teachers are aware of the clashing ideologies, teachers are critical of the errors and inconsistencies they observe in the indigenous language versions of materials they receive from the department (Sections 7.2.1.1 and 7.2.1.2). They feel justified in their critical stance because of the monoglossic policy being imposed on them (Section 6.3.3).

The next level of tension is felt by teachers when they feel bound, by the purist system, not to be inventive, yet they are aware of gaps in the register and are forced at times to invent terms. In this instance, standardisation acts both as a restricting factor and as a creative driver. My findings show that teachers do not want to be held responsible for the invention of terms, but they are aware that the job is not being done (Section 7.2.1.3). Teachers said they would prefer the standardised terms to be invented for them and to be the same for everyone (Section 7.2.1.3). This is an issue linked to standardisation of the register and of standardisation as a constraining factor. However, the analysis of the use of mathematical terminology in the survey translation activity (Section 7.3) and in the observed lessons (Section 7.4) yielded findings in relation to learners' and teachers' flexibility with and use of mathematical terminology. These findings showed that inventing words is something teachers and learners do quite freely, experiencing standardisation as a creative driver. The findings have bearing on the standardisation debate since they provide evidence of teachers using more than just the standard language – variation in terms of formal, informal and appropriate mathematical language use was noted (Figure 4.2, subcategories 4 and 5). The action of using mixed language on the part of the teachers exposes the clash and ongoing struggle/tension between the monoglossic ideology embodied in the CAPS and embodied and articulated heteroglossic ideologies of the teachers. It shows how, counter intuitively, standardisation can act as a creative driver.

My findings show that teachers are also aware of the constraints of monolingualism in the multilingual context in which they work (Section 7.2.1.4). Teachers' experience in the multilingual context has shown them that there is a clash between pure indigenous languages and "home" languages in urban areas – the pure language is another language. This presents the third level of tension that arises from the different, contradictory messages about language use that teachers hear about from research – at times driven by monoglossic ideologies and at other times driven by heteroglossic ideologies, seldom showing cognisance of the issues of standardisation. There are some messages from research that show the value of purist language use (in the home language of the learner) [101] and at other times encourage pluralist, mixed language use.[102] This represents another clash between monoglossic and heteroglossic ideologies which is constrained by standardisation – the teachers' perception is that there is no standard language. Teachers are not sure what to do in this context due to the mixed messages and they are not supported by policy to address it, since the messages and materials they receive from policy are seen to change (Section 7.2.2) or to favour monolingualism which does not take the multilingual context into account. They have a dilemma – their work in context is undermined by the monoglossic policy and the dilemma is not addressed by the opposing views of research. Here language ideologies, drivers of language use, primarily through the authority of policy and research but also through experience are constrained by standardisation. In the multilingual context teachers make a pragmatic choice, which is the next finding – they opt for the use of English (based on a monoglossic ideology), the common language.

Teachers' articulated perceptions emphasised that the lack of standardisation of the mathematical register is a constraining factor on language use which motivates them to use English for the teaching of mathematics (Sections 7.2.1.5 and 7.2.1.6). There are two key ideas that motivate teachers to use English when they teach mathematics. The first is that there is uncertainty about indigenous languages (Section 7.2.1.5) and the second is that they see English as fully standardised and that they are familiar with the mathematical terminology in English (Section 7.2.1.6). The analysis of mathematical language use (Section 7.4.2) confirms this finding – the word counts showed that more mathematical terms are spoken in English than in the indigenous languages (Section 7.4.2.1). More formal mathematical terms (Figure 4.2, subcategory 4) are spoken in English while in the indigenous languages, the word counts showed that more informal or other appropriate terms (Figure 4.2, subcategories 4 and 5) are used (Sections 7.4.2.2-7.4.2.4).

Finally, teachers spoke about the value of mixed language use and multilingual materials in support of language use in the multilingual context (Section 7.2.1.7). This represents another pragmatic choice on the part of teachers, but this time based on a heteroglossic ideology. In

[101] Research published by Taylor and von Fintel (2016) that education in the home language in the FP resulted in improved learner outcomes in the IP in was seen as influential at the time I carried out my data collection in schools in 2017 and 2018.
[102] Multiple local and international studies since the late 1990s (e.g. Setati, 1998a, 1998b; Adler, 1999; Moschkovich, 1999) showed the value of code-switching in multilingual classrooms. This research still forms the authority base for teachers' (and at times departmental) thinking in relation to the use of code-switching (and more broadly language mixing) in multilingual classrooms.

this choice, teachers, constrained by standardisation, can be seen as actively addressing the tension between the monoglossic ideology embodied in the CAPS and their own embodied and articulated heteroglossic ideologies. It shows teachers' awareness of the lack of standardisation and their desire to overcome it in practical ways. This is another instance of the counter intuitive creative drive of standardisation.

My findings show that clashing ideologies, constrained by standardisation, are creating dissonance and multiple levels of tension in the system that is at times counterproductive. In multilingual contexts there are teachers who hold different ideologies which may or may not impose on the way they teach mathematics, but ultimately their proficiency in the mathematical register will impact on their teaching (Barwell, 2018; Planas 2018). A lack in standardisation will constrain this proficiency – either because terminology may be missing or because there is uncertainty as to which terminology to use. A clash between monoglossic and heteroglossic ideologies is inevitable in the multilingual context, which is a pluralist context where the inherent diversity of language will surface. The constraint of standardisation is two-fold – firstly and more directly, it is a constraining factor, inhibiting teachers' language use. Secondly, counter intuitively, it acts as a creative driver, leading to language production on the part of the teachers and learners in response to the constraint.

7.6 Conclusion

The findings in this chapter show that teachers are aware of a lack of standardisation of mathematical terminology in the indigenous languages and to an extent, a leaning towards English language use for the terminology was detected (Section 7.2.1.5). Teachers do not want to use pure English all the time they teach mathematics, they want to be allowed to use mixed language, using the language repertoire with which they (and it appears their learners) are comfortable (Section 7.2.1.7). This confirms the findings from Chapter 6 that both monoglossic and heteroglossic ideologies drive language use. Teachers want to, and try to use standard terminology (Sections 7.3.2 and 7.4). Learners use the terminology they know and are quite flexible in adapting it using the knowledge they have (Section 7.3.1), mainly because of poor language proficiency. The translation activity exposed the fact that learners are not highly proficient in their knowledge of the standard mathematical terminology related to the topic of patterns (Section 7.3.1) while teachers seemed more proficient and familiar with the terminology. Here evidence of standardisation as a constraining factor is seen (Section 7.5).

Teachers were more able than learners to move more flexibly between the home language and English, however only three (of 62) teachers were able to translate all 20 words on the list correctly (Section 7.3.2). Observations in the multilingual classroom sample, aligned with the findings in Chapter 6, showed teachers using mixed language but not without an awareness of the standard mathematical terminology (Section 7.4). The lack of standard terms (in some cases) or greater familiarity with English standards (such as the number names) was evident in the observed lessons (standardisation as a constraint). In the analysis of the use of mathematical terminology in the observed lessons, much of the translanguaging was linked to alternating between the home language and English for these terms (Section 7.4.1. and links to Sections 6.2.3 and 6.3.4). There are productive ways in which indigenous home language number names can be used in the teaching of mathematics (Mostert, 2020; Poo &Venkat, 2021) but teachers in my sample showed a preference for the relative "ease" of using English number names (Section 7.4.1). Teachers did use standard mathematical terminology, but they used other appropriate terminology as well (standardisation as a creative driver), which lead to variation in language use in the observed lessons (Section 7.4.2 and links to 6.2.3). The word count findings are useful in the triangulation of the language use findings – they show teachers using both standard and non-standard terms according to views expressed in the survey and focus group discussions (Sections 6.3 and 7.2).

The evidence of language use in my study (survey, focus group discussions and observations) shows variation constrained by standardisation. The literature speaks of ways in which variation can be productive but there is a case for certain "standards" in mathematics so that in common assessments, textbooks and workbooks, commonly understood and accepted terminology can be used. The terminology used in publications in particular requires that standardisation is in place but as the comments from the professional translators (Section 7.1) and the teachers (Section 7.2) indicate, there is still lack of agreement on whether or not this has been achieved.

In the next chapter I will draw on the literature and pull together the findings presented in Chapters 5, 6 and 7.

Chapter 8 Discussion

8.1 Introduction

"Just 23% of South Africans identify English or Afrikaans as their home language, yet 100% of children are expected to navigate their school years in these languages exclusively" (Albertyn & Guzula, 2020). This is the opening line of an article entitled *Multilingual classrooms boost learning* in a local South African newspaper in March 2020 reporting on an open session on "Developing Multiliteracies in a Multilingual Country" hosted by the Bertha Centre at the University of Cape Town in February 2020. Since I started the journey that led to this study in 2012 much research has been carried out that points to the value of mixed language use in learning and teaching in multilingual contexts. However, to date, as this article very clearly points out, the South African language policy has not yet responded to this research or properly opened up to supporting multilingualism. Although there has been more research in relation to language and literacy than in mathematics education, there is research from the South African mathematics education community dating back to the late 1990s (and earlier than that in other countries) that speaks to the value of mixed language use in mathematics classes in multilingual contexts.

As pointed out in my literature review, this research has been carried out more in the higher grades, starting with the work of Adler and Setati (Adler, 1998, 1999; Setati, 1998a, 1998b). This work has been noted in the policy arena and by teachers, yet the policy remains rigid in terms of LoLT as explained in Chapter 1. My study has shown that teachers on the ground in multilingual classes have heard about the research on code-switching (more so than on translanguaging) and they speak of it as useful in the support of building learners' understanding even though they are aware that it is not strictly endorsed by departmental policy. The prevailing policy attitude towards code-switching in the teaching of mathematics has varied over the past 25 years, from acknowledging its value to disallowing it in favour of pure language use – currently (or at the time of my data collection) some teachers expressed the view that according to policy it seems to be out of favour. This is captured vividly in a teachers' comment in one of the focus group discussions: [103]

[103] This comment also captures the cross-cutting issue of the importance of literacy development which impacts on the learning and teaching of mathematics.

> I know that you are recording me, but I just, I need to be honest with you, because you find that some of the learners can't read. And if you can't read ... if you can't read, you won't be able to write. So just a little, just to explain to them in their mother tongue; this is what I mean, then you will just code-switch, but not right through. … It's not allowed … the department doesn't want it. (FG4S7)

At the outset of my study, I explored the theory in the literature relating to multilingualism in the teaching of mathematics and noted the dearth of such studies in the early grade mathematics which motivated me to carry out my research. To support this investigation and to situate it in the context of other relevant research, I also read further on curriculum and teaching in early grade mathematics and mathematical register. In the discussion that follows, I note how the literature was brought to bear on the data collected through my investigation. As explained in Chapter 3, I then also took time to read up on language ideologies, since it became clear to me that although policy and research drive language use, language use also has an ideological basis (whether speakers are aware of this or not). I developed an analytical framework which I used to examine the way that drivers of language use, identified as ideology and authority (research and policy) affect variation and standardisation in language use according to categories and subcategories that I defined and operationalised (Section 4.6.1). I was worried about teachers and officials who were afraid to even speak about the possibility of bilingual material in mathematics and how it could serve their purpose when what seemed clear to me was that issues that were arising in the multilingual classes I was working in could possibly be addressed by such material. [104]

In order to maintain the integrity of the study, I took a neutral stance towards language use, keeping an open mind as to what language use best facilitates the learning of mathematics in the early grades.[105] As stated in the introduction to my research questions, the goal of mathematics teaching is mathematics learning, but all teaching is rooted in language and it cannot proceed or be assessed without it (Durkin, 1991). Language mediates the learning and teaching of mathematics. That is certain. We need language to speak, think and write. I have

[104] This was in 2012 when I was working as the head of the FP Mathematics arm of the GPLMS. At one training session a district official covered her mouth while speaking to me about the bilingual materials so that nobody could lipread what she was saying.

[105] I maintained my neutrality out of respect for the views of teachers, so that I should not assume to know what is best for them, particularly as I am not conversant in the indigenous languages.

been part of many teacher development projects[106] that have been set in motion to support teachers to improve mathematics learning outcomes. All these projects have developed bilingual mathematics material for learners under my leadership. However to date, none of them have systematically researched the aspect of language use in the support of improving learning outcomes. In doing this study I set out to determine and map the terrain of language use in multilingual early grade mathematics classes. I wanted to see and hear from the teachers and learners what they were doing in their classrooms and understand why.

Having thought about the context and read the literature as described above, I set out to investigate the overarching research question for my study: *What factors drive the language use of multilingual Grade 3 and Grade 4 mathematics teachers and learners on the topic of patterns?*

In short and upfront, I identified that the primary drivers were ideology and policy (authority relations). Professional knowledge of pedagogy (linked to research) and personal experience also played a role. Language standardisation was identified as a constraining factor. To answer my question, I had to discuss findings from the data, guided by my sub-questions, which reveal the way the drivers of language use function. I had to analyse and interpret the vast quantity of data I had collected to find out what story it was telling. As indicated in Chapter 3, drawing on the work of Bakhtin (1981) and Costa (2016) my unit of analysis was the concrete utterance (spoken/written). To carry out the analysis, I needed well defined categories which I established in my analytical framework (Figure 4.2). I devised them drawing on my conceptual framework (Table 3.1) which was drawn up based on the theory of language ideology (Chapter 3), the literature of early grade mathematics teaching and curriculum (Section 2.2), mathematical register and standardisation (Section 2.3) and teaching in multilingual contexts (Section 2.4). I defined my categories and subcategories, created indicators for them and then operationalised the indicators (Sections 4.6.1.1 and 4.6.1.2) using the data from the three sources upon which I based this study – a survey, focus group discussions and classroom observations (Section 4.5).

[106] Such projects include the GPLMS, Jika iMfundo PILO (Project to Improve Learning Outcomes), NECT (National Education Collaboration Trust and TMU (Teaching Mathematics for Understanding) carried out on a provincial and national scale.

Language use lies on a continuum between multilingualism and monolingualism, and as mentioned in Section 2.3, Canagarajah (2011) cautioned against the development of a binary, but the categories I created enabled the distinction between monolingual and multilingual language use. This was necessary for me to carry out the planned language use investigation and identify language ideologies that informed language use. For the purposes of this study in early grade mathematics education, I identified two key language ideologies informing language use in a straight forward manner, linked to pure or mixed language use (Section 3.2.1). Pure language use aligns with monoglossic ideologies and mixed language use aligns with heteroglossic ideologies (García & Wei, 2014; McKinney, 2017). Since my study was a langauge idological study, I drew on the work of Schieffelin, Woolard & Kroskrity (1998) in establishing my theoretical framework. Following Kroskrity (2004) who argues that language use can be understood in relation to language ideologies whether the users of language are aware of their choices or not, I qualified my categories as articulated or embodied. This distinction was made according to whether the utterances were made when answering questions or when giving mathematical explanations. Utterances made by teachers as answers to questions in the open-ended questions in the survey or focus group discussions were categorised as articulated. Ideologies were inferred according to an articulation in favour of pure (monoglossic) or mixed (heteroglossic) language use. Utterances produced as spoken (classroom observations) or written (survey mathematics questionnaire) mathematical explanations were categorised as embodied. Ideologies were inferred from the pure/mixed nature of spoken/written utterances. In Section 6.4 the key finding was that monoglossic and heteroglossic (embodied and articulated) ideologies drive language use. This was based on my analysis of teachers' language use and perceptions of language use according to my analytical framework (Figure 4.2).

Having established how to identify ideology as a driver, I identified evidence of policy (authority) in utterances that expressed expectations from the department (or other manegerial authorities). I identified evidence of research in utterances that showed professional knowledge of pedagogy, expressing belief in a theory that promotes understanding that was ascribed to an outside authority. Finally, personal experience was identifed in utterances that expressed beliefs/knowledge in terms of teachers' own experience, acknowledging the professionalism of the teachers as reflective practitioners. I was then ready to draw up the codes needed to classify the utterances in a way that would yield insight into my investigation.

The codes that I drew up based on the categories enabled the identification of language use (pure/mixed and if mixed, code-switching/translanguaging) as explained in Section 4.6.1. There were codes for the quantitative analysis of the survey (Section 4.6.2.2) and of the observation data (Section 4.6.4.3). This coding informed the themes that emerged from the qualitative analysis of the survey, focus group discussion and observation data (Section 4.6.2.4, Section 4.6.3.2 and Section 4.6.4.4 respectively). I analysed a large body of data, and while working with, it I realised that part of it spoke directly to language use variation (pure/mixed) while part of it spoke to the standardisation debate (terminology). In Section 7.5 standardisation was presented as the constraining factor of ideology in the multilingual context where the language ideology embodied in the CAPS clashes with the reality of multilingual schools. This was the principle that guided the division of findings into Chapters 6 and 7.

In the three sections of this chapter, I draw together and discuss the findings presented in Chapters 5, 6 and 7. I have used questions to name the three sections in the chapter as I think that the findings do not point to one clear answer. Section 8.2 asks the question: *Purist or pluralist language use?* My overall finding is one of variation that points to value in both pure and mixed language use depending on when, how and where it is used. Findings show that teachers' language use is driven more by ideology and the authority of policy than it is guided by their professional knowledge and experience. Section 8.3 asks the question: *Where are we in the language standardisation process?* My findings show that clashing ideologies, constrained by standardisation, are creating dissonance and multiple levels of tension in the system that is at times counterproductive but at times produces a creative response. In Section 8.4, I summarise the argument in answer to my overarching research question by answering each of my four sub research questions in brief. The question that frames Section 8.3 is: *Ideology or pedagogy?* This question is posed to highlight the contradiction implicit in my findings in relation to language use, pedagogy and ideology. Pedagogy should be the guide in any learning and teaching endeavour. But my findings point towards ideology as a key driver, embodied in policy which is monitored by authority figures, endorsed and at times challenged by research, while at the same time constrained by standardisation.

As discussed in the literature, research on curriculum implementation suggests that teachers struggle to interpret and implement the curriculum effectively (Beukes, 2008; Chetty 2012; Chetty & Mpewu, 2008; Gauteng Department of Education, 2011; Magwa, 2013; Venkat, Adler, Rollnick, Setati, & Vhurumuku, 2009). The findings of my study provide insight into the potential for language to enable, or create barriers, to effective curriculum interpretation, since all of the principles that guide learning and teaching in early grade mathematics (Anthony & Walshaw, 2009; Hoadley, 2012) are language based (Section 2.2).

Section 8.2 that now follows considers findings from my study in relation to variation in language use.

8.2 Purist or pluralist language use?

My findings show evidence of both pure, or purist language use, aligning with monoglossic ideologies and mixed, or pluralist language use aligning with heteroglossic ideologies (García & Wei, 2014; McKinney, 2017; Schieffelin, Woolard & Kroskrity, 1998). [107] Section 8.2.1 presents the discussion of findings on variation in language use broadly across the schools in my sample showing how ideology plays out in the system. Section 8.2.2 presents a discussion more specifically on the ideologies embodied in written and spoken language use and how these relate to the articulated ideologies of teachers.

The first finding is that the context (in urban Gauteng) is a complex multilingual system, and that language ideologies embodied in policy and research are driving language use in this context.

8.2.1 The context is a complex multilingual system

The findings presented in Chapter 5 give fine detail about the multilingual context. I gave this detail because it is not often acknowledged that schools are multilingual, rather the nature of the multilingual provision remains the focus (Department of Basic Education, 2010). The policy line is that multilingual schooling is being provided across the sector according to the selection of LoLT. This does not take into consideration the heterogeneous communities that exist all over South Africa, more so in urban contexts. Migration is a factor (amongst others) that accounts for this heterogeneity of communities (Stats SA, 2020). Challenging the LoLT

[107] The terms pure, purist, mixed, pluralist, code-switching and translanguaging are defined in the glossary of terms. In the presentation of the data in Chapters 6 and 7, I consistently used the less ideologically loaded terms pure and mixed, but in this chapter, where I am bringing together all aspects of the findings and acknowledging the ideological component of language use, I use the terms purist and pluralist more often, as used in the introduction, rationale and theoretical framework chapters.

system, my findings showed that the early grade context is a heterogenous multilingual system where learner populations are not made up as policy assumes them to be (Section 5.2). The linguistic complexity of the system thus impacts on the choice of LoLT, the backbone of the CAPS multilingual offering. There is poor alignment between the home language and the LoLT for both the learners and the teachers (Section 5.3). Firstly, teachers' spoken languages vary and many of them are teaching in a language other than their home language (Table 5.2). Secondly, the relationship between learner home language and LoLT is weak (Table 5.3) and thirdly, there is a weak relationship between teacher and learner home language (Table 5.4). My findings thus show that the multilingual communities are not being served well by the CAPS language choices.

My findings support the argument made by Makoe and McKinney (2014), that in spite of the multilingual stance of the LiEP (Department of Education, 1997), provision in our schools is monolingual even though the LiEP ostensibly supports multilingualism.[108] According to official policy, teaching in early grade mathematics classes must be carried out in one language, even if the learner population of the classes is diverse in terms of language (Section 1.1). My study has shown that this language may not be the spoken language of the majority of learners in a class (Table 5.3). The situation is further complicated by the policy shift in languages between Grades 3 and 4, where the LoLT changes from an indigenous language to English. My findings show that teachers are aware that learners cannot become fluent in English with the change of a calendar year although policy is quiet on this issue (Section 6.3.2). The response to this is that some schools, including schools in my sample (12 out of 20 schools – Table 4.4), opt for English as LoLT, going "straight for English" (Badenhorst & van der Merwe, 2016; Dixon & Peake, 2008; Mohohlwane, 2020). They start teaching mathematics in English in the Foundation Phase, while in other schools the indigenous language is maintained as LoLT.

My findings show teachers going against policy in both Grade 3 and Grade 4 – where no matter what LoLT choices have been made, in Grade 3 there is evidence of English as the dominant language and in Grade 4 there is evidence of indigenous languages as the dominant language (Figure 6.7). The relationship between the LoLT and language use in these contexts is fraught – teachers are aware of policy and feel bound by it because they are monitored for their

[108] It was designed to foster multilingualism (Alexander, 1989, 2004; Plüddemann, 2002, 2015) but this purpose has not been fully achieved (Section 2.2).

compliance to it (Section 6.3.3). The findings on variation in the dominant language use according to LoLT contained an interesting anomaly. Indigenous languages were dominant in the Setswana LoLT group of schools while in the IsiZulu and English LoLT groups, English was the dominant language of the observed lessons (Figure 6.8). In all schools, the dominance of one language over another was evidence of an embodied monoglossic ideology. To the extent that teachers comply with policy, policy drives language use.

However, in spite of policy and in open opposition to it, my findings also showed that there were teachers who used mixed language (Section 6.2) (embodied heteroglossic ideology) and spoke about the value of mixed language use (Section 6.3.4) (articulated heteroglossic ideology). This aligns with research on teaching mathematics in multilingual contexts as discussed in my literature review and conceptual framework (e.g. Adler, 2001; Jorgenson, 2018; Mukucha, 2012; Setati, 2012). Mixed language use was seen to the greatest extent in the English LoLT schools and more so in the Setswana LoLT schools than the IsiZulu LoLT schools (Figure 6.10). The main reason teachers gave for using mixed language was that it aids learner understanding in the multilingual context (Section 6.3.4; Table 6.7) (articulated heteroglossic ideology). Here, the main driver of language use is seen as research, representing an authority that guides teachers as they make professional choices in the interests of learning and teaching mathematics. Teachers were aware of research favouring home language instruction (e.g. Taylor & von Fintel, 2016) and the use of mixed language (e.g. Adler, 2001; Setati, 1998a, 2005, 2008, 2012). Teachers also spoke of knowing from experience that mixed language supports learner understanding, which was thus identified as another driver (Section 6.3.5) (articulated heteroglossic ideology).

In terms of ideological drivers, we see that the monoglossic ideology embodied in the policy is driving purist language use, but there are also heteroglossic ideologies embodied in the research and articulated by teachers, that are driving pluralist language use. Thus, although the policy context does not favour mixed language use, language use varies, which is the next finding.

Section 8.1.2 has shown some of the possibilities of variation in language use in the multilingual context of my sample. Section 8.2.2 expands on the presentation of this variation.

8.2.2 The context is multilingual, but language use varies – pure and mixed language is used

The dominant voice in the literature that I reviewed on teaching mathematics in multilingual contexts argues for the use of mixed language in the teaching of mathematics. Although originally more research on multilingualism was carried out in higher grades (e.g. Adler, 1998, 1999, 2001; Aineamani, 2018; Bose & Choudhury, 2009; Bunyi, 1997; Chikiwa, & Schäfer, 2016; Essien, 2010, 2013, 2018; Kaphesi, 2002; Langa, 2006; Moschkovich, 2002; Mukucha, 2012; Setati, 2002, 2008; Wildsmith-Cromarty & Gordon, 2009) there is now more literature on the teaching of mathematics in the primary school (e.g. Essien, 2018; Mejía Colindres, 2015; Mostert, 2019; Poo &Venkat, 2021; Sorto, Mejía & Wilson, 2014). This literature aligns with the more general literature on teaching in multilingual contexts (e.g. Canagarajah, 2011; Creese & Blackledge, 2010; Cummins, 2015; García & Wei, 2014; Lewis, Jones & Baker, 2012, Makalela, 2015a, 2015b, 2019; Otheguy, García, & Reid, 2015). The main argument is that language use should not interfere with the learners' ability to speak about what they are doing and make conceptual generalisations. While the many benefits of using mixed language in the teaching of mathematics in multilingual contexts were presented, some challenges and issues that may arise in multilingual contexts when mixed language is used were also raised (Canagarajah, 2011; Ticheloven, Blom, Leseman & McMonagle, 2019; Vaish, 2019).

A key point made in my literature review was that there is a distinction between knowing words and using words (Barwell, Barton & Setati, 2009; Barwell, Leung, Morgan & Street, 2005). I contend that participating in the activity of mathematical reasoning requires knowledge of the mathematical register and the ability to use it. In my study I investigated and gained some insight into the knowledge of (Section 7.3) and variation in (Sections 6.2 and 7.4) language use, on the topic of patterns in IsiZulu, Setswana and in English. The findings in relation to this variation are presented by way of three scenarios in Section 8.2.2.

8.2.2.1 Scenario 1: Purist language use, with English as the dominant language

The first scenario is one where English is the dominant language in the teaching of mathematics, in spite of it not being the home language for the majority of teachers (Table 5.1) and learners (Figure 5.1) in my sample. Purist language use is not much supported in the literature on language use in multilingual contexts or in the mathematics education literature, although there have been studies that speak for the use of English in the teaching of Science (Mifsuda & Farrugia, 2017; Ooyo, 2015) (embodied monoglossic ideology). There were teachers who expressed discomfort about the use of pure language, saying that they used it because they felt pressure from department officials to do so (Table 6.7; Section 6.3.3). Teachers said that although they used pure language more often, they preferred using mixed language (Table 6.7; Section 6.3.4) (embodied and articulated monoglossic and heteroglossic ideologies).[109]

Teachers in the survey (Table 6.7) and focus group discussion (Sections 6.3.1 and 6.3.2) said that English should be used for the teaching of mathematics (articulated monoglossic ideology). Teachers' experience was the strongest driver of these articulated perceptions. Based on their experience teachers said that they would like the LoLT for the teaching of mathematics to be English (Section 6.3.1) and that they preferred to teach mathematics in English because they were familiar with the mathematical terminology in English (Section 6.3.2). The teachers' perceptions should be viewed in the light of Canagarajah's (2011) caution against the creation of a new binary – monolingualism/multilingualism. In the multilingual context, all of the teachers' language resources are important. Teachers may be expressing what appears to be a purist preference when what they are doing is speaking honestly about their strengths in the context of multilingualism. I contend that it is the purist stance of the CAPS curriculum, that endorses the binary, that needs to be challenged.

The preference for (or knowledge of) English was evident in the survey questionnaire activity where most teachers and many learners wrote their mathematical explanations in pure English. English was used by 83% of teachers, 38% of Grade 3 learners and 53% of Grade 4 learners when giving mathematical explanations in the survey (Section 6.2.2; Figure 6.6) (embodied monoglossic ideology). Teachers used predominantly English when teaching in the English and IsiZulu LoLT schools (Figure 6.8) (embodied monoglossic ideology). Findings also showed that in the observed lessons teachers used more English for both mathematical and non-mathematical terms when teaching in both Grade 3 and Grade 4 (Figures 6.11 and 6.12) (embodied monoglossic ideology). While the dominance of English in Grade 3 is not in accordance with CAPS home language policy, the dominance of English in Grade 4 is not

[109] Pluralist language use is discussed in Section 8.2.2.3. in Scenario 3. In this section the findings related to the scenario (purist use with English dominant) are discussed.

surprising since in Grade 4 the LoLT is English (Section 6.2.4). The mathematical word count carried out using the transcriptions of the observed lessons confirmed this finding – findings showed the highest word counts for English terms (Section 7.4.2.1). While standardisation was seen as a constraining factor in Section 7.4, possibly limiting teachers' language use, the dominance of English for mathematical words is further evidence of an embodied monoglossic ideology.

In this scenario the embodied monoglossic ideology of the CAPS policy, favouring the use of pure language, is the key driver. It is seen to be driving the language use in schools through teachers' relation to authority. An unintentional consequence of the language shift, from indigenous language in Grade 3 to English in Grade 4 (in accordance with the purist policy), seems to be that there is heightened use of English in Grade 3. Even though research predominantly points away from pure English language use in this multilingual early grade context, driven by the ideology embodied in the policy, teachers enacted pure (English) language use.

8.2.2.2 Scenario 2: Purist language use, with an indigenous language as the dominant language

In the second scenario, purist language use also holds sway, but in an indigenous language. There is research that shows the value of using the home language when learning and teaching in the early years (Langa, 2006; Taylor & von Fintel, 2016). Teachers showed awareness of this research and expressed the idea that giving explanations in the indigenous home language aids learner understanding both in the survey (Table 6.7) and in the focus group discussion (Section 6.3.5) (articulated monoglossic ideology). Teachers used predominantly Setswana in the Setswana LoLT schools (Figure 6.8) (embodied monoglossic ideology). This dominance of the indigenous language in an indigenous LoLT school was notable since in the other indigenous LoLT schools in my sample (IsiZulu schools, as discussed in Section 8.2.2.1), English was the dominant language (embodied heteroglossic ideology).

There were both teachers and learners who wrote mathematical explanations in the survey questionnaire in a pure indigenous language (Figure 6.6) (embodied monoglossic ideology).[110]

[110] Although less so than in English, see Section 8.2.2.1).

Teachers, Grade 3 learners and Grade 4 learners wrote more pure IsiZulu explanations (10%, 33% and 24% respectively) than their Setswana counterparts did (3%, 9% and 2% respectively). The findings for use of an indigenous language in written explanations shows a second variation between the Setswana and the IsiZulu LoLT schools. Finally, there was a third variation between the two indigenous LoLT schools in my sample. Pure language was used to a greater extent, both in Grade 3 and Grade 4, in the IsiZulu LoLT schools than in the Setswana LoLT schools, where there was very little pure language use observed (Figure 6.10) (embodied monoglossic ideology). This finding shows an anomaly that is worth noting – that in Grade 4, when an indigenous language is used, it is evidence of an embodied heteroglossic ideology, because the LoLT for Grade 4 is English, and so English should be used in Grade 4 lessons. Although the percentages for this language use (pure indigenous language use in a LoLT English class) were not high, (6% for IsiZulu LoLT schools and 2% for Setswana LoLT schools) they are noted. This finding sheds light on the articulated preference for explanations in the indigenous language use, indicating that, at least for some teachers, it embodied a heteroglossic ideology.

Ideology, policy, the teachers' relation to authority and research (on education in multilingual contexts and pedagogy) are again identified as drivers in this scenario. But here, ambivalence of teachers' language use preferences was evident. What emerged was that there was evidence of monoglossic and heteroglossic (articulated and embodied) ideologies driving language use, in line with the findings discussed in Section 6.4. Policy, as before, drives a monoglossic ideology, favouring teaching in pure indigenous language. The exception of teachers using a pure indigenous language when they should be using English (in Grade 4) is evidence of an embodied heteroglossic ideology resulting in a clash of ideologies.

8.2.2.3 Scenario 3: Pluralist language use

The third scenario is one where pluralist language use is favoured, although the purist policy context remains the same. The dominant argument in local and international literature on language use in education (e.g. de los Ríos & Seltzer 2017; García & Wei, 2014; Makalela, 2019) and in mathematics education (e.g. Essien, 2018; Halai & Clarkson, 2016) endorses mixed language use (embodied heteroglossic ideology). Aligned with this large body of research in favour of mixed language use in multilingual contexts, in the multilingual schools in my study there was evidence of speakers drawing on more than one language of expression. They did so both when writing and speaking mathematically.

Teachers used less mixed language in writing than learners did. Section 6.2.1 showed evidence of teachers and learners using mixed language in the survey responses – 4% and 20% (respectively) of their explanations were mixed (Figure 6.6) (embodied heteroglossic ideology). In the observed lessons teachers were seen making language use choices in spite of the LoLT (Section 6.2.3) (embodied heteroglossic ideology). Figure 6.9 showed differences between Grade 3 and Grade 4 in terms of mixed language use. While teachers spoke about using code-switching (because this was the term familiar to them) they translanguaged more often. Overall, there was a higher percentage of language mixing than pure language use in the observed lessons. Translanguaging and code-switching (mixed language use) were used cumulatively for 58% and 55% of the time in the observed lessons (respectively) in Grades 3 and 4. The analysis of mixed language use was carried out according to dominant language and LoLT. Translanguaging was the most prevalent language use in Grade 3 classes when indigenous languages were dominant (27%) while in Grade 4 classes it was used most often when English was the dominant language (37%) (Figure 6.9). Overall, in the indigenous LoLT schools, mixed language use was observed for 17% and 18% of the time in Grades 3 and 4 respectively while pure language was observed for 11% and 8% of the time in Grades 3 and 4 respectively (Figure 6.10). Examples of mixed language use were presented (Sections 6.2.3.2-6.2.3.5) in order to show the way in which teachers intuitively use code-switching and translanguaging when they teach.

Aligned to this, when teachers spoke about using English to teach mathematics, they qualified it with a desire to be allowed to use more flexible language (Section 6.3.1). The literature endorses such flexibility, with many studies showing the benefits of translanguaging (Bialystok 2006; Castro, 2015; Chin & Wigglesworth, 2007; Kovács & Mehler, 2009). Teachers spoke about preferring to use code-switching, although they did acknowledge that they used pure language often (Section 6.3.4; Table 6.7) (articulated monoglossic and heteroglossic ideologies). If one looks at the overall dominance of language use across the sample (Figure 6.7) it appears that the purist language policy shift from indigenous languages in Grades 3 to English in Grade 4 inadvertently drives mixed language use in both grades – pushing for the use of English in Grade 3 and the use of the indigenous languages in Grade 4 (Section 6.3.2).

As in scenarios one and two, the ambivalence of teachers' language use preferences, embodied and articulated monoglossic and heteroglossic ideologies come into play. In this scenario, research (professional knowledge of teaching in the multilingual context) is identified as key driver. According to this authority, teachers used mixed language, driven by heteroglossic ideologies. However, the pressure of policy (another authority) driving for purist language use was still felt. Once again, teachers' perceptions, expressed language use patterns and actual language use, provide evidence of clashing language ideologies, with the system and within themselves (Section 7.5).

Some of the issues raised by teachers in relation to the use of mixed language related to a perceived lack of standardisation of the indigenous languages. Underlying the discussion of the standardisation debate is the notion of register (Halliday, 1978) – language that serves a particular function – in this case the expression of mathematical ideas (Section 2.3). Section 8.3 presents my findings in relation to the language standardisation debate.

8.3 Where are we in the language standardisation process?

In my literature review the broader notion of register (Halliday, 1978; Setati, 2002) was discussed and, while I acknowledged that register is more than just words, words (predominantly) are the aspect of register on which this study focused.

The findings in Chapter 7, extending the findings discussed in Chapter 6, showed that standardisation was seen as the constraining factor of language use in the multilingual context. The lack of standardisation, perceived or otherwise, constrains language use and creates a problem that needs to be investigated and addressed. My research was situated in the context of the teaching of patterns, which enabled me to focus on a particular part of the mathematical register. Patterns is a topic with connections to the teaching of number sense, one of the core conceptual topics in the early grades (Chikiwa, Westaway, & Graven, 2019; Clements & Sarama, 2014; Rittle-Johnson, Fyfe, Hofer, & Farran, 2016; Suh & Seshaiyer, 2015; Zippert & Boice, 2018).

As explained in Chapter 3, Barwell (2014) speaks of the tension created by the drive for unitary language and that of heteroglossia – as one between standardisation on the one hand and the inherent diversity of language on the other hand. This tension can also be seen as one between two forces of opposing language ideologies – centripetal forces driving monoglossic ideologies (pushing for unitary language or purist language use) and centrifugal forces driving heteroglossic ideologies (pushing for mixed language or pluralist language use). In the South African curriculum policy arena these forces play out quite clearly (Section 3.2). The CAPS policy is an expression of a monolingual centripetal force opposing the centrifugal force of the multilingual LiEP policy (backed by most of the current literature on language use in multilingual contexts). The standard terminology list from the DAC dictionary is seen as the unitary curriculum language embodying a monoglossic ideology exerting a centripetal force on the variations used by speakers/writers of language (dialectical or translanguaging in nature) which in turn embody a heteroglossic ideology and push back with a centrifugal force. These two opposing ideologies (Section 6.4, Section 8.2) are driving language use and affecting development in South Africa.

In this discussion, it was not always clear what stance should be taken (and I remained neutral), because the development of languages is ongoing. But it was evident when teachers spoke, that they held some views quite strongly. They are constrained, on a daily basis, to the second assumption on which the CAPS LoLT policy is premised- the existence of standardised languages. As was discussed in the literature, the extent of language standardisation in South Africa is contested (Lafon & Webb, 2008; Mojela, 2008), and the findings from my study shed light on this from the perspective of teachers in multilingual classrooms. The focus group discussion data from my study shows that teachers are aware of and constrained by issues in relation to standardisation of language. This was discussed in detail (Section 7.5). I highlight the issue with one final quote from a teacher, which shows how the lack of standardisation affects teaching in schools, when they are left to deal with it themselves:

> In IsiZulu, it's just words that were borrowed from English. Sometimes we translate ... we use them not because we have them … sometimes we don't even have the word in English, like *symmetry*, we don't have a word in Zulu that explains symmetry. You end up creating your own word and explaining your own way. And when a child comes to you, that teacher maybe from the previous grade maybe explained it using a different word, so the child comes to your class not knowing symmetry, she knows symmetry, but not in the terms that you are trying to explain it in. So that's also a problem. (FG3S5).

Although, as it is widely recognised in the literature, mathematical language is more than just words (Barwell, Leung, Morgan & Street, 2005; Setati, 2002), the development of mathematical register is essential. Teachers and learners need the language of mathematics to participate in mathematical discussions, to think mathematically and to do mathematics (Barwell, 2018; Planas, 2018; Schäfer, 2010). They need to know the language and be able to work flexibly with it, since flexibility is a core requirement for translanguaging in a mathematics class. In multilingual contexts, for this to be possible, transferability between languages is a necessity (Canagarajah, 2011). The mathematical register in English is standard, as alluded to by the teacher in the quotation above. The question is whether it is as well-established in the indigenous languages – the teachers in my sample questioned this (Sections 7.2.1.1, 7.2.12, 7.2.1.4 and 7.2.1.5). The translation activity and lesson observations yielded data that shed light on the active use of mathematical terminology on the part of teachers and learners, which I have identified as the embodiment of standardisation – evidence of the terminology of mathematics at work. This is discussed in Section 8.3.1.

8.3.1 The embodiment of standardisation

Teachers (and learners) knowing (or not knowing) the mathematical register will influence the learning and teaching of mathematics although knowledge of the register does not automatically translate into improved mathematics learning (Barton, Fairhall & Trinick, 1998; Kaphesi, 2002; Roberts, 1998). It is also argued that mathematical terminology should not be given "high stakes" value simply in terms of definition but rather in terms of its potential to contribute to mathematical learning through debate (Morgan, 2005). This constructive mathematical debate is not possible without a fully developed mathematical register. A lack in the register creates limits – without basic knowledge of the register there cannot be sustained learning. Teachers spoke about the lack of standardisation and ways in which it affects them when they teach mathematics (Section 7.2). Proficiency and flexibility with language in a multilingual context is required if language mixing is to be supportive of learning (Barwell, 2018; Planas, 2018).

The ability to translate terms between languages was taken as an indication not only of proficiency but also of flexibility with language. Even though the mathematical register consists of more than just words (terminology), words are needed to talk about mathematical ideas that may have been drawn using a diagram or some other visual or symbolic form. The findings presented in Section 7.3 (drawing on the survey data) show that, in my sample proficiency in relation to the standard mathematical terminology of patterns (the focus of the translation activity) is lacking. Teachers' knowledge of the terminology was adequate (Section 7.3.2; Figure 7.7) but learners' knowledge of the basic terminology that formed the translation activity was very poor (Section 7.3.1; Figure 7.2). The subcategories in my analytical framework shed light on the embodiment of standardisation. Learners showed greater variation in their translations and there was evidence of learners using informal terminology (Table 7.2) (Figure 4.2, subcategory 4), appropriate but alternative terminology (Figure 4.2, subcategory 5) and a lot of correct terminology that was incorrectly spelt (Table 7.1) (Figure 4.2, subcategory 2). Teachers on the other hand used more standard (formal) terminology (Section 7.3.2; Table 7.4) (Figure 4.2, subcategory 4).

In the context of multilingualism where teachers are using translanguaging, learners need at least some proficiency in both (or all) of the languages being used. If they do not, they may be confused and not understand all of the terminology being spoken in the mathematics lessons. The evidence discussed in the previous paragraph shows that teachers use more standard terminology while learners use a wider range of terminology and invent words more liberally (Section 7.4). The question is: what does this mean for the language development and the level of understanding of the teacher talk in the lessons? Morgan (2005) emphasised the potential of mathematical terminology as a resource to be used to generate debates but for this to be the case, a certain level of knowledge of the terminology is needed. Another necessity for this kind of meaningful debate is teacher-learner interaction. The observations carried out in my study enabled a snapshot of language use but the issue of the dominance of teachers' voices during lessons (Sapire, 2018a) is problematic. If learners are not given opportunities to use the language during lessons, they will not develop their knowledge of the mathematical register nor their mathematical understanding.

An example which provides evidence of a teacher using language in a way which might compromise learning was given in Chapter 6 (Figure 6.1). The teacher uses the word *inamba* (a trans word based on English) to say number while she uses the word *nombolo* (IsiZulu word for number) to say *remainder*. Here she is inventing both words. She uses a trans word to say *number* and she uses a more pure IsiZulu (but strictly speaking inappropriate mathematical term) for the technical mathematical term, *remainder*. I contend that in terms of language use here, the trans word is not problematic, but the pure one may be. No matter where we are in relation to the standardisation of language, we are not near to a position where deep learning of concepts can happen. This relates to the issue raised by Venkat and Naidoo (2012) about teachers giving explanations that lack connections (links made between mathematical concepts) and sufficient mathematical quality to enable coherence in mathematics lessons. The language use on the part of teachers has potential to support them to make lasting connections (Barwell, 2005b; Morgan, 2005; Mostert, 2019). Since the mathematical register is more than just words, appropriate symbolic and other representations of mathematical concepts will also form part of teachers' engagements with children to facilitate connections and deep learning of mathematical concepts (Anthony & Walshaw, 2009; Askew, 2012, 2016). But teachers need to be cogniscent of the word choices they make. They need to use mathematical terminology that is correct, formal/informal and appropriate (Figure 4.2, subcategories 1, 3, 4 and 5) and they need to build up learners' knowledge of the terminology progressively over the years of schooling.

Teachers are aware of a complex set of problems linked to the standardisation (versions) of mathematical terms in the indigenous languages which they raised in the focus group discussions (Section 7.2). These are discussed in Section 8.3.2.

8.3.2 The articulation of standardisation

Many of the things that teachers spoke about pointed to the issue of standardisation of language (or lack thereof). This was presented in Section 7.2. The views that they articulated revealed that the issue of standardisation drove teachers towards monoglossic ideologies. Both teacher and learner translations in the survey translation activity showed alignment to the standardised terminology, although there was greater variation in the learner responses (Section 7.3). Teachers expressed the view that they would like to be able to teach their learners standard terminology. One of the drivers for this was common assessments which they said sometimes arrived with terminology that they did not recognise and this was very worrying to them. Since assessments can be used to judge teachers (and learners) it is understandable that they think about ways in which to enable better performance in these assessments. Their reasoning here appears to be driven by monoglossic ideologies.

Monoglossic ideologies came through in the concern that teachers felt because of the pressure on them to invent terms – they would rather that this was done for them (Section 7.2.1.3). Their criticism of the anglicisation of terms they encountered in publications (having been invented for the purpose) is also evidence of a monoglossic ideology (Section 7.2.1.2) and their focus on errors they noticed in the DBE workbooks in the indigenous language versions also point to a focus on language use that is right/wrong that must take one form only, which is monoglossic (Section 7.2.1.1). The strong leaning toward English as the "go to" language is also evidence of monoglossia (Section 7.2.1.5). This leaning was said to be desirable because of a lack of knowledge of terms in the home language and knowledge of the English terms. The value of English as an already standardised language was felt by many to be useful as a solution to the problem of a lack of standardisation of terminology in the home languages (Section and 7.2.1.6).

Heteroglossic ideologies provided an alternative view – that mixed language use supports understanding in multilingual contexts in the absence of standardisation. When speaking about language use, teachers explained that they code-switch to support learners understanding (Section 7.2.1.7) and it does seem that they do this in order to use the mathematical register in the language(s) they know their learners understand (Section 7.4). The use of mixed language seems appropriate in the multilingual context and it is at least in part driven by the constraints of inadequate standardisation. Another perception expressed by teachers was that they are aware of a clash between the "pure language" used in the DBE workbooks and common assessments and the language used in their multilingual context (Section 7.2.1.4). The tension between "pure" forms of language and the languages spoken in urban areas was expressed from a monoglossic viewpoint (a clash between different codes) although it points towards heteroglossia and the need for recognition of all versions of the register. Finally, heteroglossic ideologies also drive the view expressed by teachers that given the multilingual context, bilingual materials would be supportive of learning and teaching (Section 7.2.2).

The drivers of language development and use are the same. One can speak about them in terms of the centrifugal and centripetal forces that are inherent in language in a multilingual context (Barwell, 2014) driving unitary language or heteroglossia. Alternatively, one could speak about them in terms of monoglossic and heteroglossic ideologies driving monolingual or multilingual language use (McKinney 2017). The reality remains that language use could be undermined by the pressure of the ideological struggle which could negatively influence the quality of mathematics education if the struggle between the forces is not well resolved in the interests of good teaching.

In Section 8.4 I situate the discussion of the answer to my overarching research question: *What factors drive the language use of multilingual Grade 3 and Grade 4 mathematics teachers and learners on the topic of patterns?* in the context of the ideological struggle, constrained by standardisation.

8.4 Ideology or pedagogy?

The context of this study, South African early grade mathematics, situates it in an arena where language use and development are political (Clarkson, 2016; Mohohlwane, 2020; Phakeng, 2017). Historically poor achievement in mathematics has only slightly improved over the past 25 years and there is increasing pressure on teachers (and the Department of Education) to improve the situation. In the chapter on variation in language use, the lens of language ideologies exposed some of the tensions and differences in language use in the multilingual context of Grade 3 and Grade 4 teachers and learners who participated in the study. Language ideologies may be creating tension that works against the meaningful learning and teaching of mathematics in the early grades.

A comment that has stayed with me and motivated me to do this research was made by a high-level department official in conversation with a group of provincial officials in a discussion after I had presented a video supporting the use of the GPLMS bilingual mathematics material to them in which Kgethi Setati (now Phakeng) spoke about the use and value of multilingualism in early grade mathematics.[111] A compelling illustration given in the Setati's presentation was that of a teacher holding up a triangle and asking a learner shape what she was holding up. A voice in the learner's head was asking "What is triangle in Sepedi? What is triangle in Sepedi?" and the implication was that he was not allowed to answer in English, because it was a LoLT Sepedi school. After they had watched the presentation the official said to the group of provincial officials, "We must listen with open ears, but we must implement policy" (author's notes, 2013). In 2013, there was not much resistance to the monoglossic policy driver, that pure language should be used. In 2020, the effects of monoglossic ideology on teaching in the early

[111] The video was produced from a presentation that Setati made to the 450 GPLMS coaches in support of the bilingual materials choice (heteroglossic), which was arranged because of resistance to the bilingual presentation of learner materials, on the grounds that it clashed with CAPS (monoglossic) policy.

grades are still present – materials (the DBE workbook) are all monolingual and common assessments are as well.[112]

The terrain has shifted. In 2013, if a learner had answered "triangle", in a Sepedi LoLT ANA paper, she would have been marked wrong. The ANA is no longer with us, but in common assessments, there has been progress in terms of marking memoranda. Acceptable answers in English in indigenous language LoLT schools should now be accepted as correct.[113] However, as the discussion of my research in Sections 8.2 and 8.3 shows, there is still uncertainty and the debates are not yet finalised. After writing up this study, it seems clear to me that teachers need to be allowed to speak to learners in language(s) they understand and learners need to be allowed to respond similarly, in language(s) they feel comfortable using, but that standardisation can constrain this language use. The final section of this chapter addresses my reasoning for this claim.

Every day, teachers (and learners) use language in mathematics classes. My study has shed light on how they do this. Their language use, though predominantly pure, was mixed at times, embodying monoglossic and heteroglossic ideologies. They articulated both monoglossic and heteroglossic ideologies when speaking about their language use. The findings of my study show that there are clashing ideologies and there are clashes between reality and policy expectations. I conclude my discussion by briefly answering my four research questions, based on my findings and with reference to the relevant literature. First, I sum up the findings in relation to my first question about the LoLT of schools.

8.4.1 What is the relationship between the LoLT and home language of the teachers and learners?

The findings presented in Chapter 5 in answer to this question showed that the CAPS LoLT system, although it is designed to, does not lead to learners being taught in their home language (Tables 5.3 and 5.4). Neither does it guarantee that they will be taught by a home language

[112] Certain projects provide bilingual material and the national Mathematics Framework (DBE, 2018) called for the provision of bilingual material to all learners at least to the end of the FP but currently standard publications, the DBE workbooks and common assessments, are all still monolingual.
[113] The 2018 draft of the revised Section 4 (assessment) of the CAPS (DBE, 2018) referred to this on page 6. The final published draft of this revision was truncated and excluded this page (the final draft was published as a draft since it was not complete, as agreement had not been reached on all sections).

speaker of the language (Table 5.2). My findings showed that (at least in the schools in urban Gauteng that I visited) there is a complex multilingual system where ideology, policy, research and experience drive different forms of language use in mathematics classes (Chapter 6). I contend that these drivers complicate the relationship between the LoLT and the home language because at times they inhibit the flexibility of the teachers to use language in different ways. This finding is consistent with the literature that critiques the current monoglossic stance of the curriculum (Halai, & Clarkson, 2016; Makoe, & McKinney, 2014, McKinney, Carrim, Marshall & Layton, 2015). This literature links the language policy to the remnants of the dominance of English under colonialism and calls for it to be changed in line with more modern thinking aligned with the multilingual, multicultural nature of society (I support this call).

While Makoe and McKinney (2014) emphasise (and critique) the current monolingual stance of the curriculum, my findings showed that there has been flux over time in relation to the manner of implementation of the LoLT. The original curriculum design principles of the new South African curriculum, post-apartheid, were to promote multilingualism (Awobuluyi, 2013; Nhongo, 2013; Plüddemann, 2002, 2015) – but these principles seem to have become fuzzy and a new ideology at policy level is driving monolingualism in schools. This aligns with Beukes (2008) and Makoni and Pennycook's (2011) criticisms of the ironic curriculum change journey in post-colonial countries where at times changes in language policies have been stymied. At the time of my data collection, the department was against language mixing and in favour of pure language use. This was the view expressed by teachers (Section 6.3.3) in the focus group discussions. In the few years prior to this there had been a period where language mixing in mathematics lessons seemed to have been supported and the rigid imposition of a "monolingual" LoLT system had been less fierce. The measure of the change in the system was suggested by teachers in relation to the LoLT versions of the DBE workbooks they were able to receive. Previously, they had been allowed to get English versions of the DBE workbook (even if their school had an indigenous language LoLT) (implicit departmental permission for and enabling of multilingualism) but this was going to stop (Section 7.2.2) (implicit imposition of monolingualism). The teachers took this as a message (with high-level departmental authority) against language mixing and in favour of pure language use.[114] Teachers feel obliged to comply with the authority of the department (they are monitored for

[114] This change also may have impacted on school's choice of LoLT and resulted in the shift some made to English as LoLT as noted earlier.

compliance) but this was a source of tension for them as will be discussed in Sections 8.4.2, 8.4.3 and 8.4.4.

I now summarise the findings to answer to my second research question, about variation in language use.

8.4.2 What variation in language use is evident when teachers and learners write and speak mathematics?

Chapters 6 and 7 presented findings about variation in language use. What I found was that in spite of strong pressure to comply with the policy imperative to use pure language, teachers (and learners) enact both pure and mixed language use practices. Using the theory of language ideology (Kroskrity, 2004; Schieffelin, Woolard & Kroskrity, 1998; Silverstein, 1979; Woolard, 2021), I identified ideological drivers of language use in the utterances made in written or spoken language by teachers and learners (my unit of analysis was the written/spoken utterance). I found that teachers and learners use language on the monolingual/multilingual continuum according to their language ideologies, resulting in variation in language use. Evidence from the survey of written mathematical explanations (Section 6.2.1) and from the observed lessons of classroom teaching (Sections 6.2.2 and 6.2.3) shows teachers and learners using both pure and mixed language, driven by embodied monoglossic and heteroglossic ideologies. An analysis of when they used mixed language revealed that they do so in many different instances and for several reasons (Section 6.2.3.1.1).

Firstly, as already alluded to in the previous paragraph, there is variation in language use in relation to the use of pure/mixed language. My findings showed examples of teachers and learners using mixed language (code-switching and translanguaging, but more translanguaging) in line with descriptions of language use in the literature (e.g. García & Wei, 2014, Lewis, Jones & Baker, 2012, Makalela, 2015a, 2015b, 2019; Otheguy, García, & Reid, 2015). Setati (2008) has written about the power issues that surround language use in mathematics which implicitly addresses the ideological drivers of language use. To my knowledge, there has not been a study to date that has exposed these drivers in the way that my study has done – based on a language ideological analysis. There are several studies in the field of literacy that have addressed this to date (McKinney, 2017). I contend that in the early grades it is difficult to separate learning from language and that my study, in highlighting the ideological component of language drivers in mathematics education, will help to expose issues that may be holding teachers back and therefore hindering them from teaching to the best of their ability and learners from learning.

Secondly, not only do teachers and learners use both pure and mixed language, but they were also seen to invent mathematical terminology. This is one of the activities of translanguaging (Castro, 2015; Mejía Colindres, 2015; Sorto, Mejía & Wilson, 2014) and it is evidenced in three ways. Teachers and learners "invent" terms (1) when standard terms do not exist, (2) when they do not know the standard terms or (3) when they create terms by mixing languages in the multilingual environment. Firstly, these inventions were evident in the teachers' and learners' written mathematical explanations (Section 6.2.1). The written mathematical explanations for answers given in the survey questionnaire were mostly expressed using pure language but mixed language (to a lesser extent) was used (Figure 6.6). The mixed language was mostly in the form of translanguaging (fluid language mixing or the invention of trans words) (Figure 6.1) but some teachers and learners also used code-switching (Figure 6.2). Learners' translations also included many non-standard words, which they had created in the multilingual context (Section 7.3.1) (this was not found in the teachers' translations). These words included phonetic alternative spellings of words and pure inventions, or trans words (Section 4.6.1.2), as identified in my study. Both teachers and learners used appropriate dialectical alternatives in the translation activity (Sections 7.3.1 and 7.3.2). Secondly, in the observed lessons, findings also showed teachers using pure language and mixed language (Sections 6.4.2, 7.4.2.1 and 7.4.2.4). Findings showed that mixed language was used slightly more often in the observed lessons than in the survey, when giving mathematical explanations (Figures 6.9 and 6.10). Learners were thus likely to have been exposed to teachers' invention of words, which may have influenced and enabled them to create their own inventions as they did in their survey responses.

Thus, despite the strong monoglossic policy push towards pure language use, there was evidence of heteroglossia, which is to be expected in multilingual communities (García & Wei, 2014, Lewis, Jones & Baker, 2012, Makalela, 2019; Setati, 2012). As discussed above, teachers and learners were seen drawing on their full language repertoire in a manner less restricted than might be expected in the given monoglossic policy environment. Teachers and learners intuitively used translanguaging in the written activity and in the observed lessons. They took action, necessitated by gaps they experienced in the standardised register, to create words using their full language repertoire (English and indigenous language dialects) and translanguaging (trans words) in spite of the pure language environment. This "invention" of terms speaks to the question of language development, particularly against the backdrop of a myriad of dialects and in the context of an under-developed mathematical register (Lafon & Webb, 2008; Mafela, 2010; Mohohlwane, 2020; Mojela, 2008; Ouane & Glanz, 2010, 2011; Schäfer, 2010). The importance of this variation in language use is that, guided by my analytical framework and drawing on the data, I identified two categories of words that I accepted as correct, although they may not be accepted in the mainstream of standard mathematical terminology (Figures 7.2 and 7.7). I captured this use of language in subcategories 3 and 5 (correct/incorrect and appropriate/inappropriate) in my analytical framework (Figure 4.2). This pluralist use of language was accepted as correct although it might not necessarily be accepted by purist language users. This is a contribution of my study to the ongoing investigation into language use in the interests of teaching mathematics for understanding.

I now summarise the findings to answer to my third research question, about teachers' perceptions in relation to "best practice" for language use.

8.4.3 What are teachers' perceptions of the "best practice" in relation to language use in mathematics teaching?

Sections 6.3 and 7.2 presented the findings related to teachers' perceptions of language use in the multilingual context. I noticed that, to an extent, teachers are more aware of problems that arise and that they experience in the context, than of the solutions. That being said, they shared their views about what think is best and what they do, based on their experience and things they have heard about/read about in research. Teachers showed awareness of the literature that speaks about the use of mixed language to support learning in multilingual contexts, especially in the South African context (e.g. Setati, 1998a, 1998b, 2005, 2008; Setati & Adler, 2000). Many teachers spoke about code-switching (Sections 6.3.4 and 7.2.1.7). They also were aware of literature that supports the use of the indigenous home languages in the early grades (e.g. Taylor & von Fintel, 2016) (Section 7.5). The South African literature aligns with international literature in the field, as seen in my review of the literature (Section 2.3).

It may be that teachers' focus on problems, rather than solutions, is because their agency to act on issues is limited. Teachers are highly compliant and generally act on policy directives in accordance with monitoring by department officials. Yet, in spite of this, my findings show that while teachers feel the pressure to comply with policy regulations in relation to language use, resistance to this pressure prevails. Teachers hold onto their right to make professional choices for themselves. In my thesis I discussed the ideological drivers of language use which is grounded in the ideological nature of language (Bakhtin, 1981). This formed the basis of my theoretical framework (Section 3.2) and was demonstrated in my findings in relation to embodied and articulated language use (Chapters 6 and 7). Teachers' perceptions about "best practice" for language use their multilingual context were summarised in the discussion of their perceptions about variation in language use (Section 6.3) and the standardisation debate (Section 7.2).[115] Teachers expressed the view that department officials (authority figures) pressure them into using pure language (Section 6.3.3) although (as mentioned in Section 8.4.1) they were also aware that departmental pressure has changed over time.

Teachers' responses showed that they saw value in both the indigenous home languages and mixed language to teach mathematics. This aligns with the literature that speaks to language policy in post-colonial countries where two arguments are put forward. One argues for the use of the indigenous home language (Brock-Utne, 2007, Heugh, 2005; Ouane & Glanz, 2011) and the other for mixed language use (Makalela, 2015a, 2015b, 2019; Makoni & Pennycook, 2011; Makoe & McKinney, 2014). In spite of the pressure to use pure language, teachers expressed a preference for the use of use code-switching (Section 6.3.4), showing evidence of heteroglossic ideologies driving their perceptions. The most common reason they gave for wanting to use mixed language was that it supports learners' understanding of mathematical concepts (Section 6.3.5). They based this perception on experience and knowledge of research on mathematics teaching in multilingual contexts (authority) (Setati, 1998a, 1998b, 2005, 2008; Setati & Adler, 2000). The evidence from the classroom observations showed that teachers used mixed language in a range of ways and for various reasons as discussed in Section 8.4.2, suggesting that although they spoke more about the value of heteroglossic practices in enabling understanding of mathematical concepts, they enacted these practices in a wide variety of ways and for different reasons (Section 6.2.3.1.1). This aligns with the literature on best practice for teaching in multilingual contexts (Section 2.3).

[115] This will be discussed in Section 8.4.4 in answer to my fourth research question.

Teachers expressed a need for clarity in terms of what they should do, showing confusion in relation to "best practice". This arose particularly because of the mixed messages they receive from the department, the primary source of authority to which they are accountable (Sections 3.2.3 and 7.5). They said that the manner in which the policy has been enforced over the years has been inconsistent and that directives from province and national authorities have changed over time. Although they did not speak about this in terms of ideologies explicitly, teachers showed awareness of the political nature of policy and language use (Section 6.4). In one focus group discussion, a teacher said, "code-switching, they say you are allowed but in our last meeting they said teachers code-switch so much, now it's not allowed … if the LoLT of the school says IsiZulu, the teacher must be pure Zulu" (FG3S5). These policy shifts may have been informed by influential research that is drawn on as a source of authority as time has passed and the research itself will have been influenced by ideology (Section 7.5). Makoni and Pennycook (2011) speak about the ironic changes over time in relation to language specifications in curriculum, which are driven by lanaguge ideologies.

At all times, teachers feel they are pressured by the department to make particular language use choices (Section 6.3.3). This shows that teachers feel that their agency is thwarted, as discussed in Section 8.4.2 and it limits their ability to express ideas about "best practice". But it is important to note that Section 8.4.2. showed that teachers took action to reclaim their agency and did not entirely bow to the authority of policy. Ideas which are seen to challenge the policy create fear in the corps and are not easily taken up. In spite of the pressure of policy (currently favouring monolingualism), many teachers expressed the view that they have learned, through experience, that mixed language use can support learning (Section 6.3.4). In line with this view, they use mixed language to support learning. Teachers' perceptions of "best practice" in relation to mathematics teaching in the multilingual context are thus predominantly heteroglossic, although they feel pressured by policy to enact monoglossic practices. One view, expressed by teachers quite strongly in terms of "best practice" was in favour of the use of bilingual materials (Section 7.2.1.7) in the multilingual context. Teachers saw this as supportive of both mixed and pure language use – a pragmatic choice in a complex context (Section 7.5). The use of bilingual materials for mathematics teaching is written about in South Africa in the work of Botes & Mji (2010) and Owen-Smith (2012). I contend that the use of bilingual materials can be seen as supportive of both pure and mixed language since by nature of its provision, it contains text in more than one (pure) language, an embodiment of heteroglossia.

Bilingual materials might be a solution (as suggested by teachers) at least in the interim, in the absence of agreement on standardisation. In Section 8.4.4, I summarise the findings to answer to my fourth research question, about teachers' perceptions in relation to the language standardisation debate.

8.4.4 What are teachers' perceptions of the language standardisation debate in relation to mathematical register of patterns?

Section 8.4.2 presented the richness of teachers' and learners' language use in terms of variation. This variation was shown to occur in spite of the tensions present in the multilingual context. My findings show that, in addition to the internal pressure of clashing ideological drivers and pressure imposed by policy, the tension results from the constraints of standardisation (Section 7.5). Teachers' perceptions of the language standardisation debate emerged as evidence of this constraining effect (Section 7.2).

I found that the constraining effect of standardisation was experienced in two ways which link to the two main contradictory views about "best practice" for language use in the teaching of mathematics discussed in Section 8.4.2 . Firstly, the constraint is felt as a restriction on language use. Teachers express this perception in relation to a lack of standardised mathematical terms and it is linked to a view that monolingual teaching – in a well-developed language – would be "best" for the teaching of mathematics.

I found that teachers felt at a loss because of the "missing words" which exist because of a lack of standardisation (Section 7.2). This perception highlights an awareness on the part of teachers that the indigenous languages are not fully developed for use in the teaching of mathematics. They show this perception in their comments about the absence of words, confusion around which words to use and their desire that words be "invented" for them (Section 7.2.1.3). They criticise the department and materials developers for inconsistencies and errors in indigenous language versions of materials (Section 7.2.1.1) and they find anglicisations to be problematic (Section 7.2.1.2). They appeal to the authorities to be the custodians of the language and they hold them accountable for its development. Teachers' critique of the language use in materials they receive stems from their observation of issues that arise when learners have to participate in common assessments use language that is not familiar to them (Sections 7.2.1 and 7.2.2). Teachers are asking for a standard register that is fixed that they can get to know and use and teach to their learners. Their perception aligns with literature which argues that a well-developed mathematical register is necessary for fluent communication (Barton, 2008; Jorgenson, 2018; Pimm, 1981, 1991). I contend that this is a debate that needs to be taken up and resolved in a way that is productive for the teaching and learning of mathematics.

Secondly, the constraint is felt as a creative driver. Although teachers were aware of the constraining effect of standardisation, at times this resulted in more flexible language use and the generation of non-standard but appropriate words that teachers (and learners) used when writing/speaking mathematics (Section 8.4.2 has summarised these findings). Teachers express this perception in relation to the desire to be allowed to use mixed lanaguge and it is linked to a view that multilingual teaching, using language as a resource, would be "best" for the teaching of mathematics. This is more in line with the general voice in the literature about language use in multilingual contexts which speaks about the value of mixing languages (pluralist language use) (e.g. García & Wei, 2014, Lewis, Jones & Baker, 2012, Makalela, 2015a, 2015b, 2019; Otheguy, García, & Reid, 2015).

Section 7.5 summarised the findings in relation to clashing ideologies that drive language use, supported by authority relations. According to Barwell (2014), embodied in the articulated ideologies of the teachers is the clash between the centrifugal and centripetal forces which drive language use. The clashes between the forces or the ideologies that drive language use, create tension for teachers (and in the system) as has been shown above. But the potential of standardisation could act as a creative driver points to the possibility that the tension could be taken up and used to drive positive change rather than allowed to fester and create problems.

Awareness of the value of multilingualism (translanguaging and translanguaging pedagogy) is present in the ranks of the teachers but it has not yet reached the level of influencing policy as evidenced in the current CAPS policy. The journey from monolingualism to multilingualism and back again (Makoni & Pennycook 2011) needs to progress to the next step in the cycle – back to multilingualism. This could be more strongly so, if it is based on the learnings from the first cycle (Canagarajah, 2011).

My study has shown that there are monoglossic and heteroglossic drivers of language use which create tension in the system – for policy makers, officials who monitor the policy, teachers and learners. The resolution of the tension may lie in the resolution of the standardisation debate, since standardisation is the constraining factor.

8.5 Conclusion

My study enabled me to see that teachers feel the pressure of ideological drivers both directly and indirectly. While initially I had thought there could be language use that was purely pedagogically motivated, I realised that this is not possible, not only since the socio-historic context does not allow it but also because of the ideological nature of language (Bakhtin, 1981). For the majority of teachers, experience and professional knowledge of pedagogy have little to do with their language use choices since these drivers are overshadowed more often by the stronger drive of the authority of policy. My study yielded two key insights. Firstly, it gave insight into the implications of the monoglossic ideological bias in the curriculum policy in a context where both monoglossic and heteroglossic ideologies drive language use. This creates a system full of tension for teachers and learners. Secondly, it showed that while the language ideology embodied in the CAPS clashes with the reality of multilingual schools, standardisation is the constraining factor. In the monoglossic paradigm, standardisation comes into play as a constraining factor imposing a limiting effect. On the other hand, in the heteroglossic paradigm, resistance to standardisation produces a creative effect.

In education, language use should serve an educational purpose but the research I carried out shows that this purpose, to some extent, is being thwarted due to gaps in the language available to teachers. Thus my study supports the critique of the way in which the South African language policy has been implemented in schools written about by Makoe and McKinney (2014) (and others) who write about "the highly stratified monoglossic orientations which ironically underpin both monolingual and "multilingual" approaches" (p.105). What I found in the sample of multilingual classes I observed, whose teachers and learners I also engaged with through a survey and in focus group discussions, was that, in reality, the system has entrenched schooling in the form of multiple monolingualism (Sapire & Essien, 2021).

In multilingual early grade mathematics classes it does seem as if, at least to an extent, the monoglossic ideology embodied in the language policy is still blurring the goal of mathematics learning and teaching. My findings also showed ways in which the goals of productive language use in mathematics learning and teaching could be achieved and it motivated me to think more deeply about how to address the issues. A policy that is open and allows choices of language use rather than prescribing use has a chance of enabling pedagogical rather than ideological choices in a context where the resolution of the standardisation debate is not yet certain.

In the next chapter the I present the conclusions and recommendations based on my study.

Chapter 9 Conclusions and Recommendations

9.1 Introduction

I said in the introduction to Chapter 8 that I embarked on this study with an open mind, not wanting to push an agenda but rather to try to show the reality on the ground. My goal was to help the voices of teachers (and learners) to be heard because what I had noticed (and I also found) is that "agendas" are driving language use. I also found, that in spite of the strong external drivers, many teachers still make their own decisions and use language in a way that they feel supports learner understanding. That being said, they expressed uncertainty as to how best to use language in the multilingual context and openness to learning more (appealing to the authority of research) about how to teach effectively in this context. In this chapter I wrap up the conclusions to my study and make some recommendations based on what I found.

My study challenges both of the assumptions upon which the CAPS LoLT policy is based – one is that teacher and learner populations are homogeneous in terms of language and the other is that standard languages exist. Both assumptions were shown to be open to question by my study – essentially they do not adequately address the complexity of the South African school context. The first assumption is challenged by the poor alignment between the LoLT of schools and the home languages spoken by teachers and learners at the schools. The second assumption is challenged by the findings on variation in language use. The school context in South Africa is undeniably multilingual. The current interpretation of the LiEP (DoE, 1997) in schools is not serving the teacher and learner population adequately in that it does not respect the flexibility of language use appropriate in the context.

9.2 Conclusions

9.2.1 Language use in multilingual contexts

Language use in multilingual schools varies – teachers and learners use both pure and mixed language in spite of policy pushing towards pure language use (although not consistently so). Teachers were aware of theory that speaks of the value of code-switching in support of learning, particularly when learners are being taught in a language other than their home language. They also have a gut feeling based on experience that mixed language use is supportive of learner understanding. Most teachers had not heard of translanguaging and thus they did not speak about it, instead they spoke about code-switching to mean mixing languages. Garcia &Wei (2014) contend that translanguaging is natural in the multilingual context and my study confirms this. The observation and survey findings showed that teachers did more translanguaging when teaching than when writing mathematics. Learners also were seen to translanguage (more so in the written activity where they used many trans words) showing that they naturally use language as a resource (drawing on their full language repertoire) in the learning and teaching of mathematics.

9.2.2 Standardisation of language

Standardisation of language is contested and ideologically informed. My study has shown that teachers feel the need for standardised language in the teaching of mathematics because they are aware that some terms do not exist in the indigenous languages in which they teach. They are monitored (at times) for compliance to an ideologically driven curriculum policy which says that they must teach in pure language and thus they understandably make known their requests that this language be provided for them to use. Common assessments push teachers towards standardisation as well, since they want their learners to achieve well and they are judged according to their learners' achievement outcomes. My study showed that teachers want guidance in relation to the development of and use of language in the teaching of mathematics.

9.3 Recommendations and possible further research questions

9.3.1 Allow teachers and learners freedom of expression when teaching mathematics in multilingual contexts

Teachers' views need to be respected and further research needs to be done to inform a balanced approach that respects all views and best practice. More flexible language use for the learning and teaching of mathematics needs to be considered – where the learning and teaching of mathematics takes centre stage.

The policy should not determine the way in which teachers use language in mathematics classes to the extent that it does at present. Most importantly this is because it may inhibit learners and negatively affect their self-esteem. Learning cannot happen effectively in multilingual context if speakers are not allowed to use their full language repertoire when speaking and learning mathematics. Proficiency in language is essential for effective learning and in multilingual contexts, this proficiency encompasses more than one language. Teachers should be allowed to draw on their full language repertoires when teaching mathematics. They should be able to support and respect the full language repertoire of learners, while developing their proficiency in all of the languages which they speak.

9.3.1.1 What constitutes effective language use in multilingual mathematics teaching?

Although I used the lesson observation transcripts to identify when, why and how teachers use language mixing I was not able to go into sufficient detail in this analysis, I really only touched the surface. Further research and development programmes need to be established that could allow teachers to develop an understanding of optimal language use in the multilingual context. I recommend that a study which works closely with teachers (and learners) to further investigate effective language use in multilingual contexts (including pre-post test analysis) should be carried out. Studies which investigate similar questions in both urban and rural contexts would be useful.

9.3.2 Extend the DAC dictionary lists of synonyms

The synonyms (especially in the indigenous home languages) that exist for mathematical terminology need to be incorporated into the DAC (Department of Arts and Culture) dictionary. Translators of early grade materials tend to restrict themselves to using the terms in the DAC dictionary which limits the extension of the mathematical language of learners. English language dictionaries have several synonyms for certain terms, as do many others. The range of synonyms recognised for certain mathematical terms in the indigenous languages needs to be extended. It should include both formal and informal expressions, familiar and less familiar yet appropriate words and synonyms from all known dialects of each language so that users of the language do not feel excluded when reading the dictionary lists. Mafela (2010) contends that, "Although the inclusion of dialects should be in both the monolingual and bilingual dictionaries, it would be especially more valuable for non-speakers of the language, to have dialects included in bilingual dictionaries" (p. 830). The point Mafela makes speaks to the extended value of such expanded dictionaries – they would serve to broaden the base of all South African languages.

The fixed, limited choice of a particular term might restrict learners' expression of mathematical ideas. The DAC dictionary includes a very limited range of terms. Such limitations might inhibit the learning and teaching of mathematics. A careful study of the dictionary needs to be carried out and it needs to be added to, since questions are raised by users of this dictionary. This should be done for all mathematics terminology, in the interests of serious lexicon development. The Pan-South African Language board – PanSALB – tasked with the job of protecting and developing the languages of South Africa still has much work to do in the progressive mapping of the languages[116] and creation of dictionaries if the various official languages in the country are to be properly standardised.

9.3.2.1 How can we improve the standardisation of the mathematical register?

The mathematical register of all topics in the CAPS should be investigated in order to properly inform questions in connection with the development of languages and standardisation of the mathematical register.

9.3.3 Provide bilingual materials for teachers and learners

The lack of standardisation of certain mathematical terminology and the multilingual context together speak undeniably to the importance of providing teachers and learners with language rich support materials. The current provision of monolingual materials is inadequate, and teachers spoke strongly in favour of bilingual materials that would allow multiple access points to the text. Bilingual materials should be available so that teachers can use them flexibly in contexts when local dialects differ from standard norms. Printed material is by nature static, but the provision of bilingual materials linked to the common language English introduces some stability that teachers say is supportive. Bilingual materials should foreground the indigenous languages to play down the hegemony of English but at the same time, recognition of the multilingual context and the currency of English should not be set aside.

[116] Research such as that done in this study (and the text analysis of the RMFPM project) could be used to map the language used in the various topics in the Mathematics curriculum and further research is needed to fully address this issue.

9.3.3.1 What is the role of bilingual material in multilingual mathematics teaching?

The recommendation that bilingual materials should be provided needs to be researched so that best practice for the development and presentation of such materials can be investigated. Deeper understanding of the value of such materials and ways in which they support learning could be established.

9.3.4 Pedagogy not ideology as the guide

Ideology drives language use which is not always productive in terms of learning and teaching. What would be good is if awareness and knowledge about the effective use of language in multilingual contexts could be raised and teachers could be enabled to make best possible language use choices for the effective teaching of the multilingual learners in their classes. Many teachers asked for further support to help them learn more about effective language use in the teaching of mathematics in the multilingual context.

If the purist push could recognise the value in the pluralist drive, and both could be acknowledged for their potential value, the learning of mathematics could be the focus. Pedagogy could be given the opportunity to inform language use choices even if ideology underpins the thinking.

9.4 In closing

Parents want to give their children the best start in life. One thing that they know is that good achievement in mathematics is an enabler in life and so they want this for their children. The perception of many parents (and teachers) is that English is the best language for the teaching of mathematics. This is primarily based on their observation, and although it may be flawed, it is a strong driver because the present South African context endorses this observation – people who speak good English generally achieve well in mathematics. Teachers want to do a good job of teaching and find themselves confused when they encounter mathematical terminology that is not standard and common assessments that use this terminology, disadvantaging their learners. Thus, they too lean towards the belief that teaching mathematics in English is best, in spite of it not being the first language of the majority of the learner population and of their awareness that language mixing is supportive of learner understanding.

Policy should be revisited and drawn up to serve the multilingual community rather than remain stuck in a monoglossic paradigm (an unwanted remnant of colonialism) that limits language use. Policy should encourage language use in support of learning and should be open to heteroglossic alternatives that are found to work. In mathematics particularly, further research is needed to establish learner outcomes when they and their teachers are fully supported in the multilingual context by bilingual materials and freedom to use language based on professional choices that prioritise learner understanding is permitted.

References

Adler, J. (1998). A Language of Teaching Dilemmas: Unlocking the Complex Multilingual Secondary Mathematics Classroom. *For the Learning of Mathematics, 18*, 24-33.

Adler, J. (1999). The dilemma of transparency: Seeing and seeing through talk in the mathematics classroom. *Journal of Research in Mathematics Education, 30*, 47-64.

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

Aineamani, B. (2018). How Learners Communicate Their Mathematics Reasoning in Mathematics Discourse. In: Moschkovich J., Wagner D., Bose A., Rodrigues Mendes J., Schütte M. (Eds.), *Language and Communication in Mathematics Education. ICME-13 Monographs.* Springer, Cham. https://doi.org/10.1007/978-3-319-75055-2_6

Albertyn, L., & Guzula, X. (2020). *Multilingual classrooms boost learning.* Cape Town: UCT. Retrieved from https://www.news.uct.ac.za/article/-2020-03-03-multilingual-classrooms-boost-learning

Alexander, N. (1989). *Language Policy and National Unity in South Africa/Azania.* Cape Town: Buchu Books.

Alexander, N. (2004). The politics of language planning in post-apartheid South Africa. *Language Problems and Language Planning 28*, 113-30.

Anthony, G., & Walshaw, M. (2009). Characteristics of Effective Teaching of Mathematics: A View from the West. *Journal of Mathematics Education, 2*(2), 147-164.

Askew, M. (2012). *Transforming primary mathematics.* London: Routledge.

Askew, M. (2016). *A practical Guide to Transforming Primary Mathematics – Activities and tasks that really work*. London: Routledge.

Awobuluyi, O. (2013). Official Language Policies in Africa. Olanike Ola Orie and Karen W. Sanders (Eds.), *Selected Proceedings of the 43rd Annual Conference on African Linguistics*, (pp. 68-76). Somerville, MA: Cascadilla Proceedings Project.

Badenhorst, J., & van der Merwe, R. (2016). Trial and Error? An Inquiry into Implementing a “Straight-for-English” Approach with FP Students with Inadequate English Proficiency, in *Journal of African and Asian Studies*, accessed 25 December 2020, https://journals.sagepub.com/doi/abs/10.1177/0021909616630994?journalCode=jasa

Bakhtin, M. M. (1981). *The dialogic imagination: Four essays.* (M. Holquist, Ed.; C. Emerson & M. Holquist, Trans.). Austin: University of Texas Press.

Barton, B., Fairhall, U., & Trinick, T. (1998). Tikanga Reo Tātai: Issues in the Development of a Māori Mathematical register. *For the Learning of Mathematics*, *18*(1), 3-9.

Barwell, R. (2005a). Ambiguity in the Mathematics Classroom. *Language and Education*, *19*(2), 117-125. http://doi.org/10.1080/09500780508668667

Barwell, R. (2005b). Language in the Mathematics Classroom. *Language and Education*, *19*(2), 96-101. http://doi.org/10.1080/09500780508668665

Barwell, R. (2012). Heteroglossia in Multilingual Mathematics Classrooms. In H. Forgasz & F. Rivera (Eds.), *Towards Equity in Mathematics Education* (pp. 315-332). Berlin, Heidelberg: Springer Berlin Heidelberg. Retrieved from http://link.springer.com/10.1007/978-3-642-27702-3_28

Barwell, R. (2014). Centripetal and centrifugal language forces in one elementary school second language mathematics classroom. *ZDM Mathematics Education 46*, 911-922. doi:10.1007/s11858-014-0611-1

Barwell, R. (2016). Mathematics education, language and superdiversity. In A. Halai & P. Clarkson (Eds.), *Learning and teaching Mathematics in Multilingual Classrooms,* (pp. 25-39). Rotterdam; Boston ; Taipei: Sense Publishers.

Barwell, R. (2018). From language as a resource to sources of meaning in multilingual mathematics classrooms. *Journal of Mathematical Behavior, 50*, 155–168

Barwell, R., Barton, B., & Setati, M., (2009). Multilingual Issues in Mathematics Education. *Educational Studies in Mathematics, 64*(2), 113-119.

Barwell, R., Leung, C., Morgan, C., & Street, B. (2005). Applied Linguistics and Mathematics Education: More than Terms and Numbers. *Language and Education*, *19*(2), 141-146. http://doi.org/10.1080/09500780508668670

Barwell, R., & Setati, M. (2005). Multilingualism in mathematics education: A conversation between the north and the south. *For the Learning of Mathematics*, *25*(1), 20-24.

Barton, B. (2008). *The language of mathematics: telling mathematical tales*. New York, NY: Springer.

Bertram, C., Christiansen, I., & Makurdi, T. G. (2015). Exploring the complexities of describing Foundation Phase teachers' professional knowledge base. *South African Journal of Childhood Education, 5*, 169–190. https://doi.org/10.4102/ sajce.v5i1.355

Beukes, A. (2008). Language policy implementation in South Africa: How Kempton Park's great expectations are dashed in Tshwane. *Stellenbosch Papers in Linguistics, 38*, 1-26. doi: 10.5774/38-0-20

Bialystok, E. (2006). The impact of bilingualism on language and literacy development. In Bhatia, T.K., & W.E. Ritchie (Eds.) *The handbook of bilingualism* (pp. 577-601). Malden, MA: Blackwell Publishing.

Bose, A., & Choudhury, M. (2009). Language Negotiation in a Multilingual Mathematics Classroom: An Analysis. L. Sparrow, B. Kissane, & C. Hurst, (Eds.), *Shaping the future of mathematics education: Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia.* Fremantle: MERGA.

Botes, H., & Mji, A. (2010). Language diversity in the mathematics classroom: does a learner companion make a difference? *South African Journal of Education, 30*(1), 123-138.

Brock-Utne, B. (2001). Education for all – in whose language? *Oxford Review of Education*, *27*(1), 115–134. http://doi.org/10.1080/03054980125577

Bruner, J. S. (1966). *Toward a Theory of Instruction*. USA: Harvard University Press.

Bunyi, G. (1997). Multilingualism and discourse in primary school mathematics in Kenya. *Language, Culture and Curriculum*, *10*(1), 52-65. http://doi.org/10.1080/07908319709525240

Cai, J., Kaiser, G., Perry, B., & Wong, N. Y. (Eds.). (2009). *Effective mathematics teaching from teachers' perspectives*. Rotterdam: Sense Publ.

Cai, J., Morris, A., Hohensee, C., Hwang, S., Robison, V., & Hiebert, J. (2017). Clarifying the Impact of Educational Research on Learning Opportunities. *Journal for Research in Mathematics Education, 48* (3), 230-236.

Canagarajah, S. (2011). Translanguaging in the classroom: Emerging issues for research and pedagogy. In L. Wei (Ed.), *Applied Linguistics Review* 2, 1-28. Berlin, New York: DE GRUYTER MOUTON. Retrieved from http://www.degruyter.com/view/j/alr.2011.2.issue-1/9783110239331.1/9783110239331.1.xml

Castro, M. (2015). *Language Practices in Multilingual Ecologies during Mathematics Instruction* (Doctor of Philosophy). University of Wisconsin-Madison. Retrieved from ProQuest Dissertations & Theses Global. (UMI Number: 3707126)

Chetty, R., & Mwepu, D. (2008). Language Policy and Education in South Africa: An alternative View of the Position of English and African Languages. *Alternation, 15*(2), 329-345.

Chetty, R. (2012). The status of English in a multilingual South Africa: Gatekeeper or liberator? http://www.teachenglishtoday.org/index.php/2012/06/the-status-of-english-in-a-multilingual-south-africa/ accessed 18/01/2016

Chikiwa, C., & Schäfer, M. (2016). Teacher Code-switching Consistency and Precision in a Multilingual Mathematics Classroom. *African Journal of Research in Mathematics, Science and Technology Education, 20*(3), 244-255.

Chikiwa, S., Westaway, L., & Graven, M. (2019). What mathematics knowledge for teaching is used by a Grade 2 teacher when teaching counting. *South African Journal of Childhood Education, 9*(1), a567. https://doi.org/10.4102/sajce.v9i1.567

Chin, N. B., & Wigglesworth, G. (2007). *Bilingualism: An advanced resource book.* London: Routledge.

Chitera, N. (2011). Language of learning and teaching in schools: an issue for research in mathematics teacher education? *Journal of Mathematics Teacher Education*, *14*(3), 231-246. http://doi.org/10.1007/s10857-010-9167-3

Clarkson, P. (2016). The intertwining of politics and mathematics teaching in Papua New Guinea. In A. Anjum & P. Clarkson (Eds.), *Learning and teaching mathematics in Multilingual classrooms: Issues for policy, practice and teacher education* (pp. 25-39). Rotterdam: Sense Publishers.

Cloud, N., Genesee, F., & Hamayan, E. (2009). *Literacy Instruction for English Language Learners: A Teacher's Guide to Research-Based Practices.* Portsmouth, NH: Heinemann.

Cohen, L., & Manion, L. (1985). *Research methods in education*. London: Croom Helm.

Costa, L. R. (2016). Ideology and Scientific Dissemination: A Bakhtinian Analysis of the Discourse in *Ciência Hoje* [*Science Today*] Magazine. *Bakhtiniana, Rev. Estud. Discurso* 11(2), São Paulo *On-line version* ISSN 2176-4573. http://dx.doi.org/10.1590/2176-457323536

Creese, A., & Blackledge, A. (2010). Translanguaging in the Bilingual Classroom: A Pedagogy for Learning and Teaching? *The Modern Language Journal*, *94*(1), 103-115. http://doi.org/10.1111/j.1540-4781.2009.00986.x

Cummins, J. (2015). Translanguaging: What Does It Mean to Teach for Transfer in Educating Multilingual Students? Conference on Translanguaging–Practices, Skills and Pedagogy, Dalarna University, Falun, Sweden, April 2015. Powerpoint presentation, slide 15.

de los Ríos, C. V., & Seltzer, K. (2017). Translanguaging, Coloniality, and English Classrooms: An Exploration of Two Bicoastal Urban Classrooms. *Research in the Teaching of English, 52*(1). 55-76.

Denzin, N. K., & Lincoln, Y. S. (Eds.) (2000). *Handbook of Qualitative Research.* London, New Delhi and Thousand Oaks: Sage.

Department of Arts and Culture, (DAC). (2008). *Multilingual mathematics dictionary. Grade R-6.* Pretoria: DAC.

Department of Basic Education, (DBE). (2010). *The Status of the Language of Learning and Teaching (LoLT) in South African Public Schools: A Quantitative Review.* DBE: Pretoria.

Department of Basic Education, (DBE). (2011a). *Curriculum and Assessment Policy Statement, Final Draft, FP Mathematics Grade R-3.* Pretoria: DBE.

Department of Basic Education, (DBE). (2011b). *Curriculum and Assessment Policy Statement, Final Draft, Intermediate Phase Mathematics Grade 4-6.* Pretoria: DBE.

Department of Basic Education, (DBE). (2014). *Report on the Annual National Assessment of 2014 Grades 1 To 6 & 9.* Pretoria: DBE.

Department of Basic Education, (DBE). (2015). Circular S12 of 2015 (delivery of workbooks).

Department of Basic Education, (DBE). (2016). Item 5. Prof L Lalendle. *ATC160526: Report of the Portfolio Committee on Basic Education on its engagement with the Department of Basic Education in Cape Town, dated 24 May 2016*. DBE: Pretoria. https://pmg.org.za/tabled-committee-report/2788/

Department of Basic Education, (DBE). (2018). *Curriculum and Assessment Policy Statement Mathematics Foundation Phase Section 4: Assessment (draft).* Pretoria: DBE.

Department of Basic Education, (DBE). (2017). Guidelines for Strengthening CAPS Grades R – 3 Item B.1.4: FP (PowerPoint presentation).

Department of Basic Education, (DBE). (2018). *Mathematics Learning and teaching Framework for South Africa. Teaching Mathematics for Understanding*. Pretoria: DBE.

Department of Education, (DoE). (1997). "Language in education policy 14 July 1997" in http://education.pwv.gov.za/policies%20and%20Reports/Policies/Language.

Dixon, K., & Peake, K. (2008). "Straight for English": Using school language policy to resist multilingualism. *English Teaching: Practice and Critique 7* (1), 73-90. http://education.waikato.ac.nz/research/files/etpc/2008v7n1art5.pdf pp.73-90 Copyright © 2008, ISSN 1175 8708 73

Durkin, K., & Shire, B. (Eds.). (1991). *Language in mathematical education: research and practice*. Milton Keynes [England]; Philadelphia: Open University Press.

Essien, A. (2010). Mathematics Teacher Educators' Account of Preparing Pre-service Teachers for Teaching Mathematics in Multilingual Classrooms: The Case of South Africa. *The International Journal of Interdisciplinary Social Sciences 5*(2): 33-44.

Essien, A. (2013). *Preparing Pre-Service Mathematics Teachers To Teach In Multilingual Classrooms: A Community Of Practice Perspective.* Unpublished PhD Thesis. University of the Witwatersrand: Johannesburg.

Essien, A. (2018). The Role of Language in the Learning and teaching of Early Grade Mathematics: An 11-year Account of Research in Kenya, Malawi and South Africa. *African Journal of Research in Mathematics, Science and Technology Education*, 1-12. doi:10.1080/18117295.2018.1434453

Essien, T., Venkat, H., Takane, T., & Tshesane, H. (2014). An evaluation of the use and efficacy of the GPLMS FP multilingual mathematics materials: Issues and prospects. Draft, unpublished report, University of the Witwatersrand.

Fraenkel, J., & Wallen N. (1990). *How to design and evaluate research in education.* New York: McGraw-Hill Publishing Company.

García, O., & Baetens Beardsmore, H. (2009). *Bilingual education in the 21st century: a global perspective*. Malden, MA ; Oxford: Wiley-Blackwell Pub.

García, O., & Wei, L. (2014). *Translanguaging: language, bilingualism and education*. Basingstoke, Hampshire; New York: Palgrave Macmillan.

Gauteng Department of Education, (GDE). (2011). *Research into language in education policy in the context of Gauteng demographics: Report on policy and policy implementation in primary schools.* CEPD: Johannesburg.

Genesee, F. (2010). The Home Language: An English Language Learner's Most Valuable Resource, retrieved from http://www.colorincolorado.org/article/home-language-english-language-learners-most-valuable-resource

Gumperz, J. J. (1982). *Discourse Strategies.* Cambridge: Cambridge University Press.

Guzula, X., McKinney, C., & Tyler, R. (2016). Languaging-for-learning: Legitimising translanguaging and enabling multimodal practices in third spaces. *Southern African Linguistics and Applied Language Studies, 34*(3), 211-226.

Halai, A., & Clarkson, P. (Eds.). (2016). *Learning and teaching mathematics in multilingual classrooms: issues for policy, practice and teacher education*. Rotterdam; Boston ; Taipei: Sense Publishers.

Halai, A., & Muzaffar, I. (2016). Language of Instruction and Learners' Participation in Mathematics. In *A. Halai & P. Clarkson (Eds.), Learning and teaching Mathematics in Multilingual Classrooms,* (pp. 57-72). Rotterdam; Boston ; Taipei: Sense Publishers.

Halliday, M. A. K. (1978). *Language as Social Semiotic: The Social Interpretation of Language and Meaning.* London: Edward Arnold.

Henning, E., van Rensburg, W., & Smit, B. (2004). *Finding your way in qualitative research*. Pretoria: Van Schaik.

Heugh, K. (2005). Mother tongue education is best. *HSRC Review* 3(3), 6-7.

Heugh, K. (2014). Dreams and realities: developing countries and the English language. *Current Issues in Langue Planning, 15*(1), 110-116.

Hoadley, U. (2012). What do we know about learning and teaching in South African primary schools? *Education as Change 16*(2), 37-41. https://doi.org/10.1080/16823206.2012.745725

Howie, S., & Van Staden, S. (2012). *South African children's reading literacy achievement – PIRLS and prePIRLS 2011*. Centre for Evaluation and Assessment: Pretoria.

Jackson, S. L. (2009). *Research Methods and Statistics: A Critical Thinking Approach 3rd edition.* Belmont, CA: Wadsworth.

Jacobs, J. K., Kawanaka, T., & Stigler, J. W. (1999). Integrating qualitative and quantitative approaches to the analysis of video data on classroom teaching. *International Journal of Educational Research 31*, 717-724.

Jorgensen , R. (2018). Building the mathematical capital of marginalised learners of mathematics. *ZDM, 50*, 987–998. https://doi.org/10.1007/s11858-018-0966-9

Kaphesi, E. S. (2002). *The use of language in mathematics teaching in primary schools in Malawi: bringing language to the surface as an explicit feature in the teaching of mathematics.* PhD thesis, University of Nottingham.

Kaphesi, E. (2003). The influence of language policy in education on mathematics classroom discourse in Malawi: the teachers' perspective. *Teacher Development*, *7*(2), 265-285. http://doi.org/10.1080/13664530300200190

Kovács, A., & Mehler, J. (2009). Flexible Learning of Multiple Speech Structures in Bilingual Infants. *Science,* 325, 5940, 611-612. DOI: 10.1126/science.1173947

Kroskrity, P. V. (2004). Language Ideologies. A. Duranti (Ed.), *A Companion to Linguistic Anthropology,* (pp. 496-515). Malden: Blackwell.

Lafon, M., & Webb, V. (2008). *The Standardisation of African languages: language political realities.* http://lst-iiep.iiep-unesco.org/cgi-bin/wwwi32.exe/[in=epidoc1.in]/?t2000=027825/(100).

Langa, M. (2006). *An investigation of learners' home language as a support for learning mathematics.* Phd Dissertation, University of the Witwatersrand, Johannesburg.

Leung, C. (2005). Mathematical Vocabulary: Fixers of Knowledge or Points of Exploration? *Language and Education*, *19*(2), 126-134. http://doi.org/10.1080/09500780508668668

Lewis, G., Jones, B., & Baker, C. (2012a). Translanguaging: developing its conceptualisation and contextualisation. *Educational Research and Evaluation*, *18*(7), 655-670. http://doi.org/10.1080/13803611.2012.718490

Lewis, G., Jones, B., & Baker, C. (2012b). Translanguaging: origins and development from school to street and beyond. *Educational Research and Evaluation*, *18*(7), 641-654. http://doi.org/10.1080/13803611.2012.718488

Liddicoat, A. J., & Taylor-Leech, K. (2015). Multilingual education: the role of language ideologies and attitudes. *Current Issues in Language Planning*, *16*(1–2), 1-5. https://doi.org/10.1080/14664206.2015.995753

Lodico, M. G., Spaulding, D. T., & Voegtle, K. H. (2010). *Methods in Educational Research: From Theory to Practice.* John Wiley & Sons:

Loh, J. (2013) Inquiry into Issues of Trustworthiness and Quality in Narrative Studies: A Perspective. *The qualitative report, 18*(65), 1-15. Available from: http://www.nova.edu/ssss/QR/QR18/loh65.pdf [Accessed 4 April 2018].

Madiba, M. (2013). *Academic Literacy at FP Level.* CHE: Cape Town.

Mafela, M. J. (2010). Problems of Dialect Non-Inclusion in Tshivenḓa Bilingual Dictionary Entries. In Dykstra, A & Tanneke Schoonheim (Eds.), *Proceedings of the XIV EURALEX International Congress. 6-10 July 2010,* (pp. 824-831). Leeuwarden/Ljouwert: Fryske Akademy – Afûk.

Magwa, E. M. (2013). *The Language-in-Education Policy: Opportunities and Challenges of Implementation in a Suburban School.* Research Report Master's in Education (MEd), University of the Witwatersrand, Johannesburg.

Makalela, L. (2014). Teaching indigenous African languages to speakers of other African languages: the effects of translanguaging for multilingual development. In Van der Walt, C & L Hibbert (Eds), *Multilingual learning and teaching in higher education in South Africa,* (pp. 88-104). Clevedon: Multilingual Matters.

Makalela, L. (2015a). Moving out of linguistic boxes: the effects of translanguaging strategies for multilingual classrooms. *Language and Education*, *29*(3), 200-215. http://doi.org/10.1080/09500782.2014.994524

Makalela, L. (2015b). Translanguaging as a vehicle for epistemic access: cases for reading comprehension and multilingual interactions. *Per Linguam*, *31*(1), 15. http://doi.org/10.5785/31-1-628

Makalela, L. (2016). Presentation at Wits Staff Seminar, Staffroom, University of the Witwatersrand.

Makalela, L. (2019). Uncovering the universals of *ubuntu* translanguaging in classroom discourses, in Wei, L and Lin, A. (Eds.), *Special Issue: Translanguaging Classroom Discourse,* (pp. 237-251). Routledge Taylor & Francis Group: UK.

Makoe, P., & McKinney, C. (2014). Linguistic ideologies in multilingual South African suburban schools. *Journal of Multilingual and Multicultural Development, 35*(7), 658-673. DOI: 10.1080/01434632.2014.908889

Makoni, S., & Pennycook, A. (2011). From monolingualism to multilingualism and back again. In M. Martin-Jones, A. Blackledge & A. Cleese (Eds.),The Routledge handbook of multilingualism (pp. 439-452). London: Routledge.

McCarthy, J., & Oliphant, R. (2019). *Mathematics outcomes in South African schools: What are the facts? What should be done?* CDE: Parktown.

McKinney, C., Carrim, H., Marshall, A., & Layton, L. (2015). What counts as Language in South African schooling?: Monoglossic ideologies and children's participation. AILA Review, 28, 103-126. DOI: 10.1075/aila.28.05mck

McKinney, C. (2017). *Language and Power in Post-Colonial Schooling*: *Ideologies in Practice.* New York: Routledge.

McMillan, J. H., & Schumacher, S. (2006). *Research in Education: Evidence based enquiry* (6th ed.). USA: Pearson.

Mejía Colindres, C. A. (2015). *The role of translanguaging in Latino mathematics classrooms*. PhD dissertation, Texas State University, Texas.

Merriam-Webster. (n.d.). Ideology. In *Merriam-Webster.com dictionary*. Retrieved January 1, 2021, from https://www.merriam-webster.com/dictionary/ideology

Mifsuda, J., & Farrugia, J. (2017). Language choice for science education: policy and practice. *The Curriculum Journal, 28*(1), 83-104. http://dx.doi.org/10.1080/09585176.2016.1251847

Mohohlwane, N. L. (2020). Mother-tongue instruction or straight-for-English? The primary education policy dilemma. *RESEP working paper*. RESEP: Stellenbosch.

Mojela, V. M. (2008). Standardization or Stigmatization? Challenges Confronting Lexicography and Terminography in Sesotho sa Leboa* *Lexikos* 18 (AFRILEX-reeks/series 18: 2008): 119-130

Moore, K. (2017). *Translating a path to success.* Cape Town: UCT. Retrieved from https://www.news.uct.ac.za/article/-2017-07-11-translating-a-path-to-success?fbclid=IwAR3URJUG3UA-Vf5rhYDnT_9iR6uLlNHhoKh0-j3jQzMYMg5QiAY6Q1uCShk

Morgan, C. (2005). Term, Definitions and Concepts in Discourses of Mathematics, Learning and teaching. *Language and Education*, *19*(2), 102-116. http://doi.org/10.1080/09500780508668666

Moschkovich, J. (1999). Supporting the Participation of English Language Learners in Mathematical Discussions. *For the Learning of Mathematics, 19*(1), 11-19.

Moschkovich, J. N. (Ed.). (2010). *Language and mathematics education: multiple perspectives and directions for research*. Charlotte, NC: Information Age Pub.

Mostert, I. (2019). Number names: Do they count? *African Journal of Research in Mathematics, Science and Technology Education*, DOI: 10.1080/18117295.2019.1589038

Mouton, J. (1996). *Understanding social research*. Pretoria: Van Schaik.

Mukucha, J. (2012). T*he mathematics definition discourse: teachers' practices in multilingual classrooms.* PhD. University of the Witwatersrand.

Nhongo, R. (2013). A National Language Policy for Zimbabwe in the Twenty-first Century: Myth or Reality? J*ournal of Language Teaching and Research, 4*(6), 1208-1215. doi:10.4304/jltr.4.6.1208-1215

Ooyo, S. O. (2015). In South Africa, science should be taught in only one language – how about English? https://theconversation.com/in-south-africa-science-should-be-taught-in-only-one-language-how-about-english-43733

Otheguy, R., García, O., & Reid, W. (2015). Clarifying translanguaging and deconstructing named languages: A perspective from linguistics. *Applied Linguistics Review*, *6*(3), 281-307. https://doi.org/10.1515/applirev-2015-0014

Ouane, A., & Glanz, C. (Eds.). (2010). *Why and how Africa should invest in African languages and multilingual education. An evidence- and practice-based policy advocacy brief.* UNESCO/ADEA: Hamburg, Germany.

Ouane, A., & Glanz, C. (Eds.). (2011). *Optimising Learning, Education and Publishing in Africa: The Language Factor. A Review and Analysis of Theory and Practice in Mother-Tongue and Bilingual Education in sub-Saharan Africa.* UIL/ADEA: Germany.

Owen-Smith, M. (2012). A set of multi-bilingual methodologies to address some current problems in education. *Strategies to overcome poverty and inequality: Towards Carnegie 111, UCT conference 3-7 September*, supported by the National Planning Commission.

Phakeng, M. (2017). *Mathematics Education and Language Diversity: From Language-as-Problem to Language-as-Resource.* Keynote address at the NSTF (National Science and Technology Forum) discussion on multilingualism in STEM subjects. Emperor's Palace: Benoni.

Piaget, J. (1957). *Construction of reality in the child.* London: Routledge & Kegan Paul.

Pimm, D. (1981). Mathematics? I speak it fluently. In A Floyd (Ed.), *Developing Mathematical Thinking.* Workington: Addison Wesley.

Pimm, D. (1991). Communicating Mathematically. In K. Durkin & B. Shire (Eds.), *Language in Mathematical Education: Research and Practice,* (pp. 17-23). Milton Keynes: Open University Press.

Planas, N. (2018). Language as resource: a key notion for understanding the complexity of mathematics learning. *Educational Studies in Mathematics 98*, 215-229. https://doi.org/10.1007/s10649-018-9810-y

Planas, N., & Setati-Phakeng, M. (2014). On the process of gaining language as a resource in mathematics education. ZDM Mathematics Education, 46, 883–893. DOI 10.1007/s11858-014-0610-2

Plüddemann, P. (2002). Action and reflection: Dual-medium primary schooling as language policy realisation. *Perspectives in Education, 20*, 47-64.

Plüddemann, P. (2015). Unlocking the grid: language-in-education policy realisation in post-apartheid South Africa. *Language and Education, 29*(3), 186-199. DOI: 10.1080/09500782.2014.994523

Prediger, S., Kuzu, T., Schüler-Meyer,A., &Wagner, J. (2019). One mind, two languages—Separate conceptualisations? A case study of students' bilingual modes for dealing with language-related conceptualisations of fractions. *Research in Mathematics Education, 21*(2), 188–207. https://doi.org/10.1080/14794802.2019.1602561.

Pretorius, E. J., & Stoffelsma, L. (2017). How is their word knowledge growing? Exploring Grade 3 vocabulary in South African township schools. *South African Journal of Childhood Education*, *7*(1), a553. https://doi.org/10.4102/sajce.v7i1.553

Poo, M., & Venkat, H. (2021). Approaches that leverage home language in multilingual classrooms. In A. Essien and A. Msimanga (Eds.), *Multilingual Education Yearbook 2021: Policy and practice in STEM multilingual contexts*. Springer Nature: Switzerland.

Ramey, K., Hilppö, J., Dyer, E., Krist, C., Keifert, D., Meyerhoff, P., Champion, D., & Villanosa, K. (2016). Qualitative Analysis of Video Data: Standards and Heuristics. *Conference: International Conference of the Learning Sciences (ICLS)*.

Rittle-Johnson, B., Fyfe, E. R., Hofer, K. G., & Farran, D. C. (2016). Early math trajectories: Low-income children's mathematics knowledge from ages 4 to 11. *Child Development*. doi:10.1111/cdev.12662

Rittle-Johnson, B, Zippert, E. L., & Boice, K. L. (2018). The Roles of Patterning and Spatial Skills in *Early Mathematics Development. Early Childhood Research Quarterly*. DOI: 10.1016/j.ecresq.2018.03.006.https://www.sciencedirect.com/science/article/pii/S0885200617301801 *(8) (PDF) The roles of patterning and spatial skills in early mathematics development*. Available from: https://www.researchgate.net/publication/324135750_The_roles_of_patterning_and_spatial_skills_in_early_mathematics_development [accessed Dec 31 2020].

Roberts, T. (1998). Mathematical Registers in Aboriginal Languages. *For the Learning of Mathematics. 18*(1), 10-16.

Robertson, S. & Graven, M. (2018). Exploratory mathematics talk in a second language: A sociolinguistic perspective. *Educational Studies in mathematics, Online*. https://doi.org/10.1007/s10649-018-9840-5

Rose, S., & Van Dulm, O. (2011). Functions of code-switching in multilingual classrooms. *Per Linguam*, *22*(2). http://doi.org/10.5785/22-2-63

Sapire, I. (2017a). *Researching Multilingualism in FP Mathematics: Task 2: Text analysis.* Technical Report. Wits University: Johannesburg.

Sapire, I. (2017b). *Researching Multilingualism in FP Mathematics: Task 3: Language Survey.* Technical Report. Wits University: Johannesburg.

Sapire, I. (2018a). *Researching Multilingualism in FP Mathematics: Task 4: Teacher Interviews.* Technical Report. Wits University: Johannesburg.

Sapire, I. (2018b). *Researching Multilingualism in FP Mathematics: Task 5: Classroom observations.* Technical Report. Wits University: Johannesburg.

Sapire, I. & Essien, A. (2021). Multiple monolingualism versus multilingualism? Early grade Mathematics teachers' and students" language use in multilingual classes in South Africa. In A. Essien and A. Msimanga (Eds.), *Multilingual Education Yearbook 2021: Policy and practice in STEM multilingual contexts*. Springer Nature: Switzerland.

Sapire, I. & Roberts, G. (2017). *The status of the Language of Learning and Teaching (LoLT) in schools: A quantitative overview: 2008-2016*. Draft report. Wits University: Johannesburg.

Schäfer, M. (2010). Mathematics Registers in Indigenous Languages: Experiences from South Africa. In L. Sparrow, B. Kissane, & C. Hurst (Eds.), *Shaping the future of mathematics education: Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia.* Fremantle: MERGA.

Schieffelin, B. S., Woolard, K. A., & Kroskrity, P. V. (1998). *Language Ideologies: Practice and Theory*. New York: Oxford University Press.

Setati, M. (1998a). Code-Switching in a Senior Primary Class of Second-Language Mathematics Learners. *For the Learning of Mathematics, 18*(1), 34-40.

Setati, M. (1998b). *Innovative language practices in multilingual mathematics classrooms,* Final report, Johannesburg: University of the Witwatersrand.

Setati, M. (2005). Teaching mathematics in a primary multilingual classroom. *Journal for Research in Mathematics Education, 36*(5), 447-466.

Setati, M. (2008). Access to mathematics versus access to the language of power: the struggle in multilingual mathematics classrooms. *South African Journal of Education,* 28, 103-116.

Setati, M. (2012). Mathematics in Multilingual Classrooms in South Africa: From Understanding the Problem to Exploring Possible Solutions. In B. Herbel-Eisenmann et al. (Eds.), *Equity in Discourse for Mathematics Education: Theories, Practices, and Policies, Mathematics Education Library 55*, 125-145. DOI 10.1007/978-94-007-2813-4_8

Setati, M., & Adler, J. (2000). Between languages and discourses: language practices in primary multilingual mathematics classrooms in South Africa. *Educational Studies in Mathematics 43*, 243-269.

Setati, M., Molefe, T., & Langa, M. (2008). Using Language as a Transparent Resource in the Learning and teaching of Mathematics in a Grade 11 Multilingual Classroom. *Pythagoras, 67*, 14-25.

Silverman, D. (1998). *Harvey Sacks: Social science and conversation analysis*. New York: Oxford University Press.

Silverstein, M. (1979). Language structure and linguistic ideology. In P. R. Clyne, W. F. Hanks, & C. L. Hofbauer, (Eds.), *The elements: A parasession on linguistic units and levels,* (pp. 193-245). Chicago, IL: Chicago Linguistic Society.

Silverstein, M. (2018). Monoglot "Standard" in America: Standardization and Metaphors of Linguistic Hegemony. In D. Brenneis & R. Macaulay (Eds.), *The Matrix of Language,* (pp. 284-306). 10.4324/9780429496288-18.

Sorto, M. A., Mejía Colindres, C. A.& Wilson, A. T. (2014). Uncovering and Eliciting Perceptions in Linguistically Diverse Classrooms. *Mathematics Teaching in the Middle School*, *20*(2), 72-75. http://doi.org/10.5951/mathteacmiddscho.20.2.0072

Spaull, N. (2015). Accountability and capacity in South African education. *Education as Change*, *19*(3), 113-142, DOI: 10.1080/16823206.2015.1056199

Spaull, N. (2016a). Learning to read and reading to learn. *RESEP Policy Brief.* Department of Economics: Stellenbosch University.

Spaull, N. (2016b). Disentangling the language effect in South African schools: Measuring the impact of language of assessment in Grade 3 literacy and numeracy. *South African Journal of Childhood Education, 6*(1), a475. https://doi.org/10.4102/sajce.v6i1.475

Spaull, N., & Kotze, J. (2015). Starting behind and staying behind in South Africa: The case of insurmountable learning deficits in mathematics. *International Journal of Educational Development, 41*, 12-24. http://dx.doi.org/10.1016/j.ijedudev.2015.01.002

Stats SA (Statistics South Africa). (2020). Mid-year population estimates. http://www.statssa.gov.za/publications/P0302/P03022020.pdf

Suh, J., & Seshaiyer, P. (2015). Examining teachers' understanding of the mathematical learning progression through vertical articulation during lesson study. *Journal of Mathematics Teacher Education, 18*(3), 207-229. doi:10.1007 /s10857-014-9282-7

Taylor, S., & von Fintel, M. (2016). Estimating the impact of language of instruction in South African primary schools: A fixed effects approach. *Economics of Education Review, 50*, 75-89.

Ticheloven, A., Blom, E., Leseman, P., & McMonagle, S. (2019). Translanguaging challenges in multilingual classrooms: scholar, teacher and student perspectives. *International Journal of Multilingualism*, DOI: 10.1080/14790718.2019.1686002

Trinick, T., Meaney, T., & Fairhall, U. (2014). Teachers learning the registers of mathematics and mathematics education in another language: an exploratory study. *ZDM Mathematics Education 46*, 953–965. https://doi.org/10.1007/s11858-014-0618-7

Vaish, V. (2019). Challenges and directions in implementing translanguaging pedagogy for low achieving students. *Classroom Discourse*, *(10),* 3-4, 274-289. DOI: 10.1080/19463014.2019.1628790

van Laren, L., & Goba, B. (2013). The Volatile Issue of Language(s) of Instruction in FP Mathematics Teacher Education in a Multilingual Context. *Alternation Special Edition 9*, 169-196.

Vasagar, J. (2016). New York Times, 22 July 2016. Why Singapore's kids are so good at maths. Retrieved on 22 February 2015. https://www.ft.com/content/2e4c61f2-4ec8-11e6-8172-e39ecd3b86fc

Venkat, H., Adler, J., Rollnick, M., Setati, M., & Vhurumuku, E. (2009). Mathematics and science education research, policy and practice in South Africa: What are the relationships?, *African Journal of Research in Mathematics, Science and Technology Education,* 13:sup1, 5-25. doi: 10.1080/10288455.2009.10740659

Venkat, H., & Naidoo, D. (2012). Analyzing coherence for conceptual learning in a Grade 2 numeracy lesson, *Education as Change, 16*(1), 21-33. http://dx.doi.org/10.1080/16823206.2012.691686

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Wei, L. (2017). Translanguaging as a Practical Theory of Language. *Applied Linguistics, 39*(1), 9-30, https://doi.org/10.1093/applin/amx039

Wildsmith-Cromarty, R., & Gordon, M. (2009). Policy versus practice: the role of the home language in learning mathematics and science in English-medium classrooms. *Language Learning Journal*, *37*(3), 359-370. http://doi.org/10.1080/09571730903208520

Williams, C. (2002). Extending Bilingualism in the Education System. *Education and Lifelong Learning Committee.* **6** (2), accessed 22 February 2017, http://www.assembly.wales/Committee%20Documents/ELL%2006-

02%28p.4%29%20Dr%20Cen%20Williams%20paper-20032002-28970/3c91c7af00023d820000595000000000-English.pdf .

Wolff, H. (2018). How the continent's languages can unlock the potential of young Africans. *The Conversation*, https://phys.org/news/2018-02-continent-languages-potential-young-africans.html

Woolard, K. (1998). Language ideology. In B.S. Schieffelin, K.A. Woolard & P.V. Kroskrity, (Eds.), *Language Ideologies: Practice and Theory,* (pp. 3-25). New York: Oxford University Press.

Woolard, K. A. (2021). Language ideology. In J. Stanlaw (Ed.), *The International Encyclopedia of Linguistic Anthropology*, (pp. 1-21). John Wiley & Sons, Inc. DOI: 10.1002/9781118786093.iela0217

Woolard, K. A., & Schieffelin, B. B. (1994). Language Ideology. *Annual Review of Anthropology, 23*(1). 55-82. doi:10.1146/annurev.an.23.100194.000415.

Wortham, S. (2001). Language Ideology and Educational Research. Retrieved from http://repository.upenn.edu/gse_pubs/80

Appendices

Appendix 1: Ethics clearance letter (Protocol Number: 2016ECE024D)

Wits School of Education

WITS UNIVERSITY

27 St Andrews Road, Parktown, Johannesburg, 2193 Private Bag 3, Wits 2050, South Africa. Tel: +27 11 717-3064 Fax: +27 11 717-3100 E-mail: enquiries@educ.wits.ac.za Website: www.wits.ac.za

05 December 2016

Student Number: 8166164

Protocol Number: 2016ECE024D

Dear Ingrid Sapire

Application for ethics clearance: Doctor of Philosophy

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate, has considered your application for ethics clearance for your proposal entitled:

Multilingualism in Foundation Phase mathematics

The committee recently met and I am pleased to inform you that **clearance was granted.**

Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely,

Wits School of Education

011 717-3416

cc Supervisor - Prof Yael Shalem and Prof Mamokgethi Phakeng

Appendix 2.1: Letter of approval to undertake the research in 2017: reference D2017/368

For administrative use only:
Reference no: D2017 / 368

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GDE RESEARCH APPROVAL LETTER

Date:	**28 November 2016**
Validity of Research Approval:	**6 February 2017 to 29 September 2017**
Name of Researcher:	**Sapire I.M.**
Address of Researcher:	**11 Westcliff Drive; Parkview; 2193**
Telephone / Fax Number/s:	**011 646 1801; 082 352 2271; 011 646 5823**
Email address:	**ingrid.sapire@wits.ac.za**
Research Topic:	**Multilingualism in Foundation Phase Mathematics**
Number and type of schools:	**TWENTY Primary schools**
District/s/HO	**Ekurhuleni North; Johannesburg North and Johannesburg South**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved. A separate copy of this letter must be presented to the Principal, SGB and the relevant District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted. However participation is VOLUNTARY.

The following conditions apply to GDE research. The researcher has agreed to and may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

CONDITIONS FOR CONDUCTING RESEARCH IN GDE

1. *The District/Head Office Senior Manager/s concerned, the Principal/s and the chairperson/s of the School Governing Body (SGB.) must be presented with a copy of this letter.*
2. *The Researcher will make every effort to obtain the goodwill and co-operation of the GDE District officials, principals, SGBs, teachers, parents and learners involved. Participation is voluntary and additional remuneration will not be paid;*

2016/11/29

1

Making education a societal priority

Office of the Director: Education Research and Knowledge Management ER&KM)
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

3. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal and/or Director must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
4. *Research may only commence from the second week of February and must be concluded by the end of the THIRD quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
5. *Items 3 and 4 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
6. *It is the researcher's responsibility to obtain written consent from the SGB/s; principal/s, educator/s, parents and learners, as applicable, before commencing with research.*
7. *The researcher is responsible for supplying and utilizing his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institution/s, staff and/or the office/s visited for supplying such resources.*
8. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research title, report or summary.*
9. *On completion of the study the researcher must supply the Director: Education Research and Knowledge Management, with electronic copies of the Research Report, Thesis, Dissertation as well as a Research Summary (on the GDE Summary template). Failure to submit your Research Report, Thesis, Dissertation and Research Summary on completion of your studies / project – a month after graduation or project completion - may result in permission being withheld from you and your Supervisor in future.*
10. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned;*
11. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director/s and school/s concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

....

Dr David Makhado

Director: Education Research and Knowledge Management

DATE: 2016/11/29

Office of the Director: Education Research and Knowledge Management ER&KM)
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

Appendix 2.2: Extension of approval to undertake the research in 2018: reference D2017/368A

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE AMENDED RESEARCH APPROVAL LETTER

Date:	04 December 2017
Validity of Research Approval:	05 February 2018 – 28 September 2018 D2017/368A
Name of Researcher:	Sapire I.M
Address of Researcher:	11 Westcliff Drive
	Parkview
	2193
Telephone Number:	011 646 1801 011 646 5823 082 352 2271
Email address:	Ingrid.sapire@wits.ac.za
Research Topic:	Multilingualism in Foundation Phase Mathematics
Number and type of schools:	Twenty Primary Schools
District/s/HO	Ekurhuleni North; Johannesburg North and Johannesburg South

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

04/12/2017

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

1

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
4. *A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

Faith

Ms Faith Tshabalala
CES: Education Research and Knowledge Management

DATE: 04/12/2017

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

Appendix 3: Patterns mathematical register list (CAPS)

English	**Setswana**	**IsiZulu**
copy	kopolola	kopisha
describe	tlhalosa	chaza
extend	atolosa	nweba, khulisa
sequences	tatelano	Uhlelo lwezinkinobo; ukulandelana kwezinombolo
counting	bala	ukubala/ bala
number sequences	tatelano ya dipalo	ukulandelana kwezinombolo
geometric pattern	thutatekanyo	nokusazi mdwebo
number pattern	popego palo	uhlelo nombolo
pattern		Iphethini
change	phetogo	ushintshi
counting forwards and backwards	go bala go ya kwa pele le go ya kwa morago	ukubala uya; phambili ubuye uye emumva
complete	feleletsa	qedela
identify	tlhopha/tlhaola	khomba
predictable	diragalang ka metlha.	ngendlela engaqageleka
tables	mananeo	ithebula
logic	tatelano	Kanjani
increasing	koketsego	ngokukhula
relationships	kamano/ botsalano	ubudlelwano
symbolic	tiriso ya matshwao	Izimpawu zokuchaza
analysis	lekolola	okuhlayiza
rule	molao	umthetho
decreasing	phokotsego	
between	mo gare ga	phakathi nendawo
interval	kgaotso	isikhawu
multiple	katiso	Isiphindaphinda
number line	mola palo	inkabamudwa yezinombolo
number grid	papetlana ya dipalo	Igridi yezinombolo

English	**Setswana**	**IsiZulu**
number chain	kgolagano ya dipalo	Izinombolo ezixhumanayo
missing numbers	dipalo tse di tlogetsweng	izinombolo ezisele
flow diagram	dipapetlaneng tse di elelang	ishadi lokulandelanayo
1s	1s	1s
2s	2s	2s
3s	3s	3s
4s	4s	4s
5s	5s	5s
10s	10s	10s
20s	20s	20s
25s	25s	25s
50s	50s	50s
100s	100s	100s
ones	bonngwe	ngakunye/kokukodwa
twos	bobedi/ bopedi	ngakubili
threes	seraro/ botharo	ngakuthathu?/ngantathu
fours	ka bone/ ka bonne	ngakune
fives	ka botlhano	ngakuhlanu
tens	masome/ bosome	amashumi
twenties	bo masome-a-mabedi	ngamashumi amabili
twenty-fives	bosome a mabedi tlhano	ngamashumi amabili nanhlanu
fifties	bosome-matlhano/ bosome a matlhano	ngamashumi amahlanu
hundreds	bolekgolo	amakhulu

Appendix 4: Survey

There were eight different language versions of the questionnaire (four teacher versions and four learner versions). One exemplar of the teacher questionnaire and one exemplar of the learner questionnaire are given here.

Appendix 4.1 Teacher questionnaire exemplar – IsiZulu/English version

FP mathematics and language research survey

School: -_________/Date: _________

Background

Please note: All of this information will be treated as confidential. NO names of participants or schools will appear anywhere in the research reports.

<table>
<tr><td></td><td>Question</td><td colspan="4">Your response</td></tr>
<tr><td>1</td><td>School</td><td colspan="4"></td></tr>
<tr><td>2</td><td>LoLT(s) of the school</td><td colspan="4"></td></tr>
<tr><td>3</td><td>Your main spoken language</td><td colspan="4"></td></tr>
<tr><td rowspan="7">4</td><td rowspan="7">Other languages that you speak (and fluency)</td><td>Language</td><td>Read</td><td>Write</td><td>Speak</td></tr>
<tr><td>1</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td></td></tr>
<tr><td>6</td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Language(s) you teach mathematics in. List from most</td><td colspan="4"></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4"></td></tr>
</table>

	used to least used and expand on use to explain how/why you use these languages	
6	Grades you teach mathematics	
7	Number of learners in your class(es)	
8	Languages spoken by your learners in each class (even if it is different to the LoLT). Are there learners who speak other languages in addition to the LoLT? Indicate the grades and languages spoken	
9	Anything else you would like to note about language(S) spoken in your mathematics class(es)	

Please translate this list of wordss to English

	IsiZulu	**English**
1	ukuhlanganisa	
2	ukususa	

3	uhlelonombolo	
4	ngakuhlanu	
5	ukubala ngawo 10	
6	ukubala ngaphezulu	
7	chaza	
8	nweba/khulisa	
9	phakathi nendawo	
10	ishadi lokulandelayo	
11	phambili	
12	isikhawu	
13	isiphindaphindi	
14	iziphindaphindi zoku-2	
15	inkabamudwa yezinombolo	
16	ukulandelana kwezinombolo	
17	iphethini lokusazibalomdwebo	
18	isiyingi	
19	isikwele	
20	unxantathu	

Please complete the following:

1. Fill in the missing number:/ Faka inombolo engekho:

   228, 230, 232, ____, 236

   Explain how you got your answer:
   Chaza ukuthi uyithole kanjani impendulo yakho

   ____

   ____

2. Extend the pattern:/ Khulisa leli phethini

   93, 96, 99, ___, ___, ___

   Explain how you got your answer:
   Chaza ukuthi uyithole kanjani impendulo yakho

   ____

   ____

3. Underline the numbers do not belong to the patterns.
   Dwebela izinombolo okungadingeki ukuthi zibe kule phethini.

   3, 6, 11, 15, 18

   Explain how you got your answer:
   Chaza ukuthi uyithole kanjani impendulo yakho

   ____

   ____

Appendix 4.2 Learner questionnaire exemplar – English/Setswana version

FP mathematics and language research survey

School: -_________/Date: _________

Please note: All of this information will be treated as confidential. NO names of participants or schools will appear anywhere in the research reports.

<table>
<tr><th></th><th>Question</th><th colspan="4">Your response</th></tr>
<tr><td>1</td><td>What is your main spoken language</td><td colspan="4"></td></tr>
<tr><td rowspan="4">2</td><td rowspan="4">Do you speak other languages?

How well?</td><td>Language</td><td>Little</td><td>Good</td><td>Excellent</td></tr>
<tr><td>1</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td></tr>
<tr><td>3
Other:</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>Anything that you would like to say about learning maths in your home language?</td><td colspan="4"></td></tr>
</table>

Please complete the following:

1. Fill in the missing number:

   Tlatsa palo e e tlogetsweng:

   228, 230, 232, ____, 236

   Explain how you got your answer:

   Tlhalosa go re o fitlhetse karabo ya gago jang:

   ____

2. Extend the pattern:

   Atolosa paterone:

   93, 96, 99, ___, ___, ___

   Explain how you got your answer:

   Tlhalosa go re o fitlhetse karabo ya gago jang:

   ____

3. Underline the number that does not belong to the pattern.

   Thalela dipalo tse di sa weleng mo dipateroneng.

   3, 6, 11, 15, 18

   Explain how you got your answer:

   Tlhalosa go re o fitlhetse karabo ya gago jang:

   ____

Please translate this list of words to Setswana

	English	Setswana
1	add	
2	subtract	
3	number pattern	
4	fives	
5	counting in 10s	
6	counting on	
7	describe	
8	extend	
9	between	
10	flow diagram	
11	forwards	
12	interval	
13	multiple	
14	multiples of 2	
15	number line	
16	number sequence	
17	missing number	
18	circle	
19	square	
20	triangle	

Appendix 4.3 Teacher questionnaire survey codes

Column	Code	Explanation
A	emis	The EMIS number of the school
B	unique identifier	Teacher number allocated per teacher
C	school	School name
D	LOLT	LoLT of the school
E	Teacher HL	The home language of the teacher
F	grade	Grade
G	Number of learners in class	The number of learners in the class
H	T Other L1	The first language indicated as another spoken language by the teacher
I	Read	Indication of the ability to read the first other language
J	Write	Indication of the ability to write the first other language
K	Speak	Indication of the ability to speak the first other language
L	T Other L2	The second language indicated as another spoken language by the teacher
M	Read	Indication of the ability to read the second other language
N	Write	Indication of the ability to write the second other language
O	Speak	Indication of the ability to speak the second other language
P	T Other L3	The third language indicated as another spoken language by the teacher
Q	Read	Indication of the ability to read the third other language
R	Write	Indication of the ability to write the third other language
S	Speak	Indication of the ability to speak the third other language
T	T Other L4	The fourth language indicated as another spoken language by the teacher
U	Read	Indication of the ability to read the fourth other language
V	Write	Indication of the ability to write the fourth other language
W	Speak	Indication of the ability to speak the fourth other language

Column	Code	Explanation
X	T Other L5	The fifth language indicated as another spoken language by the teacher
Y	Read	Indication of the ability to read the fifth other language
Z	Write	Indication of the ability to write the fifth other language
AA	Speak	Indication of the ability to speak the fifth other language
AB	T Other L6	The sixth language indicated as another spoken language by the teacher
AC	Read	Indication of the ability to read the sixth other language
AD	Write	Indication of the ability to write the sixth other language
AE	Speak	Indication of the ability to speak the sixth other language
AF	Teaching L1	Language used most commonly when teaching mathematics
AG	Notes on use of language	Anything written by teachers about the use of the most commonly used language when teaching mathematics. Recorded verbatim.
AH	Teaching L2	Language used second most commonly when teaching mathematics
AI	Notes on use of language	Anything written by teachers about the use of the second most commonly used language when teaching mathematics. Recorded verbatim.
AJ	Teaching L3	Language used third most commonly when teaching mathematics
AK	Notes on use of language	Anything written by teachers about the use of the third language used when teaching mathematics. Recorded verbatim.
AL	Teaching L4	Language used fourth most commonly when teaching mathematics
AM	Notes on use of language	Anything written by teachers about the use of the fourth language used when teaching mathematics. Recorded verbatim.

Column	Code	Explanation
AN	Languages spoken by learners in class – note what the teacher said	List of languages spoken by learners in their classes as written by teachers recorded verbatim
AO	Anything else they wanted to note – write in full	Anything recorded by teachers about learning mathematics
AP	Mathq1 – yes/no	Whether or not the first maths question on the questionnaire was answered. Yes (it was), No (it was not)
AQ	Mathq1 – right/wrong	Whether the answer given to the first maths question was right or wrong. (Left blank if the question was not answered.)
AR	Mathq1 – Explanation – math/not	Whether the explanation for the answer to the first maths question was mathematical (math) or not (not). Left blank if no explanation was given.
AS	Mathq1 – Explanation – valid/invalid	Whether the explanation given for the answer to the first maths question was valid or not. Left blank if no explanation had been given.
AT	Explanation text (good examples – verbatim)	The teacher explanations for question 1 recorded verbatim.
AU	Mathq2 – yes/no	Whether or not the second maths question on the questionnaire was answered. Yes (it was), No (it was not)
AV	Mathq2 – right/wrong	Whether the answer given to the second maths question was right or wrong. (Left blank if the question was not answered.)
AW	Mathq2 – Explanation – math/not	Whether the explanation for the answer to the second maths question was mathematical (math) or not (not). Left blank if no explanation was given.
AX	Mathq2 – Explanation – valid/invalid	Whether the explanation given for the answer to the second maths question was valid or not. Left blank if no explanation had been given.

Column	Code	Explanation
AY	Explanation text (good examples – verbatim)	The teacher explanations for question 2 recorded verbatim.
AZ	Mathq3 – yes/no	Whether or not the third maths question on the questionnaire was answered. Yes (it was), No (it was not)
BA	Mathq3 – right/wrong	Whether the answer given to the third maths question was right or wrong. (Left blank if the question was not answered.)
BB	Mathq3 – Explanation – math/not	Whether the explanation for the answer to the third maths question was mathematical (math) or not (not). Left blank if no explanation was given.
BC	Mathq3 – Explanation – valid/invalid	Whether the explanation given for the answer to the third maths question was valid or not. Left blank if no explanation had been given.
BD	Explanation text (good examples – verbatim)	The teacher explanations for question 3 recorded verbatim.
BE	Explanations (3 items) IsiZulu/Setswana/Eng Zulu/TswaEng/Other/ Unintelligible	Language use in explanations for the three items – pure English (English); pure IsiZulu (IsiZulu); pure Setswana (Setswana); a mix of English and Setswana (TswaEng); a mix of IsiZulu and English (EngZulu); numeric (purely numerals and symbols used to give explanation); unintelligible (an explanation written in such a way that is could not be understood at all); other (a different language used for the explanation, e.g. Sesotho).
BF	Translations – ES/SE	The direction of translation of the individual (ES – English to Setswana; SE – Setswana to English; EZ – English to IsiZulu; ZE – IsiZulu to English).
BG	16 < t < 20	t=number of correct translations – between 16 and 20 terms correctly translated.
BH	11 < t < 15	t=number of correct translations – between 11 and 15 terms correctly translated.

Column	Code	Explanation
BI	6 < t < 10	t=number of correct translations – between 6 and 10 terms correctly translated.
BJ	1 < t < 5	t=number of correct translations – between 1 and 5 terms correctly translated.
BK	t = 0	t=number of correct translations – 0 correctly translated.
		All translations were entered in the spreadsheet verbatim. The number of correct translations was counted. Incorrect spelling was not penalised, numeric, symbolic and diagrammatic "translations" were accepted as correct.
BM-CF	ES and EZ translations	English term column headers, translated terms recorded per questionnaire verbatim
CH-DK	SE and ZE translations	Setswana/IsiZulu term column headers, translated terms recorded per questionnaire verbatim

Appendix 4.4 Learner questionnaire survey codes

Column	Code	Explanation
A	emis	The EMIS number of the school
B	unique identifier	Learner number allocated per questionnaire
C	school	School name
D	grade	Grade
E	LOLT	The chosen language of learning and teaching of the school
F	Teacher HL	The home language of the teacher (per class)
G	Learner HL	The home language of the learner (per questionnaire)
H	L Other L1	The first language indicated as another spoken language by the learner (per questionnaire)
I	L Other L2	The second language indicated as another spoken language by the learner (per questionnaire)
J	L Other L3	The third language indicated as another spoken language by the learner (per questionnaire)
K	L Other L4	The fourth language indicated as another spoken language by the learner (per questionnaire)
L	Anything else noted? Write up in full	Anything recorded by learners about learning mathematics
M	Mathq1 – yes/no	Whether or not the first maths question on the questionnaire was answered. Yes (it was), No (it was not)
N	Mathq1 – right/wrong	Whether the answer given to the first maths question was right or wrong. (Left blank if the question was not answered.)
O	Mathq1 – Explanation – math/not	Whether the explanation for the answer to the first maths question was mathematical (math) or not (not). Left blank if no explanation was given.
P	Mathq1 – Explanation – valid/invalid	Whether the explanation given for the answer to the first maths question was valid or not. Left blank if no explanation had been given.

Column	Code	Explanation
Q	Mathq2 – yes/no	Whether or not the second maths question on the questionnaire was answered. Yes (it was), No (it was not)
R	Mathq2 – right/wrong	Whether the answer given to the second maths question was right or wrong. (Left blank if the question was not answered.)
S	Mathq2 – Explanation – math/not	Whether the explanation for the answer to the second maths question was mathematical (math) or not (not). Left blank if no explanation was given.
T	Mathq2 – Explanation – valid/invalid	Whether the explanation given for the answer to the second maths question was valid or not. Left blank if no explanation had been given.
U	Mathq3 – yes/no	Whether or not the third maths question on the questionnaire was answered. Yes (it was), No (it was not)
V	Mathq3 – right/wrong	Whether the answer given to the third maths question was right or wrong. (Left blank if the question was not answered.)
W	Mathq3 – Explanation – math/not	Whether the explanation for the answer to the third maths question was mathematical (math) or not (not). Left blank if no explanation was given.
X	Mathq3 – Explanation – valid/invalid	Whether the explanation given for the answer to the third maths question was valid or not. Left blank if no explanation had been given.
Y	Explanations (3 items) English/IsiZulu /Setswana/EngZulu/ TswaEng/Numeric/ Unintelligible/Other	Language use in explanations for the three items – pure English (English); pure IsiZulu (IsiZulu); pure Setswana (Setswana); a mix of English and Setswana (TswaEng); a mix of IsiZulu and English (EngZulu); numeric (purely numerals and symbols used to give explanation); unintelligible (an explanation written in such a way that is could not be understood at all); other (a different language used for the explanation, e.g. Sesotho).

Column	Code	Explanation
Z	Translations – ES/SE or EZ/ZE	The direction of translation of the individual (ES – English to Setswana; SE – Setswana to English; EZ – English to IsiZulu; ZE – IsiZulu to English).
AA	$16 < t < 20$	t=number of correct translations – between 16 and 20 terms correctly translated.
AB	$11 < t < 15$	t=number of correct translations – between 11 and 15 terms correctly translated.
AC	$6 < t < 10$	t=number of correct translations – between 6 and 10 terms correctly translated.
AD	$1 < t < 5$	t=number of correct translations – between 1 and 5 terms correctly translated.
AE	$t = 0$	t=number of correct translations – 0 correctly translated.
		All translations were entered in the spreadsheet verbatim. The number of correct translations was counted. Incorrect spelling was not penalised, numeric, symbolic and diagrammatic "translations" were accepted as correct.
AG-AZ	ES and EZ translations	English term column headers, translated terms recorded per questionnaire verbatim
BB-BU	SE and ZE translations	Setswana/IsiZulu term column headers, translated terms recorded per questionnaire verbatim

Appendix 5 – Exemplar teacher and learner translation coding

Appendix 5.1 Grade 3 IsiZulu **–** *English learner translations*

532 learners altogether did this translation. Some gave more than one alternative translation for some terms. Not all learners translated all terms.

NOTE: 81/244 (and all other counts given in this manner in the "**Term**" column) means there were 81 different correct translation alternatives of the term (including those with incorrect spelling) out of a total of 244.

	Term	**Translations -expected term and variations in spelling**	**Translations – other acceptable translations with variations in spelling**	**Numeric/Symbolic "translations"**
1	ukuhlanganisa	add	plus	+
	81/244	40 alternative spellings noted identifiable as variations, adding, addition. addition (the term) was used 22 times	25 variations in spelling noticed e.g. plas, plase, plass	3 occurrences
2	ukususa	subtract	minus	2 – 2= 0
	112/182	33 variations were noted e.g. sabration, sabstractions, suptract, subtection	68 variations in spelling noted e.g. mainas, mainasa, manase, minas, minase, minis, minuce, mynas, minimise, remove	2 occurrences
3	uhlelonombolo	number pattern	pattern	
	10/18	8 variation of spelling were noted e.g. namber phethini, number petern; numen pateuni.		
4	ngakuhlanu	fives	fives	5
	22/100	9 variations were noted. e.g. fafy, fave, fifs, in fives, write in fives	2 interesting variations in spelling noted e.g. at 5, learners assumed they were counting at 5.	1 variation. Accepted as an example although strictly it should have been 5s e.g. 5, 10, 15, 20, 25, 30, 35, 40,
5	ukubala ngawo 10	counting with 10	ten times table	10, 20, 30, 40, 50, … 10 occurrences

	Term	Translations -expected term and variations in spelling	Translations – other acceptable translations with variations in spelling	Numeric/Symbolic "translations"
	64/104	70 variations were noted a lot of different meanings were taken as different spelling variations for e.g. count in 10, count in tens, kawiteng of 10, namber of 10, pattern of 10, write with 10.	2 interesting variations in spelling noted e.g. matibles of 10, matiples of 10	
6	ukubala ngaphezulu	count up	counting forward	
	37/66	37 variations were noted and very interesting for e.g. c up, count up, count up wort, to count up, you count up, calculate up, morthan	10 interesting variations e.g. canthing heay, cawnting upwards, count in the sky, count into the biggest counting high, counting with high number	
7	chaza	describe	explain tell (not exactly correct but acceptable)	
	67/197		67 variations were noted e.g. axplain, axmplaning, axplein, ecplain, explane, explayini, xplam, xplani 2 interesting variations were noted e.g. talk, tell me. the learners understood it to mean "talk about" which is correct.	
8	nweba/ khulisa	extend	grow (not accurately correct but acceptable)	
	8/42	3 noticeable variations e.g. exend, exenod, exstend, add	3 very interesting variations noted e.g, gr, growing, raise	
9	phakathi nendawo	between	middle	
	37/65	7 variations were noted e.g. betneer, betwee, betweet, bitween, inbetween, esayd the way, insad, inside	18 very interesting variations noted e.g. in the meagle, in the milhili, on a middle, write in mihleli (which can translate as right in the middle)	
10	ishadi lokulandelayo	flow diagram	chut	
	7/10	4 variations noted e.g. chaele that follow, chart is coming, shat following, the number the following	3 variations were noted e.g. chat, chet, chut	
11	phambili	forward	front	

	Term	Translations -expected term and variations in spelling	Translations – other acceptable translations with variations in spelling	Numeric/Symbolic "translations"
	79/86	31 variations were noted e.g. foruwandi, fowad, fowath, fowud, fow term	7 variations noted e.g. at front, in frant, infrante	
12	isikhawu	interval		
	0/0			
13	isiphindaphindi	multiplication	times	Correct sign ×
	17/23	8 variations noted e.g. maltiplation, multiplication, multiple, multiply, mutilpuy	8 interesting variations were noted e.g. reapiting, repeat, repet, ripeting, ripit	2 occurrences
14	iziphindaphindi zoku-2	multiples of 2	times two	Correct sequence i.e. 2, 4, 6, 8 3 occurrences
	11/18	8 different variations were noted e.g. count in 2, over and over gaine, repeat with, repeating with two, repet in 2, ripeting ol, ripit again	3 variations noted e.g. tams, times whit 2, times-2	
15	inkabamudwa yezinombolo	number line	following number	
	4/12	3 variations noted e.g. line of number, number, nwmberi line, compared to the setswana version "molapalo" the isizulu term "inkabamudwa yezinombolo" seemed a bit challenging for learners to understand, hence only 5 were able to write number line		
16	ukulandelana kwezinombolo	number sequence	following number	
	8/11	none	7 variations noticed e.g. fill in the missing, fill in the missing number, folo the number	
17	iphethini lokusazibalomdwebo	geometric pattern	pattern of lines	
	4/6	none	only 2 variations noted e.g. pattern, petten	
18	isiyingi	circle	sekel	Correct drawing 11 occurrences
	37/96	9 variations noted e.g. cirele, crcle, cricle, sacal, round (5)	6 variations of spelling noted e.g. sakell, sekell, sockeli, sokal	

	Term	Translations -expected term and variations in spelling	Translations – other acceptable translations with variations in spelling	Numeric/Symbolic "translations"
19	isikwele	square	box	Correct drawing 37 occurrences
	34/164	32 interesting variations noted e.g. seqaw, skwa, skwayer, skwewa, sqare, squeer, squer		
20	unxantathu	triangle	trayengel	Correct drawing 29 occurrences
	55/169	48 variation noted e.g. draingile, hrayengel, triagla, triengel, tringle	29 variations noted e.g. tranyengel, tryengel, tuyengel	

Appendix 5.2 Grade 4 Setswana-English learner translations

207 learners altogether did this translation. Some gave more than one alternative translation for some terms. Not all learners translated all terms.

NOTE: 48/100 (and all other counts given in this manner in the "**Term**" column) means there were 48 different correct translation alternatives of the term (including those with incorrect spelling) out of a total of 100.

	Term	**Translations -expected term and variations in spelling**	**Translations – other acceptable translations with variations in spelling**	**Numeric/Symbolic "translations"**
1	tlhakanyo	add	addition plus	
	48/100	5 alternative spellings noted. e.g. aad, addibog, addig, addit	plus: 14 variations in spelling noted. e.g. plas, plase, plass, pluse addition: 45 variations in spelling noted. e.g. edishine; adshen; edsane.	
2	ntsha	subtract	minus	
	40/69	6 alternative spellings noted. e.g. sadretion, saptacn, subrution, sutriction; satesh, subtrect	minus: 7 variations were noted. e.g. mainas, mannisi, mainase, minas, take out, take away, take it out	
3	popegopalo	number pattern	shapes	
	13/30	6 alternative phrases noted. e.g. number patter, number pefften, number peten, one learner wrote *pattern*.	2 variations in spelling noted. e.g. a shapes, maths shape this is a very interesting variation	
4	ka botlhano	fives	in fives	5s 1 occurrence
	40/75	4 variations were noted e.g. fifes, fivez,	17 alternative spellings/phrases noted. e.g. in fivis, on five, in fivese	5 Accepted as an example although strictly it should have been 5s. 3 occurrences
5	bala ka bolesome	counting in tens	count with tens	(10, 20, 30, 40, 50, 60, 70, 80, 90, 100) not exactly correct but accepted) 1 occurrence

	Term	Translations -expected term and variations in spelling	Translations – other acceptable translations with variations in spelling	Numeric/Symbolic “translations”
	55/94	19 alternative spellings/phrases noted. e.g. count with ten, read in tens, cut in tens, out in ten, read in ten.	16 variations in spelling were noted e.g. read with tens, to count with tens, cout with a ten	10 tens 1 occurrence
6	balela go simolola ka	count to start with	count start with	
	44/52	14 variations were noted e.g. count and sat with, count by starting with, count to start	33 variations noted e.g. read start with, start couting by this number, start couting with	
7	tlhalosa	describe	explain	
	50/128		50 variations were noted e.g. alxplan, aspain, axbin, eecipain. One learner wrote extend.	
8	atolosa/oketsa	extend		
	23/45	16 variations were noted e.g. expende, extena, etend, expand the pattern (learners are already thinking of expanding a pattern)		
9	magareng ga	between	in the middle	
	35/51	6 variations were noted e.g. between by, between with, between of; in between	34 variations were noted e.g. in the megal of, inside, megell, middle of the, 3 interesting variation was noted e.g. insayt in meaning inside.	
10	papetlakaelo	flow diagram		
		none		
11	balela go ya ka	count with	count in	
	24/26	7 variations were noted e.g. count to go to, counting to, read with, count with these. 1 interesting variation was noted e.g. read like it seems the term “to go” was mostly used as a motivation in answering	16 variations were noted e.g. count and go of, count by, count to a pattern, count with these interesting factor the term “count” was mostly used. 1 more interesting variation used is e.g. you read to	
12	kgaotso	interval	cut	
	5/12		1 variation were noted e.g. cat most learners understood it as broken numbers/units	

	Term	Translations -expected term and variations in spelling	Translations – other acceptable translations with variations in spelling	Numeric/Symbolic "translations"
13	katisanetswa	multiple		
	2/3	2 variations were noted that are close to multiple e.g. matipayi, maytnas		
14	katiso ya 2	multiples of 2	times 2	2 × 2 = (number sentence) 2 occurrences
	17/19	1 variation were used e.g. miltiply	5 variations were noted e.g. mse 2, thams 3 interesting variation was noted e.g. counting in 2	× (correct sign) 5 occurrences
15	molapalo	number line		
	18/63	17 variations were noted e.g. lane, line, nambeline, number lies, number lion	Interesting variation was also noted e.g. underline	
16	tatelanopalo	sequence	pattern	
	23/25	13 variations were noted e.g. secance, secwens, siqences	3 variations were noted e.g. pattern jeometre, patern	
17	dipaterone tsa thutatekano	geometric pattern	pattern	
	28/28	2 variations were noted e.g. jometri, jometry	17 variations were noted e.g. paten, pattens, phethen 6 interesting variations were noted e.g. shapes, pattern jomathre, perttern jometri	
18	sediko	circle	sekel	
	30/110	18 variations were noted e.g. cycle, clile, crile	10 variations were noted e.g. sekal, sekkel, sekhell 1 interesting variation was noted e.g. shape	
19	sekwere	square	skwe	
	56/94	80 variations were noted which are the highest in this analysis e.g. saque, saqure, scure, scwa, suque	10 variations were noted e.g. skawe, skwer, skwere	
20	khutlotharo	triangle		
	48/113	47 variations noted e.g. traengele, thraengele, traingel		Correct drawing 1 occurrence

Appendix 5.3 Grade 3 English-IsiZulu teacher translations

14 teachers altogether did this translation. Some gave more than one alternative translation for some terms. Not all teachers translated all terms.

NOTE: 2/13 (and all other counts given in this manner in the "**Term**" column) means there were two different correct translation alternatives of the term (including those with incorrect spelling) out of a total of 13.

	Term	**Translations -expected term and variations in spelling**	**Translations – other acceptable translations with variations in spelling**	**Numeric/Symbolic "translations"**
1	add	ukuhlanganisa		None
	2/13	One other alternative spelling noted as identifiable as a viariation of ukuhlanganisa, e.g. Hlanganisa; hlukanisa		
2	subtract	susa/ukususa		None
	2/14	One other alternative spelling noted identifiable as variations of ukususa, e.g. Susa		
3	number pattern	iphetheni yezinombolo		None
	4/9	3 alternative spellings/phrases noted e.g. iphethini lezinombolo, amaphethini wezinombolo, amaphethini ezinombolo		
4	fives	ngakuhlanu		None
	6/12	Other spelllings e.g. ngokuhlanu, okuhlanu		
5	counting in 10s	bala ngamashumi	bala ngoku-10, bala ngo 10	None
	7/13	Other alternatives of bala ngamashumi, e.g. ukubala ngamashumi, sibala ngeshumi, ukubala ngokweshumi		
6	counting on	ukubala ngaphezulu	Other spellings and phrases e.g. ukubala uqhube phambili, bala uqhubeke, bala uye phambili, ukubala uqhubekisa, bala uhube,	None
	8/9	ukubala uyephambili		

	Term	Translations -expected term and variations in spelling	Translations – other acceptable translations with variations in spelling	Numeric/Symbolic “translations”
7	describe	chaza		None
	3/11	Other spellings the phrases e.g. ukuchaza, ukuchaza kabanzi		
8	extend	khulisa	Other phrases e.g. nweba; qhubekisa, yongeza/qhubekisa	None
	4/8			
9	between	phakathi		None
	2/13	phakathi nendawo		
10	flow diagram	ishadi lokulandelayo		None
		None		
11	forwards	phambili		None
	1/12	No variations in spelling		
12	interval	izikhawu		None
	1 response	No other variations		
13	multiple	Ukuphindaphinda		None
	4/11	Other e.g. isiphindaphindi, phindaphinda		
14	multiples of 2	ukuphindaphinda kabili		None
	5/7	Other similar variations e.g. phindaphinda kabili, phindaphinda ngokubili, ukuphindaphinda kokubili, ukuphinda phinda ngokwesibili		
15	number line	umugqa wezinombolo		None
	2/8	ulayini wezinombolo		
16	number sequence	ukulandelana kwezinombolo		None
	1/7	No variations in spelling	Other spelling and phrases e.g. landelanisa ngezinombolo ; ukulandelanisa izinombolo ; izinombolo ngokulandelana	
17	geometric pattern	iphethini yomdwebo		None
	5/5	Other variations in spellings e.g.		

	Term	Translations -expected term and variations in spelling	Translations – other acceptable translations with variations in spelling	Numeric/Symbolic "translations"
		amaphethini emidwebo; iphethini yemidwebo; iphethini lomdebo; iphethini lemifanekiso		
18	circle	indilinga	isiyingi	None
	3/12	Other spelling/variations e.g. indingiliza		
19	square	isikwele		None
	1/11	No variations		
20	triangle	unxantathu		None
	1/11	No variations		

Appendix 5.4 Grade 4 Setswana-English teacher translations

4 teachers altogether did this translation. None of them gave more than one alternative translation for some terms. Not all teachers translated all terms.

NOTE: 2/3 (and all other counts given in this manner in the "**Term**" column) means there were two different correct translation alternatives of the term (including those with incorrect spelling) out of a total of 3.

	Term	**Translations -expected term and variations in spelling**	**Translations – other acceptable translations with variations in spelling**	**Numeric/Symbolic "translations"**
1	tlhakanyo	add	addition	None
	2/3			
2	ntsha	subtract		None
	1/1			
3	popegopalo	number pattern		None
	0/0			
4	ka botlhano	fives		None
	1/1			
5	bala ka bolesome	counting in tens		None
	0/0			
6	balela go simolola ka	count to start with		None
	0/0			
7	tlhalosa	describe		None
	1/3			
8	atolosa/oketsa	extend		None
9	magareng ga	between	middle	None
	1/2			
10	papetlakaelo	flow diagram		None
	0/0			
11	balela go ya ka	count with		None

	Term	Translations -expected term and variations in spelling	Translations – other acceptable translations with variations in spelling	Numeric/Symbolic “translations”
	0/0			
12	kgaotso	interval		None
	0/0			
13	katisanetswa	multiple		None
	0/0			
14	katiso ya 2	multiples of 2		None
	0/0			
15	molapalo	number line		None
	0/0			
16	tatelanopalo	sequence		None
	0/0			
17	dipaterone tsa thutatekano	geometric pattern		None
	0/0			
18	sediko	circle		None
	1/2			
19	sekwere	square		None
	1/2			
20	khutlotharo	triangle		None
	1/2			

Appendix 6: Focus group discussions

Appendix 6.1 Focus group discussion schedule

Please discuss the following questions. Allow as many different people to contribute to the discussion. Encourage teachers to give examples using any language.

1. Do you feel comfortable teaching in the LoLT of your school? Why/why not?
2. What is your view on the language policy for FP?
3. What do you think the LoLT for mathematics should be? (HL/English?)
4. What do you do when you see that the learners don't understand what you are saying? (explain/use concrete material/other?)
5. What is your view on mathematical terminology for home language in your school? Are there preferable terms/"missing terms"? (the language standardisation debate)
6. Have you noticed language inconsistencies in textbooks/DBE workbook/CAPS?
7. Did your learners experience any problems with regard to terminology when the learners wrote the ANA? (specific examples/general).
8. Do you feel any pressure to use English/home language when you teach maths? (why/who imposes/school/general explain)
9. How do you use translanguaging strategies in your teaching? (explain that this means flexible use of languages at the disposal of the learners and the teacher – freedom of expression involving multilingualism – similar to code-switching)

Appendix 6.2 Focus group discussion register

Focus group discussion Register

Date: ____

School ____

Teachers

Name	HL	Grade	Years of experience teaching maths	Prepared to be videoed? (voluntary)	Signed consent (now/before)

Focus group discussion done by ____

1. Record telephone numbers of teachers who volunteer to be observed for next stage of planning.
2. Ask teachers to complete consent forms if they did not participate in the survey.

Appendix 6.3 Focus group discussion transcription template

	SCHOOL	
	Grade	
	DATE OF INTERVIEW	
	INTERVIEWERS	
	INTERVIEWEES	
Time	**Speaker**	**Utterance**

Appendix 7: Observations

Appendix 7.1 Observation schedule

Grade 3 and Grade 4 teachers will be observed in their classrooms. Teachers will be requested to present lessons on Number Patterns.

Assurance will be given to all teachers who are observed: Observations are for research purposes only: video data will be treated confidentially. Pseudonyms will be used if a need to refer to a particular comment arises.

The following schedule will guide the observation.

1. What spoken teacher language use is observed? (LoLT/English/translanguaging)
2. What spoken learner language use is observed? (LoLT/English/translanguaging)
3. What engagements (spoken) are noted – teacher-learner and learner-learner?
4. What is the nature of the spoken interactions – mathematical/general?
5. Time segment analysis of languages used (spoken) by teachers and learners.
6. What written teacher language use (e.g. lesson planning/board work/etc.) is observed? (LoLT/English/translanguaging)
7. What written learner language use (e.g. learner exercise books/board work/etc.) is observed? (LoLT/English/translanguaging)
8. Time segment analysis of languages used (written) by teachers and learners.
9. What resources are used in the lesson by the teachers and learners?
10. What is the language present in the resources used in the lesson by the teachers and learners? (LoLT/English/both)
11. How much time is spent on interactive conversation between teachers and learners?
12. Does the use of translanguaging (if present) appear planned/unplanned?
13. Does the use of translanguaging (if present) assist the flow of the lesson – how?
14. Other emerging patterns of language use in the teaching of mathematics.

Appendix 7.2 Observation codes

Column	Code	Description
A	School	The name of the school in full
B	Grade	The Grade of the class
C	LoLT	The chosen language of learning and teaching of the school
D	Observation date	The date on which the observation was made
E	Time segment	Code in 5-minute time segments. Indicate the 5-minute interval for each segment
F	Speaker (teacher, learner, chorus)	Code for the dominant voice in the segment – teacher and learner are individual voices, chorus means the whole (or most of the class) answers together.
G	Group counting (active, rote, NOTE learner knowledge)	The Grade 3 lessons often start with a counting activity. This code captures the nature of the counting activity. Active indicates learners are doing more than just repetitive counting lead by the teacher. NOTE learner knowledge – if it is evident (for example) that in some instances some learners do not appear to be able to count – they echo/mouth the words they see others saying.
H	Teaching style (interactive, peer teaching, teacher talk)	This captures the way in which the teacher manages the lesson – does she engage the learners in discussion with her (interactive), are learners given the opportunity to teacher each other/the class (peer teaching) or does the teacher "lecture" the class – one-way teacher talk dominates in this instance.
I	Learner work (whole class, group work, independent work)	This captures the way in which the learners are engaged during the segment – are they working as part of a whole class lead by the teacher/individuals from the class; are they assigned work that is done in groups or are they set work to complete on their own (independent).

Column	Code	Description
J	Board work (teacher, learner, learners, teacher and learner)	This captures the way in which the board is used during the segment – does the teacher write/draw on it; or do the learners write/draw on it or do both parties (teachers and learners) spend time writing/drawing on the board
K	Language use (pure)	This code indicates that during this segment the teacher (and or learners) spoke only one pure language
L	Language use (translanguaging)	This code indicates that during this segment the teacher (and or learners) used more than one language as a resource in order to express themselves
M	Language use (code-switching)	This code indicates that during this segment the teacher (and or learners) used more than one language to express themselves – but in such a way that the same idea was expressed in twice – once in one language and once in another language.
N	Dominant language spoken (English, indigenous language)	This code indicates the language that dominated the speech of all speakers during the segment
O	Mathematical language (English, indigenous language, both)	This code focuses on the mathematical language (e.g. Numbers, shapes, pattern, etc.) used by speakers during the segment and identifies which language dominated this speech
P	Non-mathematical language (English, indigenous language, both)	This code focuses on the NON-mathematical language (e.g. General instructions such as take out your books, choose the blocks you like, etc.) Used by speakers during the segment and identifies which language dominated this speech
Q	Concrete materials (demonstration, learners, both)	This code indicates that during the time segment use was made of concrete materials – either by the teacher alone by way of demonstration or by the learners in the class

Column	Code	Description
R	Diagrams drawn on board (teacher, learner, both)	This code indicates that during the time segment diagrams were drawn on the board – either by teachers/learners/both
S	Diagrams explained (teacher, learner, both)	This code indicates that during the time segment diagrams that were drawn on the board were discussed and explained – either by teachers/learners/both
T	Numeric working recorded on board (teacher, learner, both)	This code indicates that during the time segment numeric working was written on the board – either by teachers/learners/both – specified
U	Numeric board work used (interactive, passive)	This code indicates that during the time segment numeric work that was written on the board was used interactively or was simply written for passive absorption.
V	Pattern example (numeric, shapes, colours)	This code indicates that in this time segment pattern examples were discussed simply as examples and indicates the nature of the examples that were discussed – numeric/shape/colour
W	Number pattern rule concept (mentioned, explained)	This code indicates that the teacher engaged with the idea of the rule that generates the pattern and explained/discussed the way the rules work (explained) or she spoke about that there are rules that generate patterns without explaining them at all (mentioned)
X	Nature of pattern (counting; add; subtract; multiply; divide; repetition; add and subtract; add and multiply; add, subtract and multiply; add, subtract and counting)	This code clarifies the way in which the teacher engaged with the generation of a pattern – she may have done this by counting/speaking about how addition/subtraction/multiplication/division generates the given pattern, or she may have simply spoken about the repetitive nature of the pattern and highlighted the repeated aspect of the pattern.

Column	Code	Description
Y	Number chart used (little, moderate, lot)	This code captures whether and how much the teacher used/referred to a number grid/chart that was displayed in her classroom in order to identify patterns.
Z	Print material (DBE workbook, worksheet, number grid)	This code captures whether and what print resources are used by the teachers and learners during the lesson.
AA	Notes	Notes should be made about any aspect of the lesson in every time segment – about ideas/issues arising from that particular segment. This will be cumulatively reviewed after the coding is completed.

Appendix 7.3 Observation transcription template

School	Grade	LOLT	Observation_date	Time_segment	Speaker	Utterance (descriptor)	Translation

Appendix 7.4 Observation transcript exemplar

School	Grade	LOLT	Observation_date	Time_segment	Speaker	Utterance (descriptor)	Translation
xxxx	3	Eng/Zul	17 May	0	Teacher	I prefer starting on the number line, I am looking at where you are seating. Two thousand and I am going to minus this one. Just minus, talk with them you can talk with them	
					Chorus (learners)	zero, zero	
					Teacher	Why are you saying zero? Zero for eng?	what?
					Chorus (learners)	Zero minus zero is zero	
					Teacher	Maseko you can talk with them	
					chorus (learners)	zero minus zero is zero	
					Teacher	Maseko actually was doing it…Maseko talk to the class. Wait for Maseko please. Maseko can you talk to them, say seven minus	
					Learner	seven minus six	
					chorus (learners)	one	
				1	Chorus (learners)	zero	
					Learner	two minus two	
					Chorus (learners)	zero	
					Teacher	because listen, because I'm having numbers…a number upfront. Because there is a number after this I can just erase this and write a a dot which means we are only adding one hundred	
					Chorus (learners)	one hundred	

School	Grade	LOLT	Observation_date	Time_segment	Speaker	Utterance (descriptor)	Translation
					Teacher	so after 2700 we have how much? Can you write the answer for us 2800 there? Right good Maseko	
				2	Chorus (learners)	Applause	
					Teacher	Classwork books. Right let's find our classwork books. Back to our classwork books (cleans the board). Today's date. What day is this?	
					Chorus (learners)	seventeen	
					Teacher	what day is this?	
					Chorus (learners)	seventeen…twenty	
					Teacher	what day is this? Is it Monday or Tuesday	
					Chorus (learners)	seventeen, Thursday the seventeen…seventeen…the date is	
				3	Teacher	the date is seventeen May (writes Thursday 17 May on the board)	
					Learner	(paging through classwork books)	
					Teacher	(writes Topic: Number Patterns on the board) Remember we said number patterns is a list of numbers that are following a certain sequence or pattern (writes the statement in the utterance on the board)	
				4	Teacher	just put a circle of clouds (draws a circle of clouds around the definition on the board)	
					Learner	Ma'am may I please go out	
					Teacher	Ehh remember we're having our DBE pages in between akere? Just use any space, an empty space that is not filled with anything.	right?

School	Grade	LOLT	Observation_date	Time_segment	Speaker	Utterance (descriptor)	Translation
				5	Teacher	Peer work neh you are going to work with your friend (writes peer work on the board) Don't forget to show your name and your friend's name also (draws a straight horizontal line as an example for learners to write their names and their peers name). Rethabile are you going to sit with Mathapelo so that you can work with Mathapelo	
				6	teacher	(writes 'complete the following pattern' on the board) I forgot to identify the book, I'm just going to write the instruction	
				7	Teacher	(writes DBE Worksheet on the board) I took this from the other book neh (writes on the board to complete the sentence 'complete the following pattern and find the rule') (Cleans the board) I don't have space so I'm going to write here for you to see) Can I clean this?	
					Chorus (learners)	Yes teacher	
				8	Teacher	(cleans the board) The instruction says…let us read it together	
					chorus (learners)	complete the pattern	
					Teacher	is (points at the board and then erases the letter T in the definition of a pattern and rewrites it?) you know t that you should see the handwriting. Can we read the instruction together	
				9	Chorus (learners)	complete the pattern and find the rule	
					Teacher	you have to tell me what does the rule says akere?	right?

School	Grade	LOLT	Observation_date	Time_segment	Speaker	Utterance (descriptor)	Translation
					Chorus (learners)	yes teacher	
					Teacher	are we together	
					Chorus (learners)	yes teacher	
					Teacher	this one is going to be (writes a) (1000,2000,3000 two empty spaces and then 6000. Continues and writes Rule and an empty space)	
				10	Teacher	(writes b. 3)	
					Moses	we have to go to another class (unclear)	
					Teacher	oh just two minutes. Ma'am are you done? Are you walking out? oh we are not aware us…is happening. As soon as we are done…just put it there I'm just going to give you just two sums akere?	right?
					Chorus (learners)	yes teacher	
					Teacher	(writes 3300, 3400,3500 and two spaces then 3800, rule and an empty space) only two sums if you can just do them then you can complete it after	

Appendix 7.5 Word counts – extended analysis

Appendix 7.5.1 English broad list word count

	Grade 3	Grade 4		Grade 3	Grade 4		Grade 3	Grade 4		Grade 3	Grade 4
pattern	264	284	subtract	57	13	multiply	0	80	circle	111	11
patterns	84	98	subtracting	14	2	multiple	26	13	square	22	41
number pattern	57	80	subtraction	3	8	multiplied	0	8	triangle	40	15
geometric pattern	9	5	minus	11	34	times	26	192	shape	75	13
count	445	72	minusing	1	0	divide	18	62	diagram	0	60
counting	160	26	take away	4	0	dividing	0	2	how many	71	56
count on	6	6	forward(s)	69	7	division	4	12	how much	3	14
counting on	6		backward(s)	98	19	increase	0	1	big	7	20
count all	4		jump	55	3	increasing	0	8	bigger	1	7
count from	16	1	jumps	34	3	decrease	0	1	small	8	11
count with	5		even	23	47	decreasing	0	1	smallest	4	2
next number	143	2	even number(s)	3	11				add	85	112
next one	27	13	odd	3	22				addition	9	17
			odd number(s)	3	22				adding	11	20
			equal	22	17				add on	5	0
			equal to	15	1				added	1	12
									plus	33	54

Appendix 7.5.2 IsiZulu broad list word count

	Grade 3	Grade 4		Grade 3	Grade 4		Grade 3	Grade 4		Grade 3	Grade 4
iphethini	2	0	susa	11	2	phindaphinda	0	14	indilinga	0	0
amaphethini	4	0	ususa	0	1	isiphindaphindi	0	1	isikwele	0	0
amaphethini ezinombolo	3	0	ukususa	0	0	uphundaphinde	0	1	unxantathu	3	0
			susa	11	2				isimo	0	0
bala	89	5	ususa	0	1	hlukanisa	23	0	umfanekiso womdwebo	0	
ukubala	8	o	khipha	1	6	uhlukanisa	9	0	mangaki	4	0
bala uqhube	0	6	phambili	1	0	ukuhlukanisa	0	0	kangaki	4	3
ukubala uqhube	0		emumva	2	0	yandisa	0	0	inkulu	3	0
bala zonke	0	0	yeqa	1	0	ukwandisa	0	0	inkulu kakhulu	0	0
bala usuke	0	0	weqa	0	0	yehlisa	0	0	incane	1	0
bala ngo	18	0	ezilingene	0	0	ukwehlisa	0	0	incane kakhulu	0	0
inombolo elandelayo, elandelayo	4	0	izinombolo ezilingene	0	0				hlanganisa	4	23
elandelayo	15	0	ugweje	0	0				ukuhlanganisa	0	0
			izinombolo eziwugweje	0	0				uhlanganisa	0	0
			ilingana	0	0				uhlanganise	1	1
			ilingana no	0	0						

Appendix 7.5.3 Setswana broad list word count

	Grade 3	Grade 4		Grade 3	Grade 4		Grade 3	Grade 4		Grade 3	Grade 4
paterone	22	15	ntsha	13	0	katiso	0	0	sediko	6	0
dipaterone	4	0	go ntsha	0	0	katisanetswa	0	0	sekwere	0	0
popegopalo	0	0	tlosa	0	0	atisa	23	0	khutlotharo	0	0
			tlosa	0	0	atisa	0	0	dipopego	4	0
bala	28	5	go tlosa	1	0	aroganya	0	0	sebopego	0	0
balela	2	1	tlosa	0	0	go aroganya	0	0	tse kae	2	0
bala go simolola ka	0	0	ko pele (pele)	55	5	aroganya			bokae	48	2
balela go simolola ka	0	0	morago	36	12	atolosa, oketsa	1	0	kgolo	124	0
bala tsotlhe	0	0	tlola	0	0	go oketsa	0	0	kgologolo	0	0
balela go ya ka	0	0	tlola	0	0	fokotsa	0	0	e nnye	0	0
bala ka	14	3	aroganywa ka bodedi	0		e eketseha	0	0	e nyenyane	1	0
nomoro e latelang	0	0	dipalo tsa go aroganywa ka pedi	0	0				tlhakanya	6	0
e latelang	15	0	go se aroganyege ka bobedi	0	0				tlhakanyo	0	0
sekgalatekanyi, palomafeta, palomaleka	0	0	dipalo tsa go se aroganywe ka bodedi	0	0				go tlhakanya	0	0
lekana, lekana le	0	0	tekanyo	0	0				tlhakanya	0	0
			karabo	15	14				tlhakantshitse	0	0
									tlhakanya	0	0

Appendix 7.5.4 Trans words broad list word count

English	Trans in IsiZulu	Grade 3	Grade 4	Trans in Setswana	Grade 3	Grade 4
add	eda, edeni	13, 1	5	edang	1	
understand	understanda	4		understandi, understandang, understande	1, 2	2
maths	e-maths, le-maths	4	1, 3			
number	unumba, inumba	4	2			
jump	jampa, siyajampa, ujampa, masijampa	11, 1, 4, 2		di-jumps	5	
practice	practiza	1				
item	i-item	1				
clear	uclear	2				
millimetres	ngama-millimetres, ama-millimetres		1, 1			
ruler	iruler					
skip	skipha	2		skipile	3	
line	kune-line	1				
chart	i-chart	1				
date	i-date	1				
pencil				de pencil		1
ball pen	iball pen	1		de ball pen		1
pattern	i-pattern		1	phethene, di-pattern	38, 2	
shape	i-shape		7	di-shape	2	
rule	i-rule					
stuck				le stucka	1	
corner				di-corner	1	
beads				de beads	1	
square				di-square	2	
align				aligna		1
extend				extenda	3	
counters				di-counters	1	
group	le-group	7				
mind maths	imind maths	2		ka-mind maths	1	
mental maths	imental maths	1				
lesson	i-lesson	1			2	
disturb				distepa	1	
number pattern				ka-number pattern	1	
number				le number, ka-number, di-number, dunamba	10, 5, 1	19
count				counta	18, 7	
confuse				la-nconfusa	1	

English	Trans in IsiZulu	Grade 3	Grade 4	Trans in Setswana	Grade 3	Grade 4
start				starteng	1	
check				checki, checka, o-chekhe	2, 4	10
sums	ama-sums		1			
example				de example		2
exercise	exesizini, ama-exercise		1, 1			
apply	aplaye		5			
draw				draweng, drawa, drowela	3, 8	2, 1
space	i-space		1			
answer	i-answer, ama-answer		4, 2	ansara, di-ansara , di-answer	15, 2	1
minus	u-minus, lo minus		2, 1	minasa	1	
board				boarting		1
correct				correctile	1	
right	e-right		32			
explain				explaina, explainele	2	3
divide				divida		1
speed				ka-speed		21
times				timesa		7
multiply	multiplaya, uyazimultiplaya, u-multiplaye, ziyamultiplaywa		11, 1, 1, 1	multiplaya	3	

Appendix 8: LETTER TO THE LEARNER

University of the Witwatersrand, Johannesburg, South Africa
School of Education
MATHEMATICS EDUCATION PHD RESEARCH THESIS

Ingrid Sapire
Wits School of Education
Curriculum Division
27 St Andrews Road
Parktown, 2193
Cell: 082 352 2271
E-mail: ingrid.sapire@wits.ac.za

25 August 2016

Dear Learner

My name is Ingrid Sapire, a PhD Student at the University of the Witwatersrand School of Education. I am doing research on: **Multilingualism in FP mathematics.**

This study involves a study in the area of learning and teaching of mathematics. The research aims at exploring how teachers use different languages (such as your home language and English or any other languages) to help you learn your mathematics better. There are studies that show that if teachers use (and allow you to use) more than one language when you are learning your mathematics this could help you to understand better what you learn. I will discuss these ideas with your teacher and give him/her a set of multilingual dictionaries that he/she will be free to use when he/she prepares for some lessons that he/she will teach you. I will contact your teacher and discuss how best to use more than one language when she is teaching you mathematics. I will then come to observe three lessons with teachers who have agreed to this observation. In these lessons your teacher will be teaching Patterns, which is part of what you need to learn in Grade 3.

I hope that you would not mind if I attend the lessons in question. When I observe the teaching of Patterns, I will not be involved in the lesson at all. I will be focusing on how your teacher uses language to explain what she is teaching. I also seek your permission to video record the lessons. I will just use a video camera to capture the lessons in order to have a record of my observations. I will also have a short list of words (a terminology survey) that I will ask you to complete for me, on the topic of Patterns. This is not a test, it is not for marks, and completing it is voluntary.

If you do not want to participate or if you decide at any time during the lesson that you would prefer to remain quiet, this is completely your choice and will not affect you negatively in any way.

I will not be using your name in this study writing, I will make one up so no one can identify you. No pictures of you will be included in the research. The videotapes are for research purposes only and will not be shown publicly. All information about you will be kept confidential in all my writing about the study. All collected information will be stored safely and destroyed within 3-5 years after I have completed my study.

Because you are under 18 your parent/guardian will also be given an information sheet and consent form.

I look forward to working with you! Please let me know if you require any further information.

I look forward to your response as soon as is convenient.

Yours sincerely,

____

Ingrid Sapire

Learner Consent Form

Please fill in the reply slip below if you agree to participate in my study called:

Multilingualism in FP mathematics

My name is: ____

Permission for terminology translation survey	**Circle one**
I agree to complete a terminology translation survey for this study.	
I know that this is not a test.	YES/NO

Permission to observe you in class

I agree to be observed in class.	YES/NO
I would like to be seated on the side of the room, not captured by camera	YES/NO

Permission to be videotaped

I agree to be videotaped in class.	YES/NO
I know that the videotapes will be used for this project only.	YES/NO

Informed Consent

I understand that:

- my name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to complete the word list and I can withdraw from the study at any time.
- I can ask not to be videotaped
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign______________________________ Date____________________________

University of the Witwatersrand, Johannesburg, South Africa
School of Education

MATHEMATICS EDUCATION PHD RESEARCH THESIS

Ingrid Sapire
Wits School of Education
Curriculum Division
27 St Andrews Road
Parktown, 2193
Cell: 082 352 2271
E-mail: ingrid.sapire@wits.ac.za

25 August 2016

Dear Parent/Guardian

My name is Ingrid Sapire, a PhD Student at the University of the Witwatersrand School of Education. I am doing research on: **Multilingualism in FP mathematics.**

This study involves a study in the area of learning and teaching of mathematics. The research aims at exploring how teachers use different languages (such as your home language and English or any other languages) to help you child learn mathematics better. There are studies that show that if teachers use (and allow learners to use) more than one language when they are learning mathematics this could help them to grasp the concepts more effectively. I will discuss these ideas with your child's teacher and give him/her a set of multilingual dictionaries that he/she will be free to use when he/she prepares for some lessons that he/she will teach you. I will contact your child's teacher and discuss how best to use more than one language to help the development of conceptual understanding of mathematics. I will then go to observe three lessons with your child's teacher. The topic that they will teach when I observe is Patterns, which is part of what learners need to learn in Grade 3.

I hope that you would not mind if I attend the lessons in question. When I observe the teaching of Patterns, I will not be involved in the lesson at all. I will be focusing on how your child's teacher uses language to make conceptual explanations clear. I also seek your permission to video record the lessons. I will just use a video camera to capture the lessons in order to have a record of my observations.

I will also have a short list of words (a terminology survey) that I will ask your child to complete for me, on the topic of Patterns. This is not a test, it is not for marks, and completing it is voluntary.

If your child does not want to participate or if he/she decides at any time during the lesson that they would prefer to remain quiet, this is completely their choice and will not affect them negatively in any way. Your child will not be advantaged or disadvantaged in any way. There are no foreseeable risks in participating.

Your child will not be paid for this study.

Your child's name and identity will be kept confidential at all times and in all academic writing about the study. His/her individual privacy will be maintained in all published and written data resulting from the study. No pictures of your child will be included in the research. The videotapes are for research purposes only and will not be shown publically. All collected information will be stored safely and destroyed within 3-5 years after I have completed my study.

Please let me know if you require any further information.

I look forward to your response as soon as is convenient. Thank you very much for your help.

Yours sincerely,

____

Ingrid Sapire

Parent/Guardian Consent Form

Please fill in and return the reply slip below indicating your willingness to allow your child to participate in the research project called:

Multilingualism in FP mathematics

I, ______________________________the parent of ________________________________

Permission for terminology translation survey	**Circle one**
I agree that my child can complete a terminology translation survey for this study. I know that this is not a test.	YES/NO
Permission to observe my child in class	
I agree that my child may be observed in class.	YES/NO
I would like my child to be seated on the side of the room, not captured by camera	YES/NO
Permission to allow my child to be videotaped	
I agree my child may be videotaped in class.	YES/NO
I know that the videotapes will be used for this project only.	YES/NO

Informed Consent

I understand that:

- my child's name and information will be kept confidential and safe and that my name and the name of the school will not be revealed.
- my child does not have to complete the word list and he/she can withdraw from the study at any time.
- he/she can ask not to be videotaped.
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____________________________ Date___________________________

University of the Witwatersrand, Johannesburg, South Africa

School of Education

MATHEMATICS EDUCATION PHD RESEARCH THESIS

Ingrid Sapire
Wits School of Education
Curriculum Division
27 St Andrews Road
Parktown, 2193
Cell: 082 352 2271
E-mail: ingrid.sapire@wits.ac.za

25 August 2016

Dear (Teacher) – individual names of teachers will be inserted

My name is Ingrid Sapire, a PhD Student at the University of the Witwatersrand School of Education. I am doing research on: **Multilingualism in FP mathematics.**

This study involves a study in the area of learning and teaching of mathematics. The research aims at exploring how teachers use different languages (such as your home language and English or any other languages) to help children learn mathematics better. There are studies that show that if teachers use (and allow learners to use) more than one language when they are teaching mathematics this could help learners to grasp the concepts more effectively. I will discuss these ideas with you and give you a set of multilingual dictionaries that you are free to use when you prepare for some lessons that you will teach. I would also like to discuss with you how best you could use more than one language to help the development of conceptual understanding of mathematics. I would then like to observe three of your lessons, if you will agree to this observation. The topic that I would like to observe when you teach is Patterns, part of the Grade 3 curriculum.

I hope that you would not mind if I attend the lessons in question. When I observe the teaching of Patterns, I will not be involved in the lesson at all. I will be focusing on how you use language to make conceptual explanations clear. I also seek your permission to video record the lessons.

I will just use a video camera to capture the lessons in order to have a record of my observations. I will also have a short list of words (a terminology survey) that I will ask you and the learners in your class to complete for me, on the topic of Patterns. This is not a test, it is not for marks, and completing it is voluntary.

Your name and identity will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study. The videotapes are for research purposes only and will not be shown publically. No pictures of you will be included in the research.

All research data will be destroyed between 3-5 years after completion of the project.

You will not be advantaged or disadvantaged in any way. Your participation is voluntary, so you can withdraw your permission at any time during this project without any penalty. There are no foreseeable risks in participating and you will not be paid for this study.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

____

Ingrid Sapire

Teacher's Consent Form

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called:

Multilingualism in FP mathematics

I, ____ give my consent for the following:

Permission to be interviewed	**Circle one**
I agree to participate in a focus group discussion for this study.	YES/NO
I know that I can withdraw from the focus group at any time and don't have to answer all the questions asked.	YES/NO
Permission to be audiotaped	
I agree to the audiotaping during the focus group discussion by the researcher	YES/NO
I know that the audiotapes will be used for this project only	YES/NO
Permission for terminology translation survey	
I agree to complete a terminology translation survey for this study. I know that this is not a test.	YES/NO
Permission to observe you in class	
I agree to be observed in class.	YES/NO
Permission to be videotaped	
I agree to be videotaped in class.	YES/NO
I know that the videotapes will be used for this project only.	YES/NO

Informed Consent

I understand that:

- my name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.

- I can ask not to be audiotaped or videotaped.
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_______________________________ Date_____________________________

University of the Witwatersrand, Johannesburg, South Africa
School of Education
MATHEMATICS EDUCATION PHD RESEARCH THESIS

Ingrid Sapire
Wits School of Education
Curriculum Division
27 St Andrews Road
Parktown, 2193
Cell: 082 352 2271
E-mail: ingrid.sapire@wits.ac.za

25 August 2016

Dear (Principal) – individual names of principals will be inserted

My name is Ingrid Sapire, a PhD Student at the University of the Witwatersrand School of Education. I am doing research on: **Multilingualism in FP mathematics.**

This study involves a study in the area of learning and teaching of mathematics. The research aims at exploring how teachers use different languages (such as their home language and English or any other languages) to help children learn mathematics better. There are studies that show that if teachers use (and allow learners to use) more than one language when they are teaching mathematics this could help learners to grasp the concepts more effectively. I will discuss these ideas with the teachers and give them a set of multilingual dictionaries that they will be free to use when they prepare for some lessons that they will teach. I would also like to discuss with teachers how best they could use more than one language to help the development of conceptual understanding of mathematics. I would then like to observe three lessons, if you will agree to this observation. The topic that I would like to observe being taught is Patterns, part of the Grade 3 curriculum.

The reason why I have chosen your school is that it is convenient to me as I live in the Johannesburg area. I will not have to travel very long distances if I am able to do observations at your school. I hope that you would not mind if I observe the lessons in question.

When I observe the teaching of Patterns, I will not be involved in the lesson at all. I will be focusing on how teachers use language to make conceptual explanations clear. I also seek your permission to video record the lessons. I will just use a video camera to capture the lessons in order to have a record of my observations. I will also have a short list of words (a terminology survey) that I will ask the teacher and the learners in his/her class to complete for me, on the topic of Patterns. This is not a test, it is not for marks, and completing it is voluntary.

The names of the research participants and identity of the school will be kept confidential at all times and in all academic writing about the study. No pictures of the teacher or learners will be included in the research. The videotapes are for research purposes only and will not be shown publicly. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

You will not be advantaged or disadvantaged in any way. Your participation is voluntary, so you can withdraw your permission at any time during this project without any penalty. There are no foreseeable risks in participating and you will not be paid for this study.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

____

Ingrid Sapire

Principal's Consent Form

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called:

Multilingualism in FP mathematics

I, ____ give my consent for the following:

Permission to use the school as a research site	**Circle one**
I agree that my School can be used for this study only.	YES/NO
Permission for terminology translation survey	
I agree that the teacher(s) and learners may complete a terminology translation survey for this study. I know that this is not a test.	YES/NO
Permission to be interviewed	
I agree to that the teacher(s) may participate in a focus group discussion for this study.	YES/NO
I know that they can withdraw from the focus group at any time and don't have to answer all the questions asked.	YES/NO
Permission to be audiotaped	
I agree to the audiotaping of the focus group discussion by the researcher	YES/NO
I know that the audiotapes will be used for this project only	YES/NO
Permission to observe in the class	
I agree that the teacher and learners can be observed in class.	YES/NO
Permission to be videotaped	
I agree to the videotaping of participating teacher(s) and learners in class.	YES/NO
I know that the videotapes will be used for this project only.	YES/NO

Informed Consent

I understand that:

- the name and information of the school will be kept confidential and safe and that my name and the name of my school will not be revealed.
- teachers do not have to answer every question and can withdraw from the study at any time.
- I can ask for the participants not to be audiotaped, or videotaped.
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign______________________________ Date____________________________

Appendix 12: LETTER TO THE DISTRICT OFFICALS

University of the Witwatersrand, Johannesburg, South Africa
School of Education
MATHEMATICS EDUCATION PHD RESEARCH THESIS

Ingrid Sapire
Wits School of Education
Curriculum Division
27 St Andrews Road
Parktown, 2193
Cell: 082 352 2271
E-mail: ingrid.sapire@wits.ac.za

25 August 2016

Dear District Official

My name is Ingrid Sapire, a PhD Student at the University of the Witwatersrand School of Education. I am doing research on: **Multilingualism in FP mathematics.**

This study involves a study in the area of learning and teaching of mathematics. The research aims at exploring how teachers use different languages (such as their home language and English or any other languages) to help children learn mathematics better. There are studies that show that if teachers use (and allow learners to use) more than one language when they are teaching mathematics this could help learners to grasp the concepts more effectively. I will discuss these ideas with the teachers and give them a set of multilingual dictionaries that they will be free to use when they prepare for some lessons that they will teach. I would also like to discuss with teachers how best they could use more than one language to help the development of conceptual understanding of mathematics.

I would then like to observe three lessons, if principals will agree to this observation. The topic that I would like to observe being taught is Patterns, part of the Grade 3 curriculum. I will request the permission of principals, teachers and learners (and their parents) in order to do these observations. When I observe the teaching of Patterns, I will not be involved in the lesson at all. I will be focusing on how teachers use language to make conceptual explanations clear.

I will seek permission to video record the lessons. I will just use a video camera to capture the lessons in order to have a record of my observations.

I also have a short list of words (a terminology survey) that I would like to ask you to complete for me, on the topic of Patterns. This is not a test and completing it is voluntary. The survey is to establish variations in language use in the topic of Patterns.

Your name and identity will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

You will not be advantaged or disadvantaged in any way. Your participation is voluntary, so you can withdraw your permission at any time during this project without any penalty. There are no foreseeable risks in participating and you will not be paid for this study.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

____

Ingrid Sapire

District Official's Consent Form

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called:

Multilingualism in FP mathematics

I, ____ give my consent for the following:

Permission for terminology translation survey	**Circle one**
I agree to complete a terminology translation survey for this study.	
I know that this is not a test.	YES/NO

Informed Consent

I understand that:

- I do not have to complete the full survey and I can withdraw from the study at any time.
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____________________________ Date___________________________

University of the Witwatersrand, Johannesburg, South Africa
School of Education
MATHEMATICS EDUCATION PHD RESEARCH THESIS

Ingrid Sapire
Wits School of Education
Curriculum Division
27 St Andrews Road
Parktown, 2193
Cell: 082 352 2271
E-mail: ingrid.sapire@wits.ac.za

25 August 2016 (dates to be amended)

Dear (Director) (individual names to be inserted)

My name is Ingrid Sapire, a PhD Student at the University of the Witwatersrand School of Education. I am doing research on: **Multilingualism in FP mathematics.**

This study involves a study in the area of learning and teaching of mathematics. The research aims at exploring how teachers use different languages (such as their home language and English or any other languages) to help children learn mathematics better. There are studies that show that if teachers use (and allow learners to use) more than one language when they are teaching mathematics this could help learners to grasp the concepts more effectively. The research will involve district officials, teachers and learners in (your district).

The reason why I have chosen your district is that it is convenient to me as I live in the Johannesburg area. I will not have to travel very long distances if I am able to do observations at schools in (your district).

I have a short list of words (a terminology survey/questionnaire) that I would like to ask some district officials, teachers and learners to complete, on the topic of Patterns. This is not a test and completing it is voluntary. The survey is to establish variations in language use in the topic of Patterns.

I would also like to discuss the idea of language use in the mathematics class with the teachers and I will give them a set of multilingual dictionaries that they will be free to use when they prepare for some lessons that they will teach. I would also like to discuss with teachers how best they could use more than one language to help the development of conceptual understanding of mathematics. I would then like to observe three lessons, if principals will agree to this observation. The topic that I would like to observe being taught is Patterns, part of the Grade 3 curriculum. I will request the permission of principals, teachers and learners (and their parents) in order to do these observations. When I observe the teaching of Patterns, I will not be involved in the lesson at all. I will be focusing on how teachers use language to make conceptual explanations clear. I will seek permission to video record the lessons. I will just use a video camera to capture the lessons in order to have a record of my observations.

The names and identities of all research participants will be kept confidential at all times and in all academic writing about the study. Individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

Participants will not be advantaged or disadvantaged in any way. Participation is voluntary, so anyone can withdraw their permission at any time during this project without any penalty. There are no foreseeable risks in participating and there will be no payment for this study.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

____

Ingrid Sapire

District Director's Consent Form

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called:

Multilingualism in FP mathematics

I, ____ give my consent for the following:

Permission to use the district as a research site	**Circle one**
I agree that my district can be used for this study only.	YES/NO
Permission for terminology translation survey	
I agree that the officials, teacher(s) and learners may complete a terminology translation survey for this study. I know that this is not a test.	YES/NO
Permission to be interviewed	
I agree to that the teacher(s) may participate in a focus group discussion for this study.	YES/NO
I know that they can withdraw from the focus group at any time and don't have to answer all the questions asked.	YES/NO
Permission to be audiotaped	
I agree to the audiotaping of the focus group discussion by the researcher	YES/NO
I know that the audiotapes will be used for this project only	YES/NO
Permission to observe in the class	
I agree that the teacher and learners can be observed in class.	YES/NO
Permission to be videotaped	
I agree to the videotaping of participating teacher(s) and learners in class.	YES/NO
I know that the videotapes will be used for this project only.	YES/NO

Informed Consent

I understand that:

- the name and information of the district and the schools will be kept confidential and safe and that my name, the district name and the name of the schools will not be revealed.
- officials and teachers do not have to answer every question and can withdraw from the study at any time.
- I can ask for the participants not to be audiotaped, or videotaped.
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign______________________________ Date____________________________