TEACHER PRACTICES USED TO MEDIATE THE SEPEDI MATHEMATICS REGISTER IN MULTILINGUAL CLASSROOMS

A research report submitted to the Faculty of Humanities, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Education

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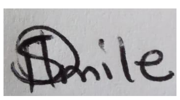
DECLARATION

I, Senamile Dlamini (589420) declare that this Research Report is my own unaided work except where reference has been made to existing and published literature. It is being submitted for the Degree of Master of Education at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree, part degree or examination at this or any other university.



March 2022

Senamile Dlamini

Johannesburg

DEDICATION

To my husband, daughter, mother and departed father. A special dedication to God for your grace has kept me through.

ACKNOWLEDGEMENTS

My uttermost thanksgiving to the Almighty God who made a way for me throughout this research report. As Travis Greene best puts it “You made a way, when [my] back [was] against the wall and it looked as if it was over. You made a way and [I am] standing here only because You made a way”.

My sincere gratitude to my supervisor, Prof. Anthony Essien, for patiently guiding me through this research report. Thank you for your unwavering support throughout this research, I really appreciate your expertise.

To my husband, Robert, thank you for selflessly fuelling me, believing in me and supporting me. Without you this research would have never been a success. To my baby girl, being your mother is the miracle I needed to keep going, and for that I will always be grateful. To my family, thank you for being the pillar of my strength, you continued to support me with your motivational words and prayers.

ABSTRACT

This study proposed to examine teacher practices used to mediate the Sepedi mathematics register in South African multilingual classrooms. The study was conducted in Foundation Phase classrooms where the Language of Learning and Teaching (LoLT) is SePedi. The participants of the study were three foundation phase teachers, one from Grade 3 and two from Grade 1. Data was collected through lesson and interview transcripts.

The study used an adapted version of Adler and Ronda's (2015) MDI framework as a conceptual and analytical framework. The study employed the MDI's three broad themes - exemplification, exploratory talk and learner participation- as key practices so findings were presented under each theme. The findings of the study revealed that teachers use similar and contrasting examples to mediate the mathematics register. Contrary to research on the use of indigenous languages in the teaching and learning of mathematics, the findings revealed that teachers maintained the cognitive demand of tasks, used the correct mathematical register in SePedi and seldom code-switched to English. Learners were active participants and used the correct SePedi mathematics register as modelled by the teachers. Based on the findings, the study recommends the use of learners' home language(s) in the teaching and learning of mathematics.

Keywords: teacher practices; mathematics register; exemplification; exploratory talk; learner participation; SePedi

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Chapter 1: Introduction to the study

1.1 Introduction

For decades, mathematics education research has focused on the use of indigenous languages in the teaching and learning of mathematics. In multilingual classrooms, using learners' home language(s) as the Language of Learning and Teaching (LoLT) mathematics has been viewed as a resource rather than a deficiency. Phakeng (2018) states that learners’ home language(s) are a resource since most learners in South Africa lack the fluency required to participate in mathematical tasks written in English. Learners’ home language(s) are thus useful tools to explain their thinking process in solving mathematics tasks. According to Van Laren and Goba (2013), university learners who study mathematics in IsiZulu find it easier to follow lectures, enjoy class, and recall what is taught because they are learning in their own language. The use of learners' home language(s) as the LoLT has the potential to enhance learners’ understanding of mathematics (Mpalami, 2022).

According to the South African school language policy, learners in the Foundation Phase can learn in their home language(s). According to UNESCO, early formal schooling should be in learners' home language(s) and the Department of Education (DoE) (2011) agrees that Foundation Phase (Grade R-3) (Foundation Phase) learners are encouraged to learn in their home language(s). In this study, I focus on Grades 1 and 3 classrooms because there are respectively the entry and exit grades in the Foundation Phase in South Africa. Early grade mathematics research has emphasised that early number learning should be mediated by the use of artefacts such as the abacus and 100 squares (Venkat & Askew, 2018) or through mathematical metaphors. Although these tools to mediate the mathematics register are beneficial, there is a need for teachers to know how to use them (Venkat & Askew, 2018) hence a focus on teacher practices is essential.

Research in multilingual mathematics classrooms should focus on classroom practices (Adler, 2001). Brodie (2008) agrees that research should focus on analysing teaching techniques and the mathematical knowledge required to improve and sustain those practices. However, the difficulty of mediation arises when techniques that mediate the mathematical register are used. The issue of mediation, according to Adler (2001), entails teachers deciding how and when to act in validating learners' different meanings and increasing their mathematical ability. Teachers are torn between supporting learners' LoLT competence and assisting learners' mathematics register proficiency.

The mathematics register can be defined as a formally developed group of meanings suitable to a particular mathematical function (Pimm, 1981). To enable access to the mathematics register, teachers implement practices that will enable learners to fluidly move from informal expressions of mathematics ideas to formal discourses of mathematics in indigenous languages. The purpose of this research is to explore how teachers in multilingual South African classrooms mediate the SePedi mathematics register.

This study is informed by this research question:

> How do teacher practices mediate the SePedi mathematics register in Grade 1 and Grade 3 multilingual classrooms in South Africa?

My interest in language and mathematics stems from my experiences as a mathematics student and teacher. Whilst doing my training at university, the LoLT was strictly English even for primary school teachers, who are then expected to know how to teach in an indigenous language as per the South African Education Language policy (DoE, 2011). This spiked an interest in studying and understanding how teachers, such as myself, can assist learners to understand the mathematical register in an indigenous language since this is not taught at most universities in South Africa.

Numerous research on teacher methods in settings where English is the primary LoLT has been prominent but focus on teacher educators or lecturers (Essien, 2020) or only on code-switching as a practice (Chikiwa & Schäfer, 2017) and on challenges with implementing policy and practice (Phakeng, 2018). In areas where the LoLT is an indigenous language, there is a scarcity of studies. Current research on teaching mathematics in indigenous languages focuses on the importance of teaching mathematics in learners' home languages (Kajoro, 2016), learners' experiences (Van Laren & Goba, 2013), student practices (Brijlall, 2011), and translating tasks from English to indigenous languages (Mpalami, 2022), rather than teacher practices. This study aims to address the gap in literature by concentrating on teacher practices in classrooms where the LoLT is an indigenous language, such as SePedi in this case. The study's major goal was to look into teachers' practices for mediating the mathematics SePedi register.

1.2 Definitions of terms

Mathematics register: A register is a collection of permissible meanings for a certain language function, as well as the words and structures that transmit these meanings (Halliday, 1978). As a result, the mathematics register is a formally constructed set of meanings appropriate for a specific mathematical function (Pimm, 1981). This includes mathematically influenced ways of interacting, reading, and writing.

Practices: Essien (2020, p.170) states that mathematical practices "are concerned with the dynamics of the learning process." This includes a focus on what teachers say and do in the classroom. It includes the examples and tasks used, what is written on the board and the exploratory talk about what is said and written.

LoLT: This is the Language of Learning and Teaching (LoLT) which can also be called the language of instruction. In this study, the LoLT is SePedi, therefore, all subjects at the school are taught in SePedi in Grade 1 to 3. This implies that the learners need to understand LoLT, both written and oral, and they will be assessed in SePedi. SePedi is one of the eleven official languages in South Africa and is mainly spoken by the Northern Sotho group hence SePedi is sometimes called Northern Sotho.

Multilingual: South Africa is a great body of diverse languages present with eleven official languages. The language in education policy states that no language should be used at the expense of another, especially in township schools where additive multilingualism is a preference (DoE, 2011). Additive multilingualism means that other languages are introduced after learners have developed skills in their home language. The idea of home language in South Africa has been challenged with recent research arguing for home languages referring to plural home languages instead of one (Phakeng, 2018). Most learners are multilingual with, for example, a mother who speaks SiSwati and a father who speaks SePedi. This then brings the idea of having home languages. Multilingualism is thus being proficient in more than one language.

1.3 Layout of the study

This study has a total of five chapters.

In **Chapter 1**, I have provided the background to the study, highlighting the need to understand the teaching and learning of mathematics in an indigenous language. This chapter engaged with the rationale for conducting this study, the objectives and the research questions this study aims to answer.

Chapter 2 presents the review of literature on the dominant practices teachers used in multilingual classrooms to mediate the mathematics register. Here, I first describe the mathematics register and the debate associated with the mathematics register especially in an indigenous language. The chapter then highlights the dominant practices used in multilingual mathematics classrooms. These practices included code-switching and revising. Moreover, in chapter two, I discuss the Mathematics Discourse in Instruction (Adler & Ronda, 2015) as the conceptual framework for this study. Here, I focus on the task exemplification and exploratory talk and how they mediate the mathematics register.

Chapter 3 discusses the research process in detail and includes the methods that were used in generating, organising and analysing the qualitative data for the study. Here, I provide an overview of the study's data collection methods, participants, ethical considerations, reliability and validity. This chapter concludes with a detailed description of how I will analyse the data.

Chapter 4 presents and critically analyses the findings from the collected data. The research data is analysed in relation to the conceptual framework, analytical framework and reviewed literature.

Chapter 5 presents a summary of the study's findings and gives directions for future research in relation to the findings of the current study. I also discuss the implications of the findings and reflect on the teacher practices to mediate the mathematics register in multilingual classrooms.

Chapter 2: Literature review and conceptual framework

2.1 Literature review Introduction

This section provides an overview of the mathematics register on a global and South African scale. The literature included here covers the mathematics register from the early 1990s to the early twenty-first century. The literature then focuses on teacher strategies in multilingual classrooms to moderate the mathematical register.

2.2 The mathematics register

A register is a collection of acceptable meanings for a certain language function, as well as the words and structures that transmit these meanings (Halliday, 1978). Pimm (1981) expanded on this concept by defining Mathematical English as the mathematics register, which is a formally constructed set of meanings appropriate for a specific mathematical function. Moschkovich (2003) used (Halliday, 1978) and Pimm (1981) to define mathematics register as modes of interacting, reading, and writing that are influenced by mathematical values and various points of view. This comprises terminology, speaking in a mathematical manner, disputing, and explaining (Barwell, 2009).

The connection between mathematics and language has received a lot of attention in the field of mathematics education research (Setati, 2008; Adler, 2001, Barwell, 2016). Learning mathematics is similar to learning a language (Pimm, 1981; Wilkinson, 2019). Mathematics should be learnt as a second language (Wilkinson, 2019) because, as Ledibane, Kaiser, and van der Walt (2018) state, it has a specific vocabulary and mathematical techniques of communicating that are similar to those of a language. Moreover, mathematics is defined by the Department of Education (2011, p. 8) as "a language that uses symbols and notations to describe numerical, geometric, and pictorial relationships." Because mathematics is not an official language in the same way that English is, it is taught in a mix of ordinary and mathematical English in mathematics classrooms (Pimm, 1981).

Understanding mathematics necessitates the use of the proper mathematical register. According to Morgan (2007), while learners' ordinary language can help them learn mathematics, failing to use the special mathematics register and methods of knowing that provide access to a deeper grasp of mathematics reinforces disadvantages and exclusion. As a result, it is critical for teachers to transition from colloquial to academic mathematical terminology. Allowing learners to use the proper mathematics register allows them to access more complex mathematics (Clarkson, 2016). Learners need the mathematics register to decode complicated problems and understand the relationships between language and mathematical symbols.

According to Essien, Chitera, and Planas (2016), the primary goal of educator training is to provide learners with access to mathematical material and register. Learners should come to "break the code" of each mathematical course by using a specialised register (Zevenberg, 2000, p. 205). This is because mathematics has a specialised vocabulary that differs from everyday English and varies between contexts within the mathematics field (Moschkovich, 2003). As a result, learning mathematics entails comprehending the various mathematical terms, each of which has a varied meaning in different settings. The mathematics register is a set of vocabulary and ways of understanding and knowing that are used to express mathematics.

Teachers in multilingual environments encounter difficulty in adopting the correct mathematical register, one justification offered is that employing the mathematics register is connected with English. The mathematics register is frequently connected with a prestigious language, which is English, because it is characterised as a fixed style of expressing and writing mathematics (Barwell, 2018; Setati, 2008). This generates the appearance that the learner's home language(s) are less relevant or have a lower standing in the mathematics domain. Despite the elevation of indigenous languages in South Africa to the status of official languages, Boughey (2002) claims that most learners are disadvantaged because their languages are frequently classified as socially and politically disadvantaged when compared to other languages.

Another issue with utilising the correct mathematics language in multilingual classrooms is that it isn't completely established in the learners' home languages. Teachers had difficulty identifying the correct Xhosa words, according to Chikiwa and Schäfer (2017), because the mathematics register in that language was not sufficiently developed. These findings correspond to the isiZulu language's lack of a mathematics language (Van Laren & Goba, 2013).

2.3 Practices used to mediate the mathematics register in multilingual classrooms

Teachers play a vital role in mediating the mathematics register by supporting learning through diverse classroom practices. The duty of mathematics teachers in multilingual mathematics classes, according to Barwell (2009), is to mediate between ordinary English and the mathematical register. In this section, I focus on the strategies that instructors utilise in multilingual classrooms to mediate the mathematical register. The study only looks at two common activities in bilingual classrooms: code-switching and revoicing. These practices were chosen because they place a strong emphasis on classroom discussions and the teacher.

Code-switching is the most common practice in multilingual situations (Adler, 2001; Setati, 2005). It is typical in multilingual classrooms in South Africa to use two or more languages, primarily English and an indigenous language (Vorster, 2008). Code-switching can be defined as communicating in more than one language.

According to Setati (2005), code-switching is beneficial since it encourages involvement and familiarises learners with the LoLT.

Code-switching has also been observed as a common practice in settings where the LoLT is an indigenous language (Essien, 2018; Van Laren & Goba, 2013). Furthermore, even if the teacher does not share his or her home language with the learners, code-switching might be a common practice (Gorgorio & Planas, 2001; Essien, 2011; 2012; Murtara & Essien, 2013). This can be accomplished by dividing learners according to their home language(s) and allowing them to express themselves in their home languages.

Although research has found certain advantages to employing code-switching in multilingual environments, there are also some drawbacks to doing so. The difficulty of code-switching, according to Adler (2001, p.85), is "not whether or not to code-switch, nor whether or not to model mathematical language, but rather when, how, and for what purposes." Teachers must choose when to code-switch because if they stay to English, learners may not comprehend; if they move to Setswana, learners may be denied access to English and perhaps the mathematical register. Teachers decide on code-switching, transitioning between the mathematical register and the LoLT, and other mathematical representations (Prediger, Clarkson & Bose, 2016).

Teachers rarely use the mathematical register as a result of this obstacle (Setati, 2008). According to Setati (2005) and Morgan (2007), switching codes without using a specialised mathematical register reinforces disadvantages and exclusion. This is related to the belief that learners do not have access to higher-status or mathematical languages. The teacher's job in a multilingual classroom, according to Adler (2001), is fraught with issues such as code-switching, which may favour one language that isn't the primary language for all learners. The issue with code-switching, according to Chikiwa and Schäfer (2017), is teaching in two languages while only writing assessments in one. While teaching is done using a combination of an indigenous language and English, assessing is done entirely in English. This begs the question of whether teachers should enable learners to speak Xhosa because tests are written in English.

Numerous research papers have been published on revoicing as a practice that can mediate the mathematics register. Revoicing (O'connor & Michaels, 1996; Michaels & O'connor, 2015) is the process of repeating a phrase using the right mathematics register. In the mathematics classroom, it entails repeating, expanding, or rephrasing one's ideas. Revoicing is vital in multilingual classrooms (Moschkovich, 1999), because learners can acquire both the mathematics language and the LoLT through revoicing. It strikes a balance between the necessity for a mathematical register and the desire to improve English proficiency. Revoicing allows learners to understand the mathematical register because teachers revoice using the correct mathematics language (O'Connor & Michaels, 1996; Michaels & O'connor, 2015).

2.5 Conceptual Framework: The Mathematics Discourse in Instruction (MDI)

Using an altered version of Adler and Ronda's (2015) Mathematics Discourse in Instruction, this study analyzes instructors' tactics for moderating the mathematics register (MDI). A collection of examples and their related tasks, exploratory conversation that names and legitimizes the learning object, and classroom interaction patterns are all defined by MDI as presenting a mathematics lesson (Adler & Ronda, 2015).

Vygotsky's idea of mediated learning underpins the Mathematics Discourse in Instruction (MDI). Because it has origins in South African mathematics teaching practices (Adler & Ronda, 2015), I decided to use it as an analytical framework for the study in order to discover the methods teachers employ to moderate the SePedi register in South African classrooms. It enables the description of teacher practices and how they relate to the learning resources accessible. The object of learning is the content that makes learning possible (Adler & Ronda, 2015). Exemplification, exploratory discussion, and learner participation are all mediational strategies that enable learners to have access to the object of learning (Adler, 2017). (Adler & Ronda, 2015). According to the MDI, there are four interconnected components in mathematics lessons: exemplification, exploratory discussion, learner engagement, and the purpose of learning (see Figure 1).

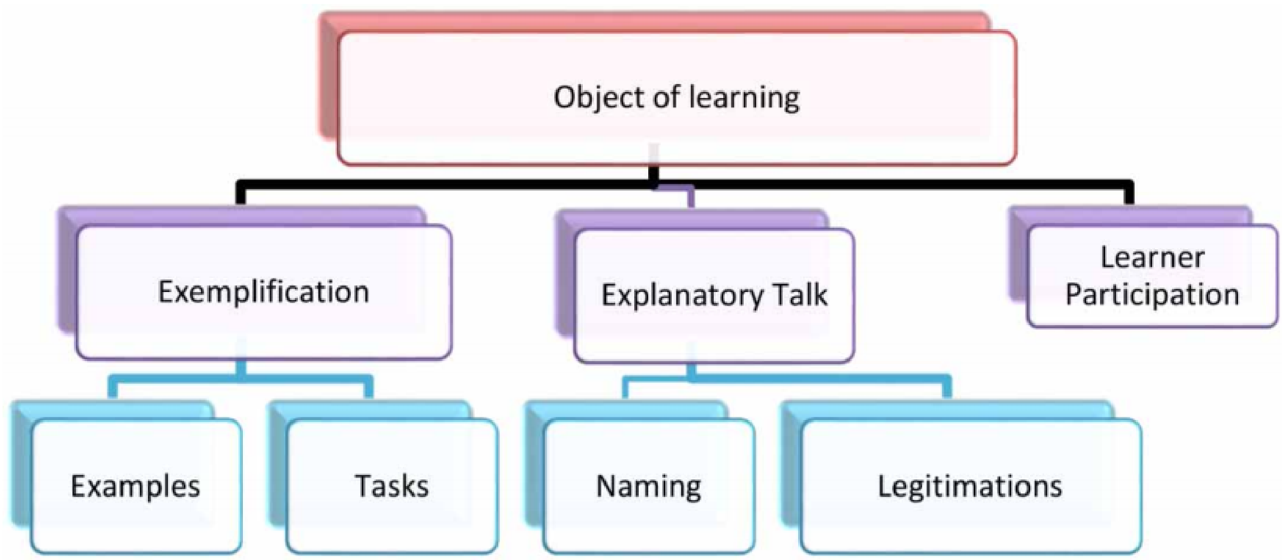


Figure 1 : The MDI (Adler & Ronda, 2015, p. 239)

In what follows, I engage with each of the components of the MDI framework.

2.5.1 Exemplification

Exemplification includes both examples and tasks.

Examples

In the teaching and learning of mathematics, examples are crucial, and they are frequently used as the learning object. A specific case of a broader class from which one can generalise can be defined as an example (Zodik & Zaslavsky, 2008). Similarity, contrast, and fusion are three types of variation identified by Adler and Ronda (2015; 2017). Similar (S) examples open up the possibility of generalising what is variable or constant. When examples use contrast (C), they draw attention to a different class, allowing for generalisation. Within the same example set, fusion (F) occurs when more than one aspect focuses on a changing or invariant object.

Tasks

Examples are accompanied by tasks because they are not self-explanatory. Tasks are defined by Adler and Ronda (2015; 2017) as what learners are expected to complete with the many examples presented. Tasks necessitate certain actions based on the level of complexity, allowing the learning object to be obtained (Adler & Ronda, 2015). The MDI focuses on the linkages between concepts and methods while dealing with tasks. This comprises following well-known procedures (K), determining which procedure to utilise by applying (A) skills, and connecting several dots (C/PS).

2.5.2 Exploratory talk

Exploratory discourse, as defined by Adler and Ronda (2015, 2017), is the communication of meanings about what is valued and respected. Its purpose is to name and legitimise what one concentrates on and discusses in terms of instances and tasks. Identifying the strategies that instructors employ to mediate the mathematics register necessitates a focus on what is deemed significant to discuss, name, and legitimise.

Naming

This is how teachers refer to the learning object. Naming is the process of using words to define other mathematical terms, symbols, representations, procedures, and relationships (Adler & Ronda, 2015). This contains both mathematical and non-mathematical terms. When referring to mathematical objects, non-mathematical (NM) is colloquial terminology, which is commonplace language or confusing pronouns.

The mathematical vocabulary, which includes mathematical terminology and formal mathematical language, is known as mathematical register. Some mathematical language used to name objects or symbols includes mathematical terminology such as labels and symbols. The use of proper labels for mathematical objects and methods is known as formal mathematical language.

Legitimating

Teachers validate what counts as mathematical knowledge by legitimising it. The mathematical domain, non-mathematical domain, curriculum, and teacher's authority are all relevant domains to legitimise the object of knowledge, according to Adler and Davis (2011). Legitimising, according to Adler (2017, p. 134), is defined as "criterion for what counts as mathematics that evolve through time in a session and provide opportunities for learning targeted toward scientific notions." The visual, positional, and everyday knowledge domains are the focus of the non-mathematical domain. A mathematical object's visual (V) clues are its appearance. Memory devices that help with recall are among them (Daddy Mommy Sister Brother - DMSB in long division).

Teacher's positional (P) assertions are made as though they are facts. The teacher is given authority since what is valued is conveyed. Everyday (E) is centred on the use of language in everyday situations. Local and general mathematics are included in the mathematical realm. Mathematics Local (L) refers to what counts as local or context-specific mathematics, such as a single-case established shortcut or convection, whereas Mathematics General (G) refers to mathematics that is global and possesses generality. This comprises all of the representations, definitions, principles, structures, and attributes found in this research.

2.5.3 Learner participation

This focuses on what learners are asked to say about the mathematical register and activities they are given (Adler & Ronda, 2015). Within learner participation, there are three criteria. The first is when a learner is given the option of providing yes/no (Y/N) or single-word answers, the second is when learners are asked questions that require them to provide reasons and engage with ideas, and the third is when learners are asked questions that require them to provide reasons and engage in a discussion. During exploratory talk, the teacher uses techniques such as probing inquiries, confirming or revoicing the contributions of the learners (Adler & Ronda, 2015). These interactions are between the teacher, the learners, and the tasks in this study.

2.5.4 The object of learning

According to Adler and Ronda (2015), the goal of the MDI was to define the mathematics that may be learned during classes, thus explaining what happens in the classroom. It specifies the material (object) that learners are supposed to learn as well as their activities in relation to the concepts taught in each lesson episode (learning). Concepts, processes, and algorithms are examples of this in a mathematics classroom.

2.6 How the MDI was adapted for this study

For the study’s analytical framework, I use the MDI framework and literature presented on teacher practices. The integration of teacher practices and the MDI for the purpose of this study is depicted as the analytical framework in Figure 3 in Chapter 3. Adler and Ronda's (2015) MDI provides a framework for examining and exploring teaching practices in South African mathematics classrooms.

2.7 Conclusion

In this chapter, I have engaged with the relevant literature for the study by first focusing on the mathematics register. I discussed how the mathematics register has been defined over the years, its importance in the teaching and learning of mathematics and its strengths and challenges in multilingual contexts. I then discussed teacher practices in multilingual mathematics classrooms focusing on code-switching and revoicing as the two prominent teacher practices. This chapter then concludes with the Mathematical Discourse In Instruction (MDI) as the conceptual framework for this study. The MDI helps us understand teacher practices in terms of the examples and tasks used, and the exploratory talk in the classroom. All these components help focus on how teacher practices bring about the object of learning hence mediate the mathematics register. In the next section, I focus on the methodology employed by this study.

Chapter 3: Research design and Methodology

3.1 Introduction

This section presents a description of the research methodology used for the purpose of this study. Here, I begin by detailing the interpretive paradigm as the study's research paradigm. This includes the research paradigm, research design and approach, data collection method and data analysis. Finally, ethical considerations for the study which include ethical clearance for the study, confidentiality, as well as anonymity are also considered in this section.

3.2 Research paradigm

This study uses an interpretivist research paradigm. A paradigm can be defined as a group of views that determine action (Denzin & Lincoln, 2011) and a research paradigm refers to the entire system of thought, the well-recognised research traditions in a particular field. There are various research paradigms including positivists and post-positivist, interpretivists and transformative paradigms (Mackenzie & Knipe, 2006). Each research paradigm represents specific ways of knowing and understanding the world.

The interpretivists paradigm holds the view that knowledge is made through local understanding. Therefore, knowledge is locally created rather than a global orientation of meaning (Feinberg & Soltis, 2009). This study employed an interpretive paradigm because understanding teachers' practices is context based hence requires a local understanding and this study does not equate to a global orientation of teacher practices. Moreover, interpretivism recognises humans as individuals having unique experiences and uses descriptions to interpret meanings of individuals (Feinberg & Soltis, 2009), hence this study used interpretivism as the working paradigm.

3.3 Research approach and design

This study employs qualitative research and a case study design technique to address the stated research issue. Qualitative research is an inquiry-based method that focuses on the variety of experiences rather than their quantification (Kumar, 2019). Qualitative research is a naturalistic investigation that tries to understand more about social phenomena in their natural environment. Because qualitative research reveals an in-depth understanding of a phenomenon through the investigation of specific circumstances and persons, it was used in this study. This method was effective since it was necessary to comprehend the contextual conditions that were pertinent to the concept being examined (Yin, 2014). The approach of this study is ideal because it reveals a deep understanding of a specific phenomenon, in this case, the strategies used by teachers to mediate the SePedi register in multilingual South African classrooms.

This study's design technique is a case study within qualitative research. A case study is a kind of investigation in which the researcher investigates a program or a person in depth (Yin, 2014). Case studies are used to gain a thorough grasp of the groups being investigated before formulating a theoretical statement. The decision to use this design was based on the notion that describing relationships is insufficient to comprehending teacher practices in multilingual classrooms. Instead, an in-depth understanding of the context in which they occur is required.

3.4 Data Collection Method

Due to the influence of the Covid-19 pandemic on academics' ability to do research in schools, I used secondary data provided by my supervisor to perform this study. The secondary data was from a particular study conducted in Foundation Phase classrooms in South Africa. In the initial consent forms, permission was granted that students may use the secondary data and Ethics clearance was obtained, **Protocol number: 2014ECE032S.** Although there was data available in both IsiZulu and SePedi, I selected the SePedi data because there is limited research in the relationship between language and SePedi or teacher practices in SePedi. This is less in comparison to the Nguni languages such as IsiZulu (Van Laren and Goba, 2013) and Xhosa (Feza, 2016; Chikiwa and Schäfer, 2017).

The participants for this study are three Foundation Phase teachers in a township school where the LoLT is Sepedi. One teacher teaches Grade 3 and the two teachers teach Grade 1. The detailed information of the participants is presented in Table 1.

	Teacher 1	**Teacher 2**	**Teacher 3**
Pseudonym	Dineo	Bongwe	Natasha
Grade	1	1	3
Lesson Topic	Adding doubles 1-5	Counting back and forward: Addition and subtraction	Fives (equivalent groups) and repeated addition
Data collected	Lesson transcript	Lesson and interview transcript	Lesson and interview transcript

Table 1: Participants of the study

I selected Grades 1 and 3 because they are the entry and exit points of Foundation Phase formal schooling in South Africa. It was not possible to get data on the same topic even for the teachers in the same grade (Grade 1) because the original data (video lessons which were transcribed) was not collected in the same year.

3.5 Data Analysis

To analyse the data, I use the analytical framework developed from Adler and Ronda's (2015) MDI and the reviewed literature on teacher practices as discussed in Chapter 2. To do this, I first discuss how I use the analytical framework to analyse data.

3.5.1 Analysis in terms of exemplification

This section includes both examples and tasks. Adler and Ronda's (2015) MDI framework analyse examples in terms of moving towards generality by focusing on the three patterns of variation; Similarity (S), Contrast (C) and Fusion (F). Tasks accompany examples and shape what it is that learners are required to do with the various examples provided (Adler & Ronda, 2015). To analyse tasks, I discern if learners are required to *carry out known* **(K)** *operations and procedures and state facts*, *apply* **(A)** *known skills and/or decide on operation or procedure to use* or to *use multiple concepts* ***(C)*** *and make multiple connections.* My codes will not have levels because I am interested in identifying the practices and not the quality of or shifts in the teacher practices. The exemplification codes are presented in Table 2.

Exemplification		
Categories	**Code**	**Recognition rule**
Examples	*Similarity* ***S***	Similar structures and focus on the same procedure
	Contrast ***C***	Bring attention to a different class.
	Fusion ***F***	Simultaneously varying/invariant
Tasks	*Know* ***K***	Stating previously learnt facts or procedures
	Apply ***A***	Apply skills
	Connect ***C/PS***	Use multiple concepts and make multiple connections

Table 2: Exemplification identification codes

3.5.2 Analysis in terms of exploratory talk

Exploratory talk is a key focus in this study because to understand the practices to mediate the mathematics register requires one to focus on what is named and talked about and in which language. As discussed in Chapter 2, Exploratory talk describes the meanings that are communicated focusing on what is important (Adler & Ronda, 2015; 2017).

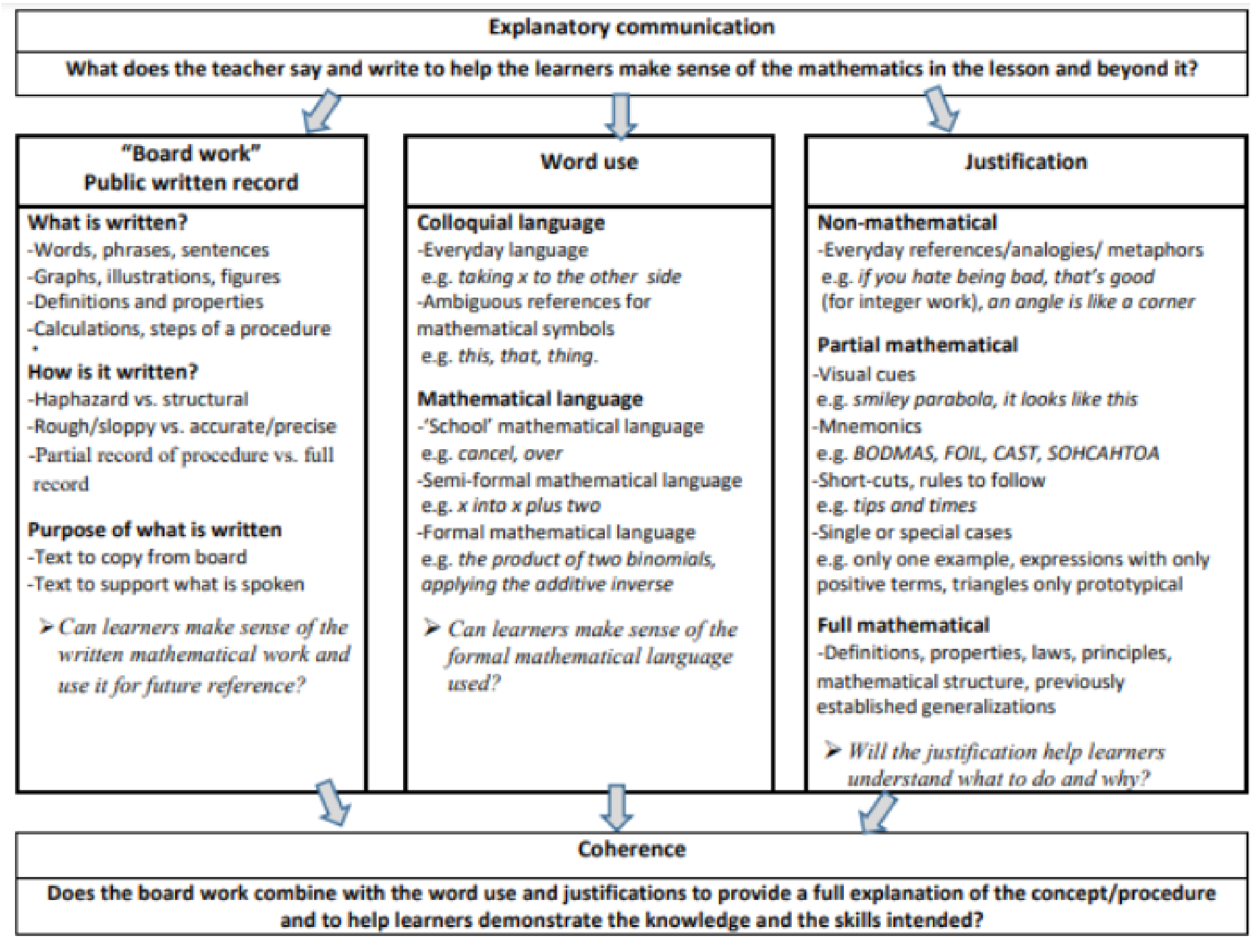


Figure 2: Exploratory analysis (Adler, 2021, p.82)

As presented in Figure 2, to analyse the data in terms of exploratory talk, I focus on how mathematical objects are named, justified and what is written on the board. My main interest here is whether the teacher uses Non-Mathematical (NM) language such as everyday language or she uses formal mathematical (M) language using the appropriate mathematics register. To analyse that, I use these identification codes for exploratory talk as presented in Table 3 under the three subdivisions; naming, legitimations and code-switching.

The focus on what is decided to be significant to talk about, describe, and legitimise in terms of the instances and tasks is required to identify the techniques teachers employ to mediate the mathematics register. Naming refers to the words used to refer to other words, procedures and images during the lesson. Here, the teacher may use colloquial language (Non-Mathematical, **NM**) which can include everyday language, ambiguous words like this, that, thing (Adler & Ronda, 2015). The teacher may also use specific Mathematical Language (**Ma)** to name. Legitimising is a practice that refers to how teachers validate what counts as mathematics knowledge. This can be Non-Mathematical by either being everyday **(E)** or positional **(P)** knowledge as if its fact or Mathematical **(M)** which can be Partial **(P),** General **(G)** or Full General **(GF)**.

Exploratory talk		
Categories	**Code**	**Recognition rule**
Naming	Non-Mathematical **NM**	Colloquial language or Non-Mathematical
	Mathematical **Ma**	Mathematical language
Legitimating	Non-Mathematical **NM**	Uses colloquial language
	Positional **P**	Teacher presents a statement as a fact
	Everyday **E**	Use everyday language
	Mathematical Local **L**	Based on a specific case
	Mathematical Full General	Equivalent representation, definitions, previously established generalisation

	GF	
Code-switching	Code-switching Mathematical **CM**	Code-switches using appropriate mathematical language such as to count, define or translate
	Code-switching Everyday **CE**	Code-switches using everyday or non-mathematical language

Table 3: Exploratory talk identification codes

I extend exploratory talk to include code-switching because the study is set in a multilingual context. Although Adler (2021) defends the absence of code-switching in the MDI, stating that it would complicate their work and distract one from the object of learning as the main goal, she acknowledges that it is a key practice in multilingual settings. Code-switching refers to the usage of multiple languages and is a key practice in my study since the focus is on the mathematics register hence understanding language usage is important. Since LoLT in this study is SePedi, the teacher uses English when code-switching. When analysing the data, I focus on how the teacher code switches between English and Sepedi when naming and legitimating, and for what purposes. Here, the teacher either code-switched using everyday language **(**Code-switching Everyday**, CE)** or used the appropriate mathematics language **(**Code-switching Mathematical, **CM)** e.g to count, to define.

3.5.3 Analysis in terms of learner participation

Learner participation is about what learners are invited to say by the teacher. Here, I have two subdivisions of learner offers in terms of what learners say and teacher revoicing referring to how the teacher responds to the learner offers. With teacher revoicing responses, I analyse if the teacher revoices by repeating learner offers or revoices by using the correct mathematical language. This is presented in Table 4.

Exploratory talk		
Categories	**Code**	**Recognition rule**
Learner offers	*Yes/No* ***Y/N***	Learners engage with Yes/no questions
	Phrases or sentences ***P/S***	Learners engage with what/how questions by providing phrases/sentences
	Discussion ***D***	Learners engage with why questions and present ideas in discussion
Teacher Revoicing	*Revoicing Repeat* ***RR***	Teacher revoices by repeating learner offer
	Revoicing Mathematical ***RM***	Teacher revoices by using the correct mathematics language

Table 4: Learner participation identification codes

Learner participation focuses on what learners are required to say and whether they are awarded opportunities to speak mathematically (Adler & Ronda, 2015). Instead of focusing only on learner's utterances as Yes/No **(Y/N)**, short phrases/sentences **(P/S)** or discussing why answers **(D)**, I also focus on how the teacher uses revoicing to respond to these learner offerings. This can be coded as repeat/reiterate (Revoicing Repeat, **RR**) or use the correct mathematics language (Revoicing Mathematical, **RM**).

The analytical framework for this study depicted in Figure. 2 views exemplification, exploratory talk and learner participation as practices that are interrelated. Since the three components are interrelated, a teacher may start with exemplification and identify the examples and tasks associated with them. The next step can be how she talked about the examples and tasks and used which language. The last step would be thinking about how learners will participate in terms of what she will invite learners to say and when, and how she will respond to those learner offers. Although not explicitly put, this pathway is the one that Adler and Ronda (2015) use in the MDI framework. The study also employs this strategy. As shown in the analytical framework, teacher practice is at the centre because it is the heart of the framework. Moreover, the three components; exemplification, exploratory talk and learner participation all work together to bring about the mathematics register.

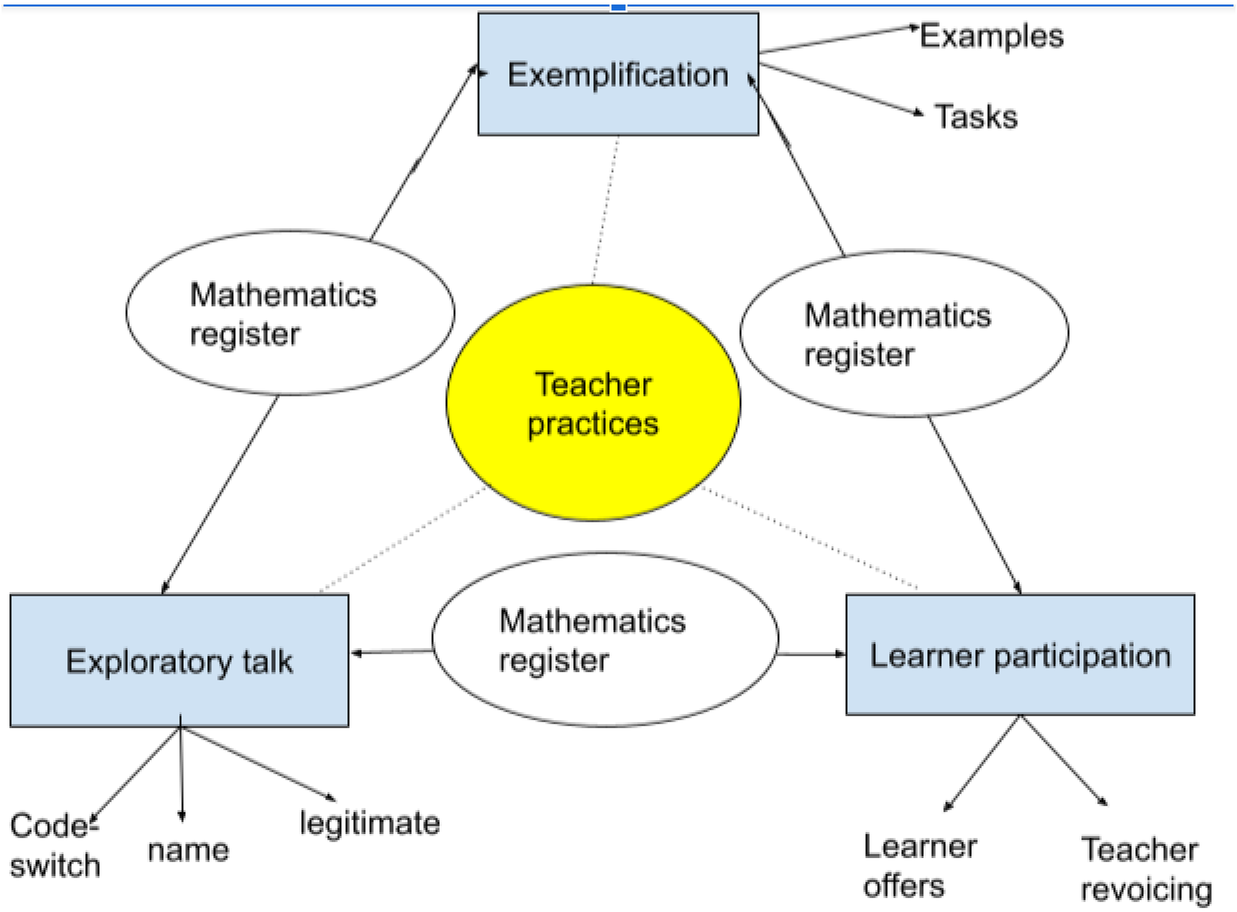


Figure 3: The analytical framework for the study

As presented in the analytical framework, it is essential to understand that I do not analyse these three components as separate but view them as interconnected thus analyse them as the teacher using them in relation to each other. In the first level, I identify the mathematics register and examples embedded in the lesson plans and as presented by the teacher. By first identifying the mathematics register, I was able to discern how the teacher mediates it. From there, I focused on the examples that the teacher chooses to use and the tasks accompanying them.

3.6 Ethical considerations

According to Punch (2005), ethical issues arise while undertaking human research. Because my research involves human data, it was necessary to consider any ethical issues that might develop over the course of the study. Despite the fact that this study relies on previously collected data, I sought and received ethical approval from the Wits School of Education Ethics Committee (protocol number 2021ECE101M). Furthermore, data was stored securely in a password-protected computer, ensuring secrecy and privacy throughout the process. To conceal the participants' identities as they appear in the detailed transcripts, pseudonyms were applied.

3.7 Limitations of data collection

The detrimental impact of the Covid-19 pandemic lockdown is one of the data collection process's drawbacks. I was unable to conduct customised teacher interviews to have an informed understanding of their practice choices. Although the secondary data contains lessons and interview transcripts, doing interviews with questions specifically designed for this study would have greatly enhanced my data.

3.8 Conclusion

In this chapter, I have engaged with the research approach employed for the purpose of this study. I began by describing the study's research design and data analysis. I wrapped up the chapter by discussing ethical issues and the constraints of the data collection procedure.

Chapter 4: Findings of the study

4.1 Introduction

The study focuses on teacher practices used to mediate the Sepedi mathematics register in South African multilingual classrooms. This chapter presents the findings and results from the data collected and analysed. To do this, I begin with the research question that informed the study and discuss the analysis questions. This section is followed by key findings that emerged from this study on the practices each teacher uses to mediate the mathematics register.

4.2 Research and analysis questions

This study is informed by the research and analysis questions presented in Table 5.

Research question	How do teacher practices mediate the SePedi mathematics register in Grade 1 and Grade 3 multilingual classrooms in South Africa?		
Category	**Exemplification (Examples and tasks)**	**Exploratory talk (word use and justifications)**	**Learner participation (doing and talking mathematics)**
Analysis questions	● What is the example set? ● What are the associated tasks? ● What is justified?	● What is said? ● In which language is it said? ● What is written on the board? ● In which way is it justified?	● What mathematical actions will learners engage in? ● What are learners invited to say? ● What are learners invited to write? ● How does the teacher respond to learners' offers?

Table 5: Analysis questions for the study (Adapted from Adler, 2021)

As discussed in Chapter 3, to analyse the data, I will use the analytical framework to describe three lessons: two from Grade 1 and one from Grade 3 all delivered in SePedi as the LoLT. I started analysing the data by identifying the intended object of learning. Although this is not the focus of my study, I acknowledge that all these teacher practices are based on the objective of the lesson. Moreover, identifying the object of learning made it possible to indicate the mathematics register associated with that object of learning. Interpreting the mathematics register as both vocabulary and ways of doing mathematics, I discuss each teacher's practices and how it illuminates the mathematics register. I end the chapter by merging the findings from all three teachers to form an overall discussion of what practices teachers used to mediate the SePedi mathematics register. Since the LoLT is SePedi, whenever the participants used English, I will write that in italics. Each excerpt presents the conversation between the teacher (T), learners in a choral mode (Lns) and an individual learner (L).

4.3 Dineo's practices

Dineo is a Grade 1 teacher. She introduced the lesson by stating the intended object of learning as "Doubling and Halving" and states that they will do doubling on that day and halving the following day. The mathematics register associated with the topic of doubling is presented in Table 6.

Topic: Addition doubles: 1 - 5	
Mathematics vocabulary	**Way of doing mathematics**
Double: Go pedifatša *Add*: Oketša *Plus*: Hlakantša *The same as*: Go swana le	Use concrete apparatus to double numbers up to 5

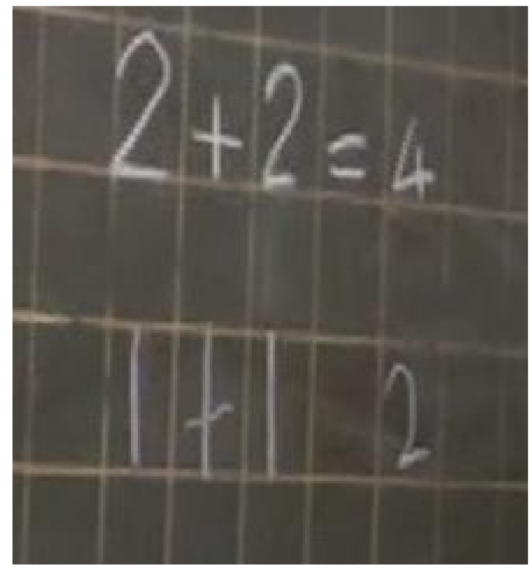
Twice: Gabedi *In between*: Magareng *Number bonds*: Go hlakantša di nomoro *Same number*: nomoro eswanang le	

Table 6: Dineo's mathematics register

The topic and mathematics vocabulary are identified from the lesson plans provided by the study materials. In the following sections, I focus on the three broad themes; exemplification, exploratory talk and learner participation to discuss how the teacher mediated the SePedi mathematics register associated with the topic of doubling.

4.3.1 Exemplification

Dineo used examples from the lesson plans and her own examples presented in Table 7. The first two examples are from the lesson plan and Examples 3 and 4 are examples the teacher chose. The last examples are learner-generated examples

<table>
<tr><th>Examples codes</th><th>Tasks</th><th>Codes</th><th>Board work</th></tr>
<tr><td>N/A</td><td>A. Na kere retlo bereka ga go pedifatša, retlo dera eng? (When we say we will work with doubling, what are we going to do?)</td><td>Task: K</td><td></td></tr>
<tr><td>Examples from the lesson plan
1. 2 + 2 = 4
2. 1+ 1 = 2</td><td>1. Ditsebe tse bedi, le bedi. Ke ditsebe tsekai gamoka? (How many ears are altogether if there are two sets of two ears?)
2. Sena le tee le tee, ke bo kae kamoka? (We have one and one, how many are there altogether?)</td><td>Examples
S, C
Tasks: K</td><td rowspan="2">

Two examples were written on the board. These were written by learners.</td></tr>
<tr><td>Teacher generated examples
3. 5+5 =10
4. 10+10 =</td><td>3. Kamoka ekopane mingwana ya gao emi kae? (How many fingers do you have altogether?)
4. Kenale sumi ke hlakantša le shome, kena le mingwana e kae? (It</td><td>Example
S, C
Tasks: K</td></tr>
</table>

20	is ten plus ten, how many fingers is that?)		
Learner generated examples 5. 3+3=6 6. 4+4=8	5. Dira mohlari obala gabedi (Provide an example of doubling)	Example: **S, C** Task: **A**	

Table 7: Dineo’s Example space

Dineo's examples brought generality through Similarity and Contrast, there was no fusion present in the classroom.

- All six examples can be coded as Similar (S) because they all focus on doubling/addition.
- The examples are Similar (S) in structure with all of them taking the format of a number added to itself that is equal to a different number (a+a=b). The structure draws attention to the critical features of doubling such as it must be the same number added.
- Examples 3 and 4 are Similar (S) in that the sum is a 2-digit number.
- Examples 1 to 4 are Similar (S) because of the way they were mediated with body parts. Example 1 was mediated with two ears per learner, Example 2, one body per learner. Example 3 and 4 are Similar (S) because they were mediated by using fingers, 5 fingers in each hand for Example 3, and 10 fingers per learner in Example 4.
- Examples 5 and 6 Contrasts (C) with Examples 1- 4 because they are mediated through the use of cubes.
- Example 4 Contrasts (C) all the other examples because it is doubling a 2-digit number.

Dineo's tasks are limited to state facts (K) with the exception of the task that required learners to generate their own example which is coded as Applying known skills (A).

- Task A requires learners to state a known fact of what it means to double. It is thus coded as carrying out known procedure or stating fact **(K)**
- Tasks 1 - 4 request learners to carry out a known procedure **(K)** of adding the same number twice or doubling.
- Tasks 3 and 4 can be coded as stating a known fact **(K)** because of the way they were mediated. For example, Task 3, "Kamoka ekopane mingwana ya gao emi

kae? (How many fingers do you have altogether?)" requires learners to state a known fact of how many fingers they have.

- Tasks 1- 4 have Similar **(S)** examples which were mediated using body parts
- Task 5 is coded as applying known skills **(A)** because learners are required to create their own examples based on what they have learnt about doubling. This led to learner-generated examples as seen in Example 5 and 6. Moreover, this task can be viewed as applying knowledge **(A)** because learners need to create different examples from the ones already discussed in the classroom and use a different way to mediate these examples. The learners used counters to explain their examples instead of the body parts seen in Examples 1-4.

4.3.2 Exploratory talk

In the section on exploratory talk, I discuss how Dineo's examples and tasks were named and legitimated, hence how they mediated the SePedi mathematics register. Here, I also focus on how the exploratory talk brought about the critical features of the examples provided. To do this, I present a transcription as presented in Excerpt 1 on how the teacher used the examples from the lesson plans to mediate the SePedi mathematics register.

Excerpt 1

1. T: Re tsena mo thutong ya rona, mo thutong ya rona retlo bereka ga go pedifatša. Retlo beraka ka eng bana baka? (Now we are going to start with our lesson. In today's lesson we are going to Double. What are we going to do, my children?)
2. Lns: Go pedifatša (To double)
3. T: Retlo etsang? (What are we going to do?)
4. Lns: (Go pedifatša) To double
5. T: Na kere retlo bereka ga go pedifatša, retlo dera eng? (Someone explain to me what we are going to do when we double. Raise your hand and tell us what it means to double. Yes [pointing at a learner to answer]).
6. L: Go bala ga bedi (To count twice)
7. T: Go bala nomoro ga bedi ga bedi (To count twice. It's to count a number twice). [She chooses one learner (L1) to come up and points at his ears].
   Motho o, unale tsebe tse kai? (How many ears does he have?)
8. Lns: Tse pedi (Two)
9. T: Utsiba bjang? Oh o tseba gore ke motho? How did you know? Why did you not count one, two [pointing at learners' ears. Learners do not answer] Oh so you know just because he is human.
10. Lns: *Yes teacher*
11. T: [Calls on a different learner. First learner is still there]. Motho o unale tsebe tse kae? (How many ears does L2 have?)
12. Lns: Tse Pedi (Two)
13. T: Kenyaka kuba bega gausi le gausi, gore pedi, retloi bala ga bedi. Tsebe tse pedi, tsebe tse pedi, pedi reibala ga bedi. Wabona gori bari wapedifatša. (I want them [L1 and L2] to stand next to each other. When we have these ears together, two ears and two ears, we will count two ears twice. L1 has two ears, L2 has two ears. Do you see that we double?) Akere ubala ka kai. Ga bedi ga bedi. Ditsebe tse bedi, le bedi. Ke ditsebe tsekai gamoka? (How many times will we count? We are counting two twice. You see that you are doubling. So now when we have two sets of two ears, how many ears is that in total? [She points to a learner])
14. L: Nne (Four)
15. T: *Very good*. Are ye kamoka (Let us all say it together).
16. Lns: Ke nne (It is four)
17. T: They have four ears when they are two but if it's just one person it's two ears. Can someone come and write this on the board? Raise your hands. [She chooses one learner]. We want to see how you are going to write doubling two on the board.
18. L: [writes 4 on the board]
19. T: You are writing the answer, we want the equation first. [She erases the four]. (Renyaka go bona pedi Hlakantša le pedi e gofa) We want to see two plus two is equal.
20. L: [Writes 2 + 2 = 4]

21. T: Talk to us
22. L: Pedi hlakantša le pedi e gofa nne (Two plus two is equal to four).
23. T: Yes, we have our first two [pointing at L1's ears]. How many times do we count it? Twice, here it is [pointing at L2's ears] and this is equal to four. Do we understand?
24. Lns: *Yes teacher*
25. T: You can go and sit down [Chooses two different learners; L3 and L4]. Since we have bodies, we are going to use our bodies to learn. How many learners are at the front?
26. Lns: Babedi. (There are two.)
27. T: Babedi, if L3 ali fela botlo reng? (They are two. If L3 was alone would you say?)
28. Lns: Tee (One)
29. T: You will say one. [Brings learners close to each other]. Sena le tee le tee, ke bo kae kamoka? (So now we have one and one.) How many are they?
30. Lns: Ba bedi (two)
31. T: Re tlori ba bedi. Tee, pedi. If re bala tee ka bedi, re tlo tola pedi. Tee Hlakantša le tee, e gofa, pedi (Then we say they are two. We say one, two. So then when we count one twice, we get two. One plus one is two.) L3 write it for us so we can see it. L3:[writes 1+1=2]
32. T: Eh, re bala nomoro ga bedi, ka SePedi goa pedifatša, ka se goa *it is to double the number* (Yes, we count it twice, in Sepedi it's go pedifatša , in English you double the number. What do you do?
33. Lns: *You double the number*
34. T: Yes, say it again in English
35. Lns: *You double the numbe*r

Excerpt 1 shows how Dineo uses mathematical language to name objects. She starts the lesson by introducing the object of learning to the class as "go pedifatša" which means to double (line 1). Her naming can be coded as Mathematical **(Ma)** because she uses the correct mathematical language. Stating the object of learning is beneficial because as Adler (2021, p79) states, "it points intentionally to the mathematics that needs to be mediated" hence allows learners to know what they need to learn and understand during that lesson. She encourages learners to know how to pronounce the mathematics language "go pedifatša" by making them repeat after her. The teacher provides the first task as defining doubling "Na kere retlo bereka ga go pedifatša, retlo dera eng?" which translates "Someone explain to me what we are going to do when we double) as depicted in lines 5 - 6. This task of defining doubling can be coded as carrying out known procedures and stating facts **(K)** because learners need to define doubling without applying skills or connecting any concepts. Her practice is coded as legitimating using mathematical criteria that is full general **(GF)** because she is using a definition which brings attention to generality. Starting the lesson with defining as a practice is in line with the findings from Essien (2012) where a teacher educator from one university started the lesson by defining terms. Here, the teacher educator defined concepts verbally, wrote them on the board then read them out to learners. Although Essien (2012) points out that the teacher educator provided formal definitions without the input of learners, Dineo values learner input since she asks learners to define terms. Allowing learners to define *go pedifatša* (doubling) is advantageous because it ensures that learners do not solely depend on the teacher for knowledge and that their voices are not silenced. As learners define terms, they exercise their agency and develop their identity in mathematics as part of the mathematics community (Gardee & Brodie, 2019). Having agency in mathematics allows learners to understand the mathematics register of "go pedifatša" for themselves since they are seen as active participants of the mathematics community.

Dineo mediated the mathematics register by using Similar **(S)** examples (Examples 1 to 4) which were all illustrated with body parts. Here, Dineo first uses colloquial/non-mathematical language **(NM)** to name objects, by emphasising that learners use their everyday knowledge of body parts to double (line 25). This makes her legitimating criteria everyday **(E)** and positional **(P)** because she is basing her explanation of doubling two on the "fact" that "motho o nale tsebe tse pedi" humans have two ears (line 9) or because the learners are human then they have five fingers on each side of the hands. Dineo is using common instances to help students better understand scientific ideas, rather than teaching about these events in and of themselves (Sikoyo & Jacklin, 2009). This requires learners to view everyday concepts of body parts as an object to be studied rather than an environment to be experienced (Charlot, 2009) because instead of viewing fingers as how they experience them e.g using them to eat or type on a computer, learners need to view fingers as objects to be counted. Here, the teacher is using everyday concepts of body parts to explain the mathematical concept of doubling.

Dineo uses code-switching to translate the word "double" to English and this is the only time she code-switched to English (line 32-35). Her code-switching is Code-switching Mathematically **(CM)** because it allows learners to know the mathematical register of doubling in both SePedi and English. She then revoiced by repeating then allowed all learners to say double in English, “You double the number” which can be coded as Revoicing Repeat **(RR).** According to Setati (2005) and Clarkson (2016), code-switching without access to the mathematics register reinforces contextual disadvantages by limiting learners' access to higher status versions of the LoLT or the mathematics register. By Dineo using the correct mathematics language when she code-switches, she enables learners to have access to the mathematics register. This is a good practice as pointed out by Essien (2010) that engaging learners using the different languages present in the class has the potential of enabling epistemic access.

Although the teacher used positional and visual cues to explain the concept of doubling and how to double, she then moved to the mathematical. This can be seen with Example 2 in line 33 where she moved to Full General Mathematics **(GF)** legitimating that “Tee Hlakantša le tee, e gofa, pedi” translated as “One plus one is equal to two”. Dineo used Full General mathematics **(GF)** because “Tee Hlakantša le tee, e gofa, pedi” is context-independent. Dineo allowed a learner to write that example on the board. Allowing learners to write mathematically shows that learners make sense as they write simple expressions and allows them to explain the reasoning accompanying what they write (Lampen & Brodie, 2020). This is seen in lines 20 - 22 where the learner wrote 2+2= 4 (presented in Table 7 board work). The learner is able to write mathematically by using the correct mathematical symbols + and =, and numbers 2 and 4. Moreover, the learner is able to speak using the correct mathematics register in line 22, “Pedi hlakantša le pedi e gofa nne” which means “Two plus two is equal to four”. Dineo encourages learners to speak and write mathematically (in line 21) where she encourages the learner to speak and explain what the knowledge that is context-independent and based on generalisation is powerful knowledge (Young & Muller, 2013) and allows learners access to the specialised mathematics register.

4.3.3 Learner participation

Dineo revoices the learner's offer of the meaning of doubling in line 5-7 in Excerpt 1. Since she repeated what the learner said, her revoicing is coded as Revoicing Repeat **(RR)**. Revoicing by repeating an utterance is crucial because it allows the teacher to capitalise on learners' contributions for overall class engagement (Essien, 2013), giving an utterance an extra chance to be heard and giving listeners more time to reflect on its meaning (Forman & Ansell, 2002). Dineo mediated the SePedi mathematics register by Revoicing Repeating **(RR)** the definition of doubling as "Go bala nomoro ga bedi ga bedi" (To count a number twice). This definition enables learners to understand the mathematics language of doubling and how to do it in a specific mathematical way (bala ga bedi - count twice).

Providing tasks that allow learners to speak mathematically is another way that Dineo mediates the SePedi mathematics register. The learners are active participants and they are invited to engage with mathematical ideas beyond validating yes or no to the teacher's questions. Learner participation can mainly be coded as using Phrases and Sentences **(P/S).** These phrases included definitions (in line 5-6 as discussed above) and numbers such as "tee" "pedi" "nne" (one, two, four respectively) as indicated in line 8, 12, 14, 26, 30 and 32. Learners were also given an opportunity to explain in line 22, "Pedi hlakantša le pedi e gofa nne" (Two plus two is equal to four). This is the first example Dineo used from the lesson plans. Here, the teacher first mediated the mathematics register by providing cues for what the learner should say as seen in line 19, "Renyaka go bona pedi hlakantša le pedi e gofa" (We want to see two plus two is equal to) hence making her naming mathematical **(Ma).** This encourages learners to speak and write mathematically and acquire more Cognitive Academic Language Proficiency (CALP) than Basic Interpersonal Communicative Skills (BICS). CALP refers to learners' ability to understand and express, in both oral and written modes, concepts and ideas that are relevant to mathematics while BICS refers to conversational fluency in a language (Robertson & Graven, 2018). Since Dineo used the language relevant to mathematics such as; "Hlakantša" which means plus and "e gofa" which means is equal to, she enabled the learner to also speak mathematically. Therefore, Dineo mediates the SePedi mathematics register by modelling the use of the correct mathematical language.

The summary of Dineo's practices is presented in Table 8.

Exemplification		**Exploratory talk**			**Learner participation**	
Examples	Tasks	Name	Legitimate	Code-switch	Learner offers	Teacher Revoice
Similarity **(S)** Contrast **(C)**	Known procedure and facts **(K)** Apply known facts **(A)**	Non-Mathematical **(NM)** Mathematical **(Ma)**	Non-Mathematical **(NM)**, Everyday **(E)**, Positional **(P)** Mathematical Full General **(GF)**	Code-switching Everyday **(CE)**	Yes/No **(Y/N)** Phrase/ sentence **(P/S)**	Revoice Repeat **(RR)**

Table 8: Summary of Dineo's practices

Dineo's practices included the use of Similar **(S)** examples in structure, focusing on doubling and being mediated through body parts allowed learners to see generality in understanding the concept of "*go pedifatša" (doubling).* Her example space also included examples that bring Contrast **(C)** in terms of the way they were mediated. Her dominant task practice was providing tasks that required learners to state a known fact or carry out a known procedure **(K)** with only one task that required learners to apply known skills **(A)**. The way Dineo structured the task increased learner participation in the classroom which included Yes/No **(Y/N)** and more structured mathematical responses which included phrases and sentences **(P/S)** hence she had multiple opportunities to revoice by repeating **(RR)** learner offers for the whole class. Dineo's exploratory talk moved from Non-mathematical **(NM)** statements to Mathematical **(Ma)** where she uses the correct mathematics words, symbols and explanations. All these practices worked together to mediate the SePedi mathematics register associated with doubling because she used examples that offer generalisation, used the correct mathematical language to name and legitimate and allowed learners to also participate using the SePedi mathematics register.

In the next section, I will discuss Bongwe's practices.

4.4 Bongwe's practices

Bongwe is a Grade 1 teacher. She introduced the lesson by announcing "Today we are going to do counting", in Sepedi. The mathematics register associated with the topic of counting is represented in Table 9. This is in line with the object of learning in the lesson plan which is "Counting on and back - Addition and Subtraction".

Object of learning: Counting on and back - Addition and subtraction up to 5	
Mathematics vocabulary	Way of doing mathematics
Take away ntša *More than:* go feta *Less than:* bonyane go *How many:* bokae *Altogether:* kamoka *Left:* go shetše	● Identify number bonds 1-5 ● Solve and explain solutions to practical problems involving equal sharing and grouping ● Add and subtract up to 5 using concrete apparatus, number lines and pictures

Counting on: balela pele *Counting back:* balela morago *Add:* Oketša *Subtract:* fokotša *The same as:* go tswanang le	

Table 9: Bongwe's mathematics register

In the next section, I engage with Bongwe's exemplification, exploratory talk and learner participation and they mediate the mathematics register.

4.4.1 Exemplification

Teacher Bongwe's topic and mathematics are identified from the lesson plans. The first two examples she presented are from the lesson plans and the last example is a teacher-generated example as presented in Table 10.

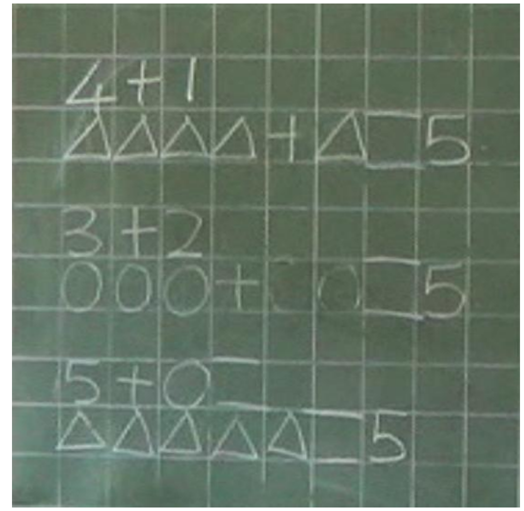
Examples codes	Tasks	Codes	Board work
From the lesson plans: 1. 4+1= 5 2. 3+2= 5 Teacher-generated 3. 5+0 = 5	Mare dira hlanu, re tlo hlakanya eng le eng? (Which two numbers can we add together to make 5?)	Examples **S, C** Tasks **K,A**	
The teacher used different strategies to show two numbers that are added together to make five. These include the use of fingers, shapes, counters and an abacus.			

Table 10: Bongwe’s example space

All three examples are Similar (S) in that they all focus on addition and they add to the sum of 5 and are all mediated through shapes and objects such as fingers, the abacus and cubes.

- All three examples are similar in structure, they have the structure a + b = 5.
- Examples 1 and 3 contrast with Example 2 contrast because the teacher used triangles to draw as opposed to the circles for Example 2.

There was only one task in Bongwe's classroom (Mare dira hlanu, re tlo hlakanya eng le eng? Which two numbers can we add together to make 5?). This would require Grade 1 learners to apply known skills of addition and subtraction to answer the task. I thus code this as applying **(A)** known skills or deciding on a procedure to use. This was the only task throughout the lesson, with Bongwe using different artefacts such as an abacus, counters and shapes to discuss the examples. Bongwe could have extended the tasks to allow learners to use the different artefacts. For example, since she had already provided examples on the board and used fingers and shapes to illustrate them, she could have allowed a learner to demonstrate 3 + 2 = 5 using counters, but instead she did all the tasks herself. That's the same line with the finding from Adler and Ronda (2015) where the teacher, Ms X, did all the tasks herself. This would have elevated her tasks to enable learners to use multiple representations which is at a higher level than applying knowledge (Adler & Ronda, 2015; 2017). Moreover, although Bongwe's task is coded as applying knowledge **(A),** she answers all the tasks and provides all examples herself. This reduces the cognitive demand of the task and Adler and Ronda (2015; 2017) state that some tasks are set up at applying known skills but then reduced to carrying out known procedures when the teacher unfolds it. This can thus constrain learners' understanding of the mathematics register and keep learner participation at Yes/No **(Y/N)** which was a dominant practice in Bongwe's lesson.The lesson starts with Bongwe presenting a counter with a number written on it and asks learners to identify the number. Learners choral respond, "one". She then presents a different number while learners respond "two", "three", "four" and the last number is "five". Next Bongwe uses the abacus as learners continue in the class choral count one to five. The use of fingers, counters and abacus is important and as Venkat and Askew (2018) state, can be seen as key mediating tools in teaching primary mathematics. Choral counting in the Foundation Phase is seen as a resource because it provides a range of opportunities for learners to engage in reasoning in ways that make sense to them (Turrou et al., 2017). By Bongwe starting the lesson with this counting activity, it makes learners understand the number 5 and the mathematics register associated with it.

4.4.2 Exploratory talk

In the next section, I use Excerpt 2 to discuss how Bongwe named and legitimised the examples to mediate the mathematics register.

<u>Excerpt 2</u>

1. T: Ke mang okang butsa mare dira hlanu, re tlo hlakanya eng le eng? Re tlori nee hlakantsa le tee, akere? (Who can tell me, what two numbers make up the number five when added together? [No one responds]. We can say four plus one gives you five right? [Demonstrates to learners four fingers on her right hand one finger on her left hand.])
2. Lns: *Yes*
3. T: Mare dira hlanu, re tlo hlakanya eng le eng? Re bolela ka hlanu akere. (What other two numbers can you tell me that when added together will give you the number five? We are talking about the number five right? [Showing five fingers with her hands])
4. Lns: *Yes*
5. T: Re nale nne hlakantsa le tee, akere? Kego bodishe gore reberekisha dilo. (We've got four plus one right [*Teacher writes on the chalkboard 4+1*] I told you that we are going to use things when we are counting? [She draws four + one triangles (see board work in Table 8) As she counts one to four plus one.])
6. Lns: *Yes*
7. T: Retlo bala kamoka. (We are all going to count together)
8. T and Lns: Tee, Pedi, Taru, nne hlakantsa le tee e gofa hlanu. (One, two, three, Four plus one is equal to Five. [*Bongwe, pointing at the triangles as they count].)*
9. T: Are bale gape.(Let's count again.)
10. Lns: Tee, Pedi, Taru, nne hlakantsa le tee e gofa hlanu. (One, two, three, four plus one is equal to five.)

11. T: Ke hlanu akere? Tee, Pedi, Taru hlakantsa le tee, pedi. (The answer is five right? [*Teacher writes the answer 5 on the board*.] Let us look at other numbers that give you five right? Three plus two. Let us count together, One, two, three plus One, two [Bongwe and Lns chant together as Bongwe points to the circles on the board] Let us count them again [They repeat].)
    Re kari hlanu le lefêla. (We can say Five plus zero right? [Bongwe writes five+xero on the board then draws five triangles].)
12. Lns: *Yes*
13. T and Lns: Tee, Pedi, Taru, nne, hlanu. (One, two, three, Four, Five [Bongwe and lns chant together].)
14. Lns: *Yes*
15. T: Lefêla ke tshe kai? (How many numbers are zero?)
16. Lns: Five
17. T: Lefêla ke tshe kai? (How many numbers are zero?)
18. Lns:Lefêla? (Nothing.)
19. T: Leféla gora gori a gona sello. Ke ngwarile te kai, tše hlanu? (Zero means there is nothing. Five plus zero gives us Five. You see, I drew Five triangles. That would mean zero has no value. Therefore our answer will be five. [pointing at the sum on the board])

Bongwe uses non-mathematical **(NM)** language to name objects. In Excerpt 2, line 5, she refers to shapes as “dilo-things” instead of the correct SePedi register *sebopego* which means shapes. She is using an ambiguous word “dilo-things” which might also mean she was including the other artefacts she used later in the lesson such as the abacus and counters. Therefore, the ambiguous statement “Kego bodishe gore reberekisha dilo. I told you we are going to use things” constraints learners’ understanding of the correct mathematics language.

Bongwe’s dominant naming can be coded as Mathematical **(Ma)** because throughout the lesson, she used mathematical language appropriately. She named numbers mathematically and used mathematical terms and symbols such as ″Oketša*, Hlakantša,* fokotša, add, plus, subtract” to explain procedures. She also writes mathematically on the board (see board work in Table 8) using the mathematical symbols and shapes. To legitimate, she uses Mathematical criteria, Full General **(GF)** because she is not basing her explanations on context-based object (shapes) instead she uses the artifacts as a way to demonstrate her general statements as she explains two sets of numbers that add to five (Lines 1, 8 and 11). Bongwe's practice of using the correct mathematical language allows learners to have access to advanced forms of mathematics hence enabling them to understand the mathematics register (Clarkson, 2016).

Bongwe uses SePedi throughout the lesson with very limited code-switching in her lesson: the use of English only coming from the learners chanting, “Yes”. Her code-switching is thus coded as Code-switching Everyday **(CE)** because they used everyday language when code-switching. One explanation for the limited use of code-switching can be found in the interview transcript with Bongwe where she said, “I am hundred percent Pedi" hence she is comfortable with teaching in Sepedi. Bongwe, however, acknowledges that the mathematics register is challenging to translate to Sepedi since the lesson plans are written in English. This challenge was also experienced by teachers from Van Laren and Goba (2013) with the isiZulu mathematics register, Chikiwa and Schäfer (2017) with the Xhosa mathematics register and Mpalami (2022) with Sepedi, IsiZulu, Xhosa and Sotho mathematics register. The mathematics register may be associated with English, translating lesson plans and mathematics materials from English to SePedi is difficult. The mathematics register is frequently connected with a prominent language such as English (Barwell, 2016) since it is considered as a set manner of communicating and writing mathematics (Setati, 2008).

4.4.3 Learner participation

Bongwe's learner participation can mainly be coded as Yes/No **(Y/N)** because she offered opportunities for learners to answer Yes/No questions as seen in lines 2, 4, 6, 12 and 14. In Line 3 where Bongwe presents the final task as “Re bolela ka hlanu, akere?-

We are talking about the number five right?" where she asked learners to identify two numbers that add to five and when no one responds, she funnels by asking them if they know that she is talking about the number 5. Although Bongwe's task of "Which two numbers add to five?" can be coded as applying known skills **(A)**, she answers all the questions herself. By answering the task herself and only requiring the learners to answer simple questions, she is funnelling. Herbel-Eisenmann and Breyfogle (2005) state that funelling is when a teacher asks questions that lead to a desired answer.

Bongwe's funnelling strategy reduces the cognitive demand of the task (Brodie, 2008) and leaves the learners' participation to simple Yes/No **(Y/N)** responses. This can be viewed as right answerism because Bongwe asks closed questions thus limiting learners' ability to voice their thoughts (Robertson & Graven, 2018). On the other hand, Bongwe's funnelling can be positive in that it increases learner participation (Makonye & Khanyile, 2015) because as the learners offer Yes/No **(Y/N)** answers, they all participate in a choral response. Encouraging learner participation allows them to be part of the mathematics community thus helps them understand the mathematics register.

As the lesson progresses, Bongwe invites learners to state phrases and sentences **(P/S)** by counting and speaking mathematically through a choral class chant. In line 7 and 9, she encourages learners to count with her "Retlo bala kamoka. (We are all going to count together)" hence allowing them to use the mathematics register to participate. Learners used the correct mathematics register by offering "Tee, pedi, taru, nne hlakantsa le tee e gofa hlanu (One, two, three, four plus one is equal to five)". Learners following the teacher's modelling is in line with the findings from Venkat and Askew (2012, 2018) where learners watch how the teacher acts and talks mathematically then they use the appropriate actions and language for themselves as modelled by the teacher. Therefore, by Bongwe inviting learners to participate by offering phrases mediated the SePedi mathematics register.

Bongwe revoices learners' meaning of zero and explains it using visuals drawn on the board. This can be coded as Revocing Mathematical **(RR)** as she repeated what the learner said by expanding on it using the correct mathematical register. This is in line 20 where she expands that zero means there is nothing and uses the triangles she drew on the board to explain that 5 added to zero (nothing) is equal to five. (Line 20: Leféla gora gori a gona sello. Ke ngwarile te kai, tše hlanu fela? [Zero means there is nothing. Five plus zero gives us Five. You see, I drew five triangles only. [Pointing at the sum on the board]). This practice allows learners to understand the special mathematics language of zero.

The summary of Bongwe's practices is presented in Table 11.

Exemplification		**Exploratory talk**			**Learner participation**	
Examples	Tasks	Name	Legitimate	Code-switch	Learner offers	Teacher Revoice
Similarity **(S)** Contrast **(C)**	Known procedure and facts **(K)**	Non-Mathematical **(NM)** Mathematical **(Ma)**	Non-Mathematical **(NM)**, Mathematical Full General **(GF)**	Code-switching Everyday **(CE)**	Yes/No **(Y/N)** Phrase/ sentence **(P/S)**	Revoice Mathematical **(RM)**

Table 11: Summary of Bongwe's practices

Bongwe's practices included the use of Similar **(S)** and Contrast **(S)** examples to bring generality by focusing on the number bonds of 5 and being mediated through artefacts. Her dominant task practice was carrying out known procedures **(K)** with learners' participation limited to Yes/No **(Y/N)** and stating phrases/sentences **(P/S)** through choral counting. She also incorporated learner offers and revoiced them using the appropriate mathematics register **(RM).** Bongwe also mediated the Sepedi mathematics register through modelling the use of the appropriate mathematics **(Ma)** language when naming and legitimating objects and procedures.

In section 4.5, I discuss Natasha's practices.

4.5 Natasha's Practices

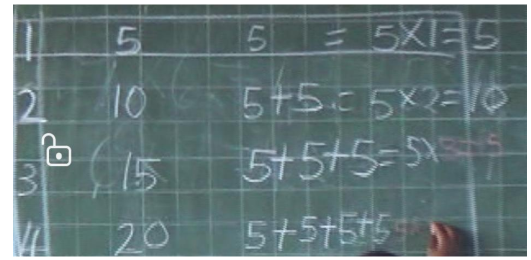
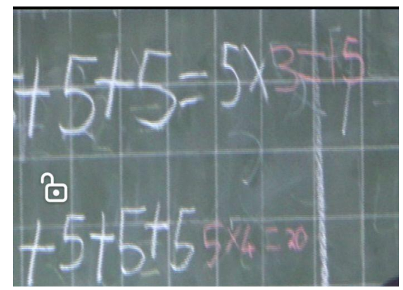
Natasha is a Grade 3 teacher. The object of learning in her classrooms was repeated addition and multiplication. The mathematics register linked with the object of learning is represented in Table 12.

Topic: Fives (equivalent groups) and repeated addition	
Mathematics vocabulary	Way of doing mathematics
Add: Oketša *Repeated addition*: Oketša ganti *Groups*: setlĥopha *Fives*:bbo hlanu *Multiply*: ntifatša	Solve repeated addition problems up to 50 using 5s. Multiply numbers 1 to 10 by 5 Use appropriate mathematics symbols (X, =, +)

Table 12: Natasha's mathematics register

4.5.1 Exemplification

Natasha presented examples as per the lesson plan. Her example space is presented in Table 13 below.

Examples	Tasks	Codes	Board work
1. $5 = 5X1 = 5$ 2. $5 + 5 = 5X2 = 10$ 3. $5 + 5 + 5 = 5X3 = 15$ 4. $5 + 5 + 5 + 5 = 5X4 = 20$	For each example, these were the tasks presented by the teacher. 1. How many sticks are there altogether? 2. How many groups? 3. How many in each group? 4. How can we write this as an addition number sentence? 5. How can we write it as a multiplication number sentence?	Examples **S, C, F** Tasks **K, A, C/PS**	 

1 child	5	1 group of 5	1 x 5 = 5
2 children	5 + 5 = 10	2 groups of 5	2 x 5 = 10
3 children	5 + 5 + 5 = 15	3 groups of 5	3 x 5 = 15
4 children	5 + 5 + 5 + 5 = 20	4 groups of 5	4 x 5 = 20

The teacher used these examples as presented in the lesson plan.

Table 13: Natasha's example space

Natasha's examples included all three patterns of variation; similarity (S), contrast (C) and Fusion (F).

- Natasha's examples are similar **(S)** because they all focus on multiplication as repeated addition. The structure of the examples is also similar (S) thus brings about the critical features of repeated addition and multiplication. The structure starts with the number of 5s as repeated addition, then 5 multiplied by the number of learners/groups then the answer or total number of sticks. The examples progress from simple to more complex with one 5 to four 5s.
- Since the examples bring about addition and multiplication, they can be coded as fusion (F). As stated above, the examples are similar (S) because of how they are structured. For instance, Example 2 and 3, start with repeated addition 5 + 5 = 10 and 5 + 5+ 5 = 15 respectively. This brings about the critical features of addition and allows for generality in terms of the structure of repeated addition. Simultaneously, these examples contrast (C) each other. This is because they are then presented as multiplication where 2 X 5 = 10 and 3 X 5 = 15. Therefore, these examples also bring Fusion (F) because they simultaneously involve several critical aspects in the same example space (Olteanu, 2018).

Natasha's tasks vary from carrying out known procedures to applying known skills to making connections.

- The first two tasks can be coded as carrying out a known procedure (K) of counting the number of sticks and groups.
- Task 3 is applying knowledge (A) where learners are required to apply the knowledge from Task 1 and 2 of how many sticks and groups (learners). The learners need to apply this knowledge to repeatedly add or to multiply to find the number of sticks altogether.
- Task 4 and 5 are coded as making multiple connections (C/PS) between repeated addition and multiplication.

These tasks link to each other and move from simple to complex while building on each other. Wilkinson (2019) states that teachers should design tasks that offer learning activities because they encourage the use of the mathematics register. In the next section on exploratory talk, I discuss how Natasha used the examples and tasks to mediate the SePedi mathematics register.

4.5.2 Exploratory talk

In this section, I will discuss how Natasha mediates the mathematics register through code-switching, naming and legitimating. In Excerpt 3, I present the transcription to best understand the talk in Natasha's class.

<u>Excerpt 3</u>

1. T: Agotle ngwana o-*one* otswere di-*sticks* tse *five.* Dibale badibone. (Can one learner carrying five sticks come. [L1 goes to the front]. Count them so they can see.)
2. Lns: *One, two, three, four, five* [Counting the sticks and raising each one as she counts]
3. T: Uyi kae, uyi-*one*. Obadile di-sticks tse *five*. Tse dikae (She is one and she counted five sticks. [she draws a table on the board and writes 1 and 5 next to it (see Table 11 for board work). How many?)
4. Lns: *Five*
5. T: Five areke. Ago tle o mongwe o tshwere five. De bale. (Five right. Someone else who is carrying five sticks should come. Count your sticks. [L2 goes to the board]).
6. L2: *One, two, three, four, five* [Counting the sticks and raising each one as she counts]
7. T: Obadile tse *five.* Sentshe bale kae, two. Babadile di-sticks tshedi kae, ebela bai *two so?* (She counted five sticks. How many sticks did they count since they are two?)
8. L: *Ten*
9. T: Gale one, ubalile tse five, ga bale two, babadile tshe 10. Gabale three? Gabali e-three, wa boe three yitla pele. Utla le de-sticks udi bale (When there is only one learner, she counts five sticks and if they are two, they count ten. [She writes 2 and 10 on the board]. When they are three [writes three on the board]. Third person comes with your sticks to count.)
10. L3: [comes up to the board] *One, two, three, four, five* [Counting the sticks and raising each one as she counts]
11. T: Obadile tse kae? How many did she count?
12. Lns: *five*

13. T: Tsei-five, bona bae three so de-sticks tse kae? (Five. There are three so how many sticks do they have?)

14. L: *Fifteen*

15. T: *FIfteen*. So retlo lebela huri okay, mo obalile tshei 5. Mo ten go yetshitswe keng, ke 5 plus five. Mo fifteen go yetshitswe di-five tse kae? Reka reng? Ke tloba *le mmh plus mmh plus mmh*. (Fifteen. So we see that here we have five [Writing 5], Here ten sticks are made from five plus five [writes 5 +5]. So then fifteen is made up of how many fives?. It is going to be mmh plus mmh plus mmh. Let us hear it from L8)

16. L8: five plus five plus five

17. T: Say it again, louder this time.

18. L8: five plus five plus five

19. T: Five plus five plus five [writes on the board 5+5+5]. Le ae bona? (Do you understand?)

20. Lns: Yes ma'am

21. T: Aretse four. Tla kapila. (Let us do four. [she writes four on the board]. Come quickly L9)

22. L9: [comes up to the board] One, two, three, four, five [Counting the sticks and raising each one as she counts]

23. T: ke tsekae. (How many are there?)

24. Lns: five

25. T: Ke tse *five, and* bona bae *four*. Ke *five plus five plus five plus five. Plus five engwe?* (There are four learners so it's five plus five plus five plus five [writes five+five+five+five]. Plus another five?)

26. Lns: *No teacher*

27. T: Defeditshe. Why keka kentshe five engwe? (Are they done? Why should I not write another five?)

28. Lns: Ka bane bai four. (Because there are four.)

29. T: Ka bane bai four. (Because there are four). So what will the answer be?

30. Lns: Twenty

31. T: Twenty. Nia bona five eh, eh uska nyaki go ngwala le five ei one utlori 5 kamotho oi one ke 5 (So here if you like you can say five times one person is equals to five [write 5 X 1=5]) Mo ketlori five kabatho bababedi ke? (five times two people is equal to?) [writes 5 X 2=10]

32. L: ten

33. T: Kemang o tlong direla eh kebone, kei ngwala bjang if keka nyaki ibe yi plus, kenyaka ka times? He kesa nyaki gori five plus five kere five times two. I ngifa yona answer eh. Kemang o katla. (Who is going to do the next one for me? If I do not want to write it as plus, I want to write it as times. How should I write it? You see, if I do not want to say five+ five, I say five times two and it still gives me the answer ten. How can we do this one [pointing at [five+five+five].)

34. L: [writes 5 X 5 X 5]

35. T: Keyona? (Is it correct?)

36. Lns: No

37. T: Kemang o katla. Who can come and do it correctly? [Teacher erases 5 X 5 X 5], another learner writes 3 to make 5 X3]

38. Etlo bang *answer*? (What is the answer going to be?)

39. L: [writes fifteen]

40. T: *Very good.* Are mshapeleng matsogo. (Clap hands for her). Someone else must come to do the last one.

41. L: One, two, three, four [counts the number fives then writes five X four=. He then moves to the times table and uses it to count five times four.] One, two three four [Points at the five times table, five, ten, fifteen, 20 respectively. He writes =20].

As depicted in Excerpt 3, Natasha uses Mathematical **(Ma)** language that is local **(L)** or specific to a single case. For example, in line 9, "Gale one, ubadile tse five, ga bale two, babadile tshe 10. When there is only one learner, she counts five sticks and if they are two, they count ten. [She writes 2 and 10 on the board].". Here, the teacher mediates the topic of multiplication using the "groups-of" method. For example, 5 X 2 is mediated as 2 groups of sticks. Understanding multiplication as groups-of method is prominent amongst early grade mathematics learners (Kosko, 2019) and in textbooks (Booysen, Westaway & Vale, 2022). This is coded as the mathematical language that is local **(L)** or specific to the context of groups-of sticks.

Since Natasha only used examples from the lesson plans, her examples were more structured and progressed in complexity as discussed in section 4.5.1. This made her overarching legitimating criteria Mathematical **(Ma)**. In Line 15, she presents repeated addition based on the number of learners carrying five sticks.

> "So retlo lebela huri okay, mo obalile tshei 5. Mo ten go yetshitswe keng, ke 5 plus five. Mo fifteen go yetshitswe di-five tse kae? Reka reng? Ke tloba *le mmh plus mmh plus mmh*. (So we see that here we have five [Writing 5], Here ten sticks are made from five plus five [writes 5 +5]. So then fifteen is made up of how many fives?. It is going to be mmh plus mmh plus mmh."

Here, she writes 5 and 5 + 5 on the board as a way to mediate the mathematical way of doing repeated addition. She then allows learners to speak mathematically by providing a prompt with her next task of , "It is going to be mmh plus mmh plus mmh." This task is coded as applying **(A)** known skills because the learners need to look at what was previously written and make a pattern on which numbers represent the "mmh". Here, learner participation can be viewed as offering a phrase or sentence **(P/S)** of five plus five plus five as seen in line 16.

Natasha's Task 5 of "Kemang o tlong direla eh kebone, kei ngwala bjang if keka nyaki ibe yi plus, kenyaka ka times? Who is going to do the next one for me? If I do not want to write it as plus, I want to write it as times." in Line 33 can be coded as making multiple connections **(C/PS)**. This task encourages learners to write mathematically hence encourages learners to understand the mathematical ways of doing mathematics. Natasha's task is mediating the mathematical register because as Barwell (2018) and Wilkinson (2019) state, teachers should engage learners in challenging mathematics tasks that require them to interpret tasks and make connections using the whole communicative repertoire which includes writing.

By using mathematical language **(Ma)** appropriately and using it to the full general criteria **(GF)**, Natasha is demonstrating the complex and precise ways of doing mathematics (Bailey, Maher & Wilkinson, 2018) hence she is mediating the mathematics register. For example, Natasha used the multiplication table during the Mental Maths activity and the learner who was writing (line 41) also used the multiplication table. Moreover, Natasha mainly uses code-switching to demonstrate a mathematical way of speaking. Her code-switching can be coded as code-switching mathematical **(CM)** because she used the correct mathematics register to explain procedures. For example, she used English to name all numbers hence counting was done in English. Moreover, Natasha used English mathematics vocabulary such as "add, plus, multiply, is equal to", as seen in Lines 15, 19 and 25. Code-switching mathematical **(CM)** was a dominant practice as Natasha spoke mathematically using English and only used SePedi to provide instructions to learners. Therefore, she is mediating the English mathematics register hence allowing learners to understand the English language. This would be beneficial for the Grade 3 learners because as per the language policy, they will learn in English from Grade 4 onwards. It is thus important that they understand the mathematics register in English. Essien (2011, p. 113) proposes that although using learners' home language, i,e SePedi, is an important practice in multilingual classrooms, sometimes, ¨the deliberate use of English is essential for enculturating learners into the mathematics English register¨. This can be a rationale for Natasha to code-switch to English as a way to encourage the Grade 3 learners to understand the mathematics register in English as they will start using English as the LoLT in Grade 4.

4.5.3 Learner participation

As modelled by Natasha, most of her learner offerings are code-switched to English. These include counting (Lines 2, 4, 6, 8, 10, 12, 14, 16, 18, 22) and Yes/No **(Y/N)** in lines 20 and 36. These findings of prominent use of English in a classroom where the LoLT is an indigenous language are in line with those of Feza (2016) where Grade R learners were more comfortable counting in English than in the LoLT, Xhosa. Feza (2016) suggests the reason for this is because English is used in the community. In the case of Natasha, an additional reason would be perhaps to allow learners to also know the English mathematics register because they will use English as the LoLT in the following year in Grade 4.

Learners are active participants and are invited to state Phrases and Sentences **(P/S)** such as counting sticks "One, two, three, four, five" (in Lines 3, 6, 8, 10, 13, 22) and using mathematical words and symbols (plus, is equals to). Learners were also invited to write mathematically on the board. Natasha's tasks required learners to make connections (**C/PS**) between the concepts of addition and multiplication, and give reasons through discussions **(D).** In Line 25-29, Natasha asks the learners if she should write another five, when learners offer No **(Y/N)**, she asks them to provide a reason why. In Line 35 and 36, learners evaluate the answer as incorrect as the teacher invites them to evaluate the answer as correct or incorrect "Keyona? (Is it correct?)". This makes learner participation Yes/No **(Y/N).** The active learner participation in Natasha's class was a way to mediate the mathematics register of speaking and doing mathematics.

Natasha incorporated learners' offers by writing them on the board. In line 19, she revoices the learner's offer "five plus five plus five" then writes it on the board for everyone to see. This can be coded as Revoicing Mathematical **(RM)** because she expanded on the learner offer by writing it on the board.

Exemplification		**Exploratory talk**			**Learner participation**	
Example	Tasks	Name	Legitimate	Code-switch	Learner offers	Teacher Revoice
Similarity **(S)** Contrast **(C)** Fusion **(F)**	Known procedure and facts **(K)** Apply known facts **(A)** Use multiple concepts and make multiple connection **(C/PS)**	Mathematical **(Ma)**	Mathematical Local **(L)** Full General **(GF)**	Code-switching mathematical **(CM)**	Yes/No **(Y/N)** Phrase/ sentence **(P/S)**	Revoice mathematical **(RR)**

Table 14: Summary of Natasha's practices

Natasha's practices included all three patterns of variation; Similar **(S),** Contrast **(C)** and Fusion **(F).** Her dominant task practice was carrying out known procedures **(K)** with learners' participation involving Yes/No **(Y/N)** and stating phrases/sentences **(P/S)** and discussions **(D)** because she asked for reasons. She incorporated learner offers and revoiced them using the appropriate mathematics register **(RM).** Natasha also mediated the Sepedi mathematics register through modelling the use of the appropriate mathematics **(Ma)** language when naming and legitimating objects and procedures. Code-switching mathematics **(CM)** was a dominant practice in Natasha's classroom with all numbers named in English.

4.6 Conclusion

In this chapter I used the analytical framework based on the MDI to discuss Dineo, Bongwe and Natasha's practices. Using the three broad themes (exemplification, exploratory talk and learner participation) for each teacher, I discussed how they mediate the SePedi mathematics register in the topic of addition. In chapter six, I discuss the overall findings of the study on how all three teachers' practices mediated the SePedi mathematics register.

Chapter 5: Summary of findings and discussion

5.1 Introduction

This study sought to investigate the teacher practices used to mediate the SePedi mathematics register in multilingual Foundation Phase classrooms in South Africa. The study proposed to achieve an understanding of the practices teachers use to mediate the mathematics register in classrooms where the LoLT is an indigenous language. The study was designed to engage with the research question, *How do teacher practices mediate the SePedi mathematics register in Grade 1 and Grade 3 multilingual classrooms in South Africa?* In keeping with this objective, this study focused on teachers' use of examples and tasks in exemplification, naming and legitimating in exploratory talk and on what the teacher invites learners to say in learner participation. In this concluding chapter, I provide the summary of findings as presented in Chapter Four and further discuss the relationship between exemplification, exploratory talk and learner participation and how they mediate the SePedi mathematics register. Lastly, I present the implications from these findings and make recommendations based on the findings.

5.2 Mediating the Sepedi mathematics register through exemplification, exploratory talk and learner participation

The findings revealed that teachers used similar and contrasting examples. The findings point out that teachers maintained the cognitive demand of the tasks by presenting applying (A) knowledge questions. This is contrary to research by Setati (2008) stating that when teachers use indigenous languages through code-switching, they reduce the cognitive demand of tasks. The reduction of the cognitive demands of tasks can not be linked to the use of indigenous languages because teachers can reduce the cognitive demand of tasks even when teaching in a prestigious language such as English. In a study by Adler and Ronda (2015) the teacher, Ms X, reduced the cognitive demand of the task by answering all the questions herself teaching in English. Therefore, it is not through the use of indigenous language that cognitive levels can be reduced, it can be reduced when using English if the teacher responds to the questions himself or herself.

Code-switching was seldom used in the Grade 1 classes, with the teacher using this practice for everyday language such as yes/no. However, code-switching was the dominant language practice in Grade 3, with both the teacher and learners solely naming numbers in English. Natasha using the correct mathematics language of "plus, multiply, add, times, is equal to" when explaining procedures allowed the learners to understand the mathematics register in English as well. This might be because Grade 3 is the last class where the LoLT is SePedi since as per the language policy (DoE, 2011), from Grade 4 onwards, all learners should learn in English. The teacher might then be using the English mathematics register to enculturate the learners to learn in English the following year.

In all three classes, learners were actively engaged and continuously participated using the correct SePedi mathematics register such as when they counted or offered short answers in phrases or sentences (P/S). These findings of increased participation with the use of indigenous languages are in line with Robertson & Graven (2020) stating that learner participation increases when learners are allowed to speak in their home languages. They argue that a significant hindrance to learner participation is when they are denied the use of their home language(s). Moschkovich (2019) also shares the same view that the use of learners' home language through code-switching provides resources for learner participation.

The teachers used the correct SePedi mathematics register to name and legitimate. They used technical mathematics terms such as; go pedifatša, oketša, hlakantša which mean doubling, plus, add. These findings are in line with the findings from Mpalami (2022) stating that the use of learners' home languages has the potential to enhance their understanding of the mathematics register when the teacher models the mathematics register. These findings are contrary to those of Setati (2008) where teachers did not use the correct mathematical terms in Setswana. Van Laren and Goba (2013) also highlight the difficulty of using the mathematics register in IsiZulu and Schäfer (2010) in Xhosa. The findings of this study, however, revealed that teachers used the correct SePedi mathematics register and had technical mathematical terms to name and legitimate objects.

To conclude, the data revealed that teachers mainly used similar examples and maintained the cognitive demand of the tasks. Maintaining the cognitive demand of the tasks allowed teachers to mediate using the correct mathematical language. Having similar examples enabled the teachers to name and legitimate using the correct mathematical language because they know what to say based on the similar structures. Since the teachers modelled the correct mathematics register through exploratory talk, learner participation was based on learners using the mathematical language by offering sentences and phrases such as counting and naming mathematical procedures in SePedi.

5.3 Limitations of this study

The limitations of this study stem from not being able to collect data due to the Covid-19 pandemic. I thus used secondary data of lesson and interview transcripts. The data did not allow me to make judgments on the rationale for the procedures teachers utilised because the interviews were not suited to my topic, which is a general limitation of this study. For instance, it would have been beneficial to understand why Natasha used code-switching mathematics as a dominance practice, and why the Grade 1 teachers did not code-switch as much. Although this is placed as a limitation in this study, it did not have any major implications because my focus in this study was to understand how teacher practices mediate the SePedi mathematics register, not the rationale for such practices.

Another limitation of this study is that the sample size was relatively small and the study was limited to only one school. Having another teacher from Grade 3 would have enriched my data so there are two teachers in each grade. This is because the Grade 1 teachers' practices were very similar so it would be interesting to see if another grade 3 teacher's practices would be similar to Natasha's.

5.4 Recommendations

Based on the findings and research gaps, three major recommendations were made. The first recommendation is on teacher development on how to effectively use the practices of exemplification, exploratory talk and learner participation with the use of an indigenous language. This teacher development would benefit both pre-service and in-service teachers in implementing effective practices when teaching in a multilingual South Africa.

The second recommendation is for teachers and learners to use the learners' home languages as the LoLT because it has benefits such as increased learner participation (Robertson & Graven, 2018). With the use of indigenous languages, teachers need to use special mathematical terms to name objects and model the mathematics register. This will encourage learners to see their home languages as adequate instead of viewing them as inferior as stipulated by Setati (2008) and Phakeg (2018).

Another recommendation is based on further research that focuses on other effective practices used in mathematics multilingual classrooms to mediate the mathematics register other than the ones discussed in this paper. Exploring more effective teaching practices is essential in the Foundation Phase (Venkat & Askew, 2018) since the LoLT is an indigenous language. Since the findings revealed that there was more code-switching in Grade 3 than in Grade 1, additional research should explore how this impacts the bridge between Grade 3 and 4 because the LoLT in Grade 4 is English. Moreover, further research may engage with translanguaging as a practice, and how it impacts the mediation of the mathematics register.

5.5 Conclusion

In this study, I have used an adapted version of Adler and Ronda’s (2015) MDI framework to discuss teacher practices used to mediate the SePedi mathematics register in Foundation Phase multilingual classrooms. With schools in South Africa allowed to use an indigenous language as the LoLT, I was interested to understand how teachers mediate the mathematics register in that indigenous language. The aim of this study was not to criticise foundation phase teachers on how they teach but to appreciate the current practices present in multilingual classrooms where the LoLT is an indigenous language. The findings show how teachers mediated the mathematics register using exemplification, exploratory talk and learner participation as proposed by the MDI. Conducting this research has made me aware of my practices as a mathematics teacher, hence it stems as a reflection tool.

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