EXPLORING LANGUAGE PRACTICES OF IMMIGRANT MATHEMATICS TEACHERS IN MULTILINGUAL GRADE SIX CLASSROOMS IN SOUTH AFRICA

by

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DECLARATION

I, Faith Lindiwe Tshabalala, declare that this project is my own original work, and this work has not been previously submitted. I am the sole author of this work. Every contribution to this project and every quotation from the work of others has been acknowledged through citation and referencing. I am aware that plagiarism is unethical, and I understand what plagiarism is. I am also aware of the University's policy on plagiarism. I have also not allowed anyone to copy my work and pass it off as his or her own.

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ABSTRACT

Research in South African multilingual mathematics classrooms has shown that English additional language learners in the intermediate phase are mostly challenged by the fact that they have to learn mathematics in English, a language that many of them are not fluent in. To enable mathematical understanding, teachers use their own and learners' language resources, for instance, code-switching, gestures, images, and prior knowledge. But what has not been looked at is what and how immigrant teachers, who do not share a home language with English additional language learners, use language practices to create opportunities for the development of procedural and conceptual mathematical Discourse. Thus, this study aims to describe what language practices such teachers use, and the meanings these language practices give to procedural and conceptual mathematical Discourse when performing the functions of describing mathematical procedures and concepts, asking informational questions, and clarifying these questions. The study also explores how the teachers explain their use of these language practices.

To achieve this aim, the study follows a social practice perspective of language, which views language as having both function and form. I use the three key language functions for teaching as identified by Pozzi, namely, describing mathematical procedures and concepts, asking informational questions, and clarifying questions. As the teachers use language practices to perform Pozzi's language functions, I look at the meanings they are building, using six of the seven building tasks from Gee, namely, activities, identities, relationships, politics, connections and sign systems and knowledge, with the main focus on building procedural and conceptual mathematical knowledge. I focus on three teachers from Zimbabwe, with each teacher teaching a different mathematical topic in a grade six classroom in a different school setting. The teacher from a school in an informal settlement focused on functional relationships, the teacher from the township focused on transformational geometry, and the one from a rural area focused on addition and subtraction of decimal fractions in Gauteng Province of South Africa. Data was collected through pre-observation individual interviews, classroom observation of one lesson per teacher, post-observation individual teacher interviews on language practices used in the lesson, and a focus group interview with all three teachers. Data was analyzed using Gee's method of Discourse analysis.

The teacher interviews indicate that the choices of the language practices were made to enable mathematical understanding, to consider the learners' future learning in English dominant system, and to consider the immigrant teachers' positioning. Throughout their lessons, the teachers used a range of language practices such as English language, code-switching, gestures, images, formal mathematical language, informal mathematical language, learners' everyday context, previously learned mathematical concepts, decomposition, revoicing, and different forms of questions, individually and in an integrated manner. In each lesson a teacher worked to-and-fro between particular language practices, developing a pattern that connected procedural and conceptual mathematical Discourse as relevant to the mathematical topic. However, at certain moments a language practice may have worked against a teacher's intention.

The teachers used some language practices more than others, depending on the functions they were being used to perform. English language was used in most parts of the lessons by the three teachers, in all three of Pozzi's language functions, thus building politics by making English important for building mathematical knowledge. The language practices that were mostly used to support the language function of asking informational questions were different forms of questions and revoicing. Images and gestures, which in Gee's terms refer to buildingsign systems, were mostly used to clarify questions. Learners' everyday contexts, previously learned mathematical concepts, decomposition, and informal mathematical language, which inGee's terms is building connections, were also mostly used to clarify questions. Code-switching to Setswana seemed to be used as a last resort to clarify questions after other languagepractices had failed, intending to build an understanding of concepts and also to build identityand relationships with the learners who did not understand English.

The three teachers in my study come from the same country of origin and their motivations for using language practices are similar. However, in practice, these teachers make choices that are related to their knowledge of specific learners, the school context, the topic, their fluency in Setswana, and the home language of the learners. The Analytical Framework offers a structured tool for teacher education and professional development, helping teachers adapt language practices to build procedural and conceptual mathematical knowledge across various topics. The Framework is also adaptable for research, providing flexibility to analyze language practices and extend its use to different mathematical topics and contexts.

Keywords: Mathematics, immigrant teachers, language practices, language functions, multilingual classrooms, English additional language learners, building tasks.

DEDICATION

To my Lord and Saviour, Jesus Christ for strengthening me throughout the journey.

To my family

My husband, William Tshabalala, for all the sacrifices, patience, prayers, and support.

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GLOSSARY OF TERMS

GDE	Gauteng Department of Education
LoLT	Language of Learning and Teaching
CoP	Communities of Practice
DBE	Department of Basic Education (South Africa)
SACE	South African Council for Educators
LiEP	Language in Education Policy
TPD	Teacher Professional Development
ATP	Annual Teaching Plan

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CHAPTER 1

1.1 INTRODUCTION

Over the course of more than twenty years as a primary school mathematics teacher in one of the schools in Gauteng Province (one of South Africa's nine provinces), I became interested in the interaction between language and mathematics teaching and learning. Over the years, I observed how language, particularly English as the language of learning and teaching (LoLT), impacted classroom interactions and learners' mathematical learning experiences. This interest deepened during my postgraduate studies, where I focused on promoting conceptual understanding and mathematical reasoning in multilingual classrooms (see Tshabalala, 2018). I also published some articles focusing on mathematical reasoning in multilingual classrooms about language choice and what that communicates, and how English additional language teachers enable conceptual understanding in these mathematics classrooms (Tshabalala, 2012, 2018; Tshabalala & Clarkson, 2016). Through this practice and research, I learned to appreciate the complexities of teaching mathematics in multilingual mathematics classrooms.

In January 2006, I was promoted to the position of a principal, and I continued teaching mathematics at a school that had learners from different parts of South Africa and other African countries, including Mozambique, the Democratic Republic of Congo, and Zimbabwe. Regardless of having these diverse learners, mathematics was taught in English language, which was an official language of learning and teaching (LoLT) from Grade Four. Over and above that, I worked with teachers who were from Zimbabwe, who were teaching these learners from diverse contexts because immigrant teachers were also very welcome in South Africa, as they were employed in public schools (Ranga, 2013).

As I transitioned into a research role for the Provincial Gauteng Department of Education, I became increasingly curious about the language practices of mathematics teachers, especially those who did not share the same language background as their learners. This curiosity led me to pursue a PhD focusing on how primary school mathematics teachers, particularly immigrant teachers, use language practices to create opportunities for the development of procedural and conceptual mathematical Discourse.

In discussing my interest in Discourse, it is essential to highlight the theoretical framework that informs my research. I draw upon Gee's (2011) concept of Discourse with a capital 'D,' which refers to socially constructed ways of using language and other symbolic forms to enact particular identities, activities, and relationships. This framework allows me to explore how language practices in the classroom shape the development of procedural and conceptual mathematical Discourse among learners. I give details regarding the reasons for this use in Chapter Two, Sections 2.2 and 2.3.

Initially, my PhD research aimed to explore language practices among South African teachers who shared a home language with their learners, which were either isiXhosa, isiZulu, or Setswana. However, through a pilot study involving an immigrant teacher and Setswana-speaking learners, I realized the significance of immigrant teachers' experiences and their impact on classroom dynamics. This prompted me to refocus my research specifically on immigrant teachers and Setswana-speaking learners, as this intersection presented unique challenges and opportunities for language use in the mathematics classroom (Section 3.2.3.2).

My interest in the creation of opportunities for the development of procedural and conceptual mathematical Discourse was propelled by the fact that, as discussed in Section 2.2.1, these opportunities cannot happen without language (Shortino-Buck, 2017). Robertson & Graven, (2020) argue that language is essential for effective mathematics teaching and learning. In particular, in my context, the challenges learners have when learning mathematics in a language they are not proficient in, primarily English, are well documented (e.g., Adler, 1998; Nkambule, 2012; Robertson & Graven, 2019; Setati, 2008).

For my context, I specifically wanted to focus on the teaching of multilingual Grade Six learners. In practice, many English additional language learners "are taught mathematics in English from grade four" (DoE, 2009, Annual School Survey, p. 20). This suggests that Grade Six learners have only been taught content subjects in English for two years in their schooling life. The trajectory of my research journey reflects a deepening interest in understanding the complexities of language use in multilingual mathematics classrooms, particularly among immigrant teachers and English additional language learners. By focusing on the creation of opportunities for the development of procedural and conceptual mathematical Discourse, my study seeks to shed light on how language practices shape learners' mathematical learning experiences in diverse educational contexts.

1.2 BACKGROUND TO THE PROBLEM

1.2.1 Multilingualism in South African classrooms

South Africa recognizes 11 official languages, reflecting its cultural and linguistic diversity. These languages are IsiZulu, Afrikaans, English, isiNdebele, isiXhosa, Sesotho, Setswana, siSwati, Tshivenda, Xitsonga, and Sepedi. This linguistic diversity is reflected in the country's educational system, where individuals often speak multiple languages and may be proficient in several official or regional languages. These languages contribute to the rich linguistic tapestry of South African society (Heugh, 2013). In this study, multilingual classrooms are those in which the participants (learners, teachers, or others) are potentially able to use more than one language, other than the LoLT, which is English (Setati & Barwell, 2006). In this study, English additional language learners refer to the learners whose home language is not English but who are taught mathematics in English. While some people may be fluent in two or three languages, others may be proficient in more, contributing to the rich linguistic tapestry of the South African context. Language use can vary between urban and rural areas, with urban communities typically exhibiting greater linguistic diversity due to the convergence of people from various backgrounds.

In the educational context, the language background of individuals influences the types of schools and mathematics classrooms present in South Africa. Some schools operate as parallel medium institutions, offering instruction in more than one official language to accommodate parents' language preferences for their children. Others may focus on leveraging the language resources of teachers and learners, regardless of whether they are shared or not, while some are defined by their language of learning and teaching (LoLT). South African classrooms can be categorized as heterogeneous or homogeneous multilingual environments, however the two are not distinct. Heterogeneous classrooms feature learners from diverse linguistic backgrounds, while homogeneous classrooms consist of learners who share a common home language but may still have exposure to additional languages.

In homogeneous multilingual contexts, a dominant language prevails, often because of historical, political, or economic factors. Languages like Afrikaans and English hold prominence alongside indigenous African languages. However, even within these dominant languages, there are variations and dialects, blurring the lines of homogeneity. Heterogeneous multilingualism acknowledges the co-existence of diverse languages without privileging any single one. South

Africa’s 11 official languages exemplify this diversity. However, the practical implementation of multilingual policies remains complex, leading to linguistic inequalities. Communities often blend languages, code-switch, and create hybrid forms. This fluidity challenges neat categorization, causing schools to struggle with balancing linguistic rights and effective education.

Learners’ home languages intersect with classroom instruction. In the classrooms teachers and learners navigate their linguistic identities, drawing from various linguistic resources, where homogeneity and heterogeneity inter-mingle, reflecting the nation’s complex history. Within these multilingual classroom contexts, English-dominant classrooms are those where English serves as the primary language of instruction, despite learners having varying levels of proficiency in English and speaking different home languages. Home language-based classrooms prioritize instruction in learners’ home languages, gradually introducing English as a subject or secondary language as mandated by the Language-in-Education Policy (LiEP).

Instructional practices in multilingual classrooms vary, with approaches such as transitional bilingual education, maintenance bilingual education, and dual-medium bilingual education employed to support language development and academic success as highlighted by Kennedy (2019). ‘Transitional bilingual education’ refers to early education that starts with a significant portion of instruction in the learners' home language, with an increasing emphasis on English as they progress through the grades. Kennedy (2019) indicates that transitional bilingual education refers to early education that starts with a significant portion of instruction in the learners' home language, with an increasing emphasis on English as they progress through the grades. ‘Maintenance bilingual education’ refers to the instruction that is provided in both the home language and English across all grade levels, ensuring that learners develop strong linguistic skills in both languages. In ‘dual-medium bilingual education’, both languages are used as mediums of instruction, often with the aim of achieving equal proficiency in both.

These diverse approaches operate within the same language policy environment, highlighting the complexity of language dynamics in South African schools. Teachers may use both languages interchangeably throughout the day (Kretzer & Kaschula, 2021). Kretzer & Kaschula (2021) indicate that these various types of multilingual contexts in South African schools are all functioning within the same language policy environment (as described in Section 1.2.3). These diverse multilingual contexts highlight the complexity of language dynamics in South African schools and thus require a variety of approaches to be used to navigate linguistic diversity in the classrooms (Hooijer & Fourie, 2009).

1.2.2 Mathematics curriculum in South African classrooms.

The South African Curriculum and Assessment Policy Statement (CAPS) for mathematics encourages teachers to expose learners to mathematical reasoning (DoE, 2011). In 2018 the Basic Department of Education introduced the Mathematics Teaching and Learning Framework for South Africa. This Framework was developed to boost and support the implementation of the Mathematics Curriculum and Assessment Policy Statement (CAPS) (Department of Basic Education (DBE), 2018). According to the framework, mathematics teaching and learning need to be supported so that learners can become mathematically proficient, and the teachers should strive to focus on teaching mathematics for conceptual understanding, develop procedural fluency in learners, develop learners' strategic competence, provide multiple and varied opportunities for learners to develop their mathematical reasoning skills, promote a learning-centred classroom in ways that foreground mathematical learning for all (DBE, 2018, p. 8).

The framework further indicates that when teachers promote mathematical reasoning, learners should learn to speak formal mathematical language and also be able to talk about mathematics (DBE, 2018). It is noted in the framework document that it (the framework) does not replace the Curriculum and Assessment Policy Statement (CAPS). What it rather does is present numerous options and new ways of mathematics teaching, learning, and assessments, thus promoting mathematical proficiency in learners. The framework explicitly uses four of the five Kilpatrick, Swafford, and Findell's (2001) strands of mathematical proficiency, which I explainin detail in Section 2.2.2. These four strands are read into the Framework, stipulating that it is attempting to lay a firm foundation for a new way in which mathematics can be taught and learned.

According to the CAPS (DoE, 2011), teachers should support learners so that they may be able to explain how they got to the answers. They should support learners with the language that will help them to be able to talk about their thinking, their answers, solutions, and strategies (DoE, 2002). In other words, the teacher's role is to create opportunities for the development of procedural and conceptual mathematical Discourse, and this needs language. I explain this in detail in my literature review in Chapter Two, Section 2.2.3. All teachers are expected to enhance learners' understanding through diverse types of questions that provoke critical thinking and mathematical understanding (Steyn & Adendorff, 2020). In such supportive environments, learners would develop the confidence they need to explore mathematical problems and the ability to make conjectures during the emergence of mathematical Discourse.

1.2.3 Education policy on language

The South African Constitution emphasizes language as a right to ensure social justice and social cohesion by recognizing eleven official languages (Constitution of the Republic of SouthAfrica 200 of 1993). In the Language In Education Policy for Schools (LiEP), which is the policy on how different languages should be used in schools for teaching and learning in South Africa, equal status for all South African languages is guaranteed (DoE, 1997). To address the effects of previous racially discriminatory legislation and practices, the LiEP for schools gives all South Africans the right to an education in the language of their choice in public schools (South African Schools Act 84 of 1996). The LiEP promotes the inclusion of all 11 South African official languages as a medium of instruction in schools and protects parents' democratic rights regarding the choice of medium (The Language in Education Policy, 1996). If this policy is applied in the schools where my study was conducted, it implies that the Setswana learners who are taught by immigrant teachers may never experience that right to be taught in a language of their choice.

The policy stipulates that schools can use the learner's home language for the first three years of schooling, with the addition of either English or Afrikaans as a second language before switching to instruction in English for all content subjects. This has thus become a common practice in the contexts where my study was conducted though the Language in Education Policy (LiEP) in South Africa is designed to promote multilingualism and inclusivity in schools.

1.2.4 Practice regarding policy implementations

The Department of Basic Education prioritizes the "previously marginalized official Indigenous languages, and the learning and teaching of all the official languages of the Republic at all levels of schooling" (p. 12) as one of the goals of the Department of Basic Education's Draft Language Policy (2015). However, schools with the support of the parents decide the suitable LoLT(s) to be offered at the school based on the learner demographic of the school (Heugh, 2013; Plüddemann, 2018). Although policy values multilingualism and language rights for all, and prescribes home language in the foundation phase, the power of English in society shows that it

(English) is the dominant LoLT, where some Grade One multilingual classrooms are choosing English language as their LoLT (Heugh, 2013). The content subjects' textbooks in English additional language schools are also written in English language from Grade Four, and the learners are also assessed in English language, except in their home languages. Makoe & McKinney (2014) indicate that regardless of what the policy says, English has been given a high status by parents, including parents whose children are in English additional language schools. Evidence in research also shows that teachers do value and use their home language for conceptual understanding, and identity (e.g. Maluleke, 2019) and they also draw on other language practices other than the named languages as a resource (e.g. Chikiwa, 2021).

Research findings also indicate that English teachers who teach mathematics in English additional language schools prefer to use English because it is perceived as an international language and because textbooks, examinations, and higher education are all in English (Mahlambi & Mawela, 2021; Robertson & Graven, 2019, 2020). This suggests that in practice, English has become the norm, thus negatively impacting the promotion of multilingualism in South African schools (Heugh, 2013). When creating opportunities for the development of procedural and conceptual mathematical Discourse, teachers are guided by policy on how language should be utilized. The implementation of the policy depends on the specific context of the school, where it is located, and the parents' choices of LoLT.

Although some schools choose English as a language of teaching and learning from Grade One, in practice, teachers use home language other than English to teach mathematics in those classrooms because of lack or insufficient resources (Owen-Smith, 2010; Mudau, 2019). Over and above the LoLT, teachers also use other language practices to facilitate teaching and learning. These include verbal and non-verbal language practices, which may include learners' home languages, gestures, images, formal and informal mathematical language, and learners' everyday context (e.g., Chikiwa, 2021; Kasmer & Billings, 2017; Planas & Setati-Phakeng, 2014). I give more details about the language practices in Section 2.2.5. The way teachers use these language practices may enable or hamper the development of procedural and conceptual mathematical knowledge (Smith & Feels, 2017).

1.2.5 Effect of English language and its dominance on learner performance

Research findings show that most English additional language learners in South African multilingual classrooms do not master, either their home languages or English language by the fourth grade, yet these learners have to learn mathematics in English when they enter Grade Four (e.g. Chikiwa & Schafer, 2014; Robertson & Graven, 2019; Wildsmith-Cromarty &Balfour, 2019). This may be caused by the fact that some have not developed adequate English language proficiency to be taught mathematics through English language but are forced by socio-politically driven perceptions (Robertson & Graven, 2019).

Molteno (2017) argues that when learners transition from their home language to English language in Grade four, most of them experience a substantial barrier to learning because of the cognitive demands related to learning mathematics in English when they are not fluent in it. Limited fluency in the language of learning and teaching, in this case, English, may be the reason for the learners' poor performance. What may contribute to this limitation is that by the end of Grade Three, learners' experience of using language may be diverse because English additional language learners may have had very little (if any) exposure to English in or outside the classroom (Van der Berg, Tyler, Gustafsson, Spaull, and Armstrong, 2011; Spaull, 2016). The challenge may also be caused by that some learners may have been taught mathematics in their home languages, other than English language in their first three years of schooling (Essien, 2018). It should be noted that in most classes where the LoLT is English (including inmy study), Grade Six learners are only in the third year of the transition from their home language LoLT to English language LoLT.

Essien & Setati (2006) and Essien (2013) in the studies conducted in South Africa, found that when the learners' English proficiency levels were improved, their mathematics performance also improved in the tests. This implies that many schools may be struggling because of the learners' language proficiency level in the language of teaching and learning. In such contexts, teachers are expected to create opportunities for the development of procedural and conceptual mathematical Discourse.

1.2.6 Gauteng context

The Language-in-Education Policy (LiEP) is pivotal in shaping the educational landscape, particularly in determining the language used as the medium of instruction in mathematics classrooms, as highlighted in Section 1.2.3. However, research reveals challenges in implementing LiEP in Gauteng province, South Africa, due to its diverse population resulting from migration. This diverse population leads to multilingual classrooms, affecting mathematics teaching, especially in the Foundation and Intermediate Phases. Immigrant teachers' language practices in supporting learners during the Intermediate Phase, therefore warrant exploration.

The demographic diversity in Gauteng impacts both teachers and learners. In instances where there are not enough learners for separate classes, the 'best fit' Language of Teaching and Learning (LoLT) is used, often based on the majority of learners' home language. This situation may lead to learners attending schools where their home language is not offered, as their numbers do not justify it. Consequently, some learners are taught in languages other than their primary home language. Teachers may also find themselves teaching mathematics in a language they are not proficient in to secure their jobs.

Despite the policy's emphasis on using LoLT exclusively in mathematics classrooms, there may not always be a match between LoLT and learners' or teachers' home languages (Sapire & Roberts, 2017). This discrepancy persists despite the availability of a policy that supports multilingualism and instruction in all official South African languages.

A study in Gauteng focusing on multilingualism in foundation phase mathematics highlighted issues such as lack of standardized mathematics terminology in learners' home language curriculum materials, errors and omissions in translation, and variation in teachers' knowledge of mathematical vocabulary (Sapire, 2018). Sapire (2018) indicates that these factors can compromise the teaching and learning of mathematics in multilingual settings.

Challenges encountered in the foundation phase may persist into the intermediate phase (Grades 4 to 6), potentially hindering the development of mathematical proficiency. Learners transitioning to this phase may struggle with both the Language of Teaching and Learning (LoLT) and formal mathematical terminology, resulting in gaps in mathematical knowledge. For instance, learners accustomed to African language terms for mathematical concepts may encounter standardized mathematical language in Grade Four, posing challenges for teachers not fluent in the learners' home languages. Consequently, teachers in the intermediate phase are required to employ language practices to foster procedural and conceptual mathematical understanding, yet language barriers may impede effective communication and knowledge transfer (Le Michael & Tshuma, 2019; Sapire & Roberts, 2017).

Research reveals that some schools lack a clear transition policy for learners moving to Grade Four, where mathematics is taught in English (Sapire & Roberts, 2017; Sapire, 2018). Consequently, Intermediate-phase mathematics teachers may struggle to support learners in adapting to formal mathematical language in English. Dhlamini's study (2020) highlights Intermediate Phase teachers’ concerns, noting they often feel the need to reteach Foundation Phase concepts due to learners’ inadequate procedural and conceptual mathematical knowledge stemming from language challenges encountered in earlier grades.

1.2.7 Immigrant mathematics teachers in South Africa

A 2011 report by the Centre for Development and Enterprise (CDE) highlights constraints faced by South African educational reform due to a shortage of skilled educators, trainers, and mentors (Rasool & Botha, 2011; Van Broekhuizen, 2015). This shortage adversely affected the quality of mathematics education (South African Council for Educators, 2010), prompting changes in immigration laws in 2010 to provide special work permits for immigrant mathematics teachers. The CDE report suggests that the government's options for improving education were limited to either significantly upgrading domestic educational systems or sourcing skills from outside South Africa (CDE, 2011). Since 1994, immigrant teachers have been required to apply for permits to teach in South Africa, but the 2010 law amendments facilitated their residency and employment in the country.

While the South African government was encouraging immigrant mathematics teachers to come and support mathematics teaching and learning in South Africa, in 2010, the Minister of Education encouraged qualified immigrant teachers, to fill some of the vacant posts in mathematics and science in the country, indicating that such skilled people were desperately needed in South Africa (Rasool & Botha, 2011). These immigrant teachers were specifically targeted because South Africa recognizes their qualifications.

The Commonwealth Teacher Recruitment Protocol (CTRP), adopted in 2004 CTRP played a significant role in assisting countries, including South Africa, to manage teacher migration. This initiative was a response to concerns raised by several Commonwealth nations, particularly smaller states, regarding the shortage of qualified teachers in their workforce. The CTRP aimed to address this issue by facilitating the recruitment of teachers from other Commonwealth countries, such as Zimbabwe, to meet the educational needs within South Africa. Van

Broekhuizen (2015) identified that in each year South Africa would need approximately 20 000-30 000 new qualified teachers, just to replace the teachers leaving the system and also to maintain current teacher-learner ratios.

The immigrants' language resources vary, and the school contexts in which they work vary in South African schools as indicated by Daley & Warman, (2019). Daley & Warman, (2019) highlight that some are English additional language speakers who teach mathematics English additional language learners; English additional language speakers who teach English first language learners; English first language speakers who teach English additional language learners as well as English first language speakers who teach English additional language learners. Some immigrant teachers might be English additional language speakers and have experience working within the context of educational policies. Some are English additional language speakers who might not be used to teaching in English (Daley & Warman, 2019).

Like South African teachers, these immigrant teachers find themselves in a situation where they must adhere to the LiEP when teaching (Robertson & Graven, 2020). For instance, the focus of this study is on English additional language immigrant teachers' use of language practices in mathematics classrooms of English additional language learners, specifically because, as noted in Chapter Two, Section 2.2.6. Through this research, I want to know the language practices they use, and how and why they use them, especially under such complex contexts in the Gauteng province.

In this study, my cases are three schools (rural, township, and informal settlement) where immigrant teachers from Zimbabwe teach Grade Six mathematics classrooms because these teachers fit my criteria when I was conducting a pilot study, as explained in Sections 1.2 and 3.2.3.2. At the time of the initial stages of my study, it was reported that about 40,000 immigrant teachers from a range of countries were already in South Africa (Van Broekhuizen, 2015). I have motivated why I chose teachers from this country in my study in Section 3.2.3.2.

Though immigration is encouraged by the government, the conditions in the country do not make it easier for immigrants to live and teach in South Africa. This is because some South Africans have a negative attitude towards non-citizens, migrants, and refugees and thus the issue of xenophobia affects these immigrant teachers (Matsinhe, 2011; Manik, 2011b; Tarisayi & Manik, 2021). Tarisayi & Manik (2021) indicate that some of the challenges that immigrant teachers experience are poor salaries, no job security, xenophobic attitudes, attacks, and workplace frustrations and some South Africans perceive immigrants as people who steal their jobs (Matsinhe, 2011, Manik, 2011b; Tarisayi & Manik, 2021). Over and above the issues of xenophobia, these immigrant teachers need to renew their work contracts every quarter (every three months) which may suggest that there is no job security for them.

Though immigrant teachers may have extensive knowledge with regards to mathematics and teaching mathematics some of the conditions indicated in LiEP may not be easy for some of them to implement because they may find themselves teaching learners who do not share their home language. Makonye (2017), emphasizes that immigrant teachers were taught a particular curriculum, aligned to the policies of their country, not for South African learners. I had to look at the meanings (in Gee's (2011) terms, as described in Section 2.3) the immigrant teachers build in South African mathematics classrooms as they use language practices to create opportunities for the development of procedural and conceptual mathematical Discourse. Within this context, my study seeks to explore their use of language practices, the reasons why they use them, and the meanings that are built, in Gee's terms (2011) when they use such language practices when they build procedural and conceptual mathematical knowledge using Pozzi's language functions.

1.3 PROBLEM STATEMENT AND RESEARCH QUESTIONS

As indicated in Section 1.2.1, the CAPS curriculum requires teachers to help learners develop mathematical proficiency where learners can explain and justify their answers. Teachers need to ensure that whenever learners explain and justify their answers or whenever they do problem-solving, they use formal mathematical language. In the process of developing mathematical proficiency in learners, mathematics teachers are expected to address these language complexities faced by English additional language learners in their mathematics classrooms because a big part of learning mathematics is about gaining fluency in the language of mathematics. If the learners are not fluent in their LoLT, this may be a barrier to their understanding of formal mathematics language as they are learning mathematics in English as indicated in Section 1.2.4.

The focus of this study was on immigrant teachers' use of language practices when teaching English additional language learners in South Africa and the meanings the use of these language practices gives when building mathematical knowledge. This is important to explore because since South Africa has historically appointed such teachers, there is little research that has been done on mathematics teaching by immigrant teachers. This study that focuses on immigrant teachers aimed to develop our understanding of the language practices they use in multilingual mathematics classrooms, and how and why they use them when creating opportunities for the development of procedural and conceptual mathematical Discourse. I am interested in the language practices, specifically, how the immigrant teachers used them for particular mathematical topics. I needed to see the kind of meanings that are being built whenthey use various language practices.

As indicated in Section 1.2.4, several studies have been conducted on language practices English additional language South African teachers used when teaching mathematics in English additional language mathematics classrooms in South Africa (Adler, 1998; Setati, 2001, 2005; Tshabalala & Clarkson, 2016; Robertson & Graven, 2020). When immigrant teachers come to South Africa, some of them teach English additional language learners whom they do not necessarily share their home language with. In addition, most learners in multilingual classrooms in Gauteng province are taught in English, which is a language that is neither the teachers' nor the learners'.

In particular, the study sought to answer the following questions:

i. In a mathematics lesson, what language practices does the teacher use during the creation of opportunities for the development of procedural and conceptual mathematical Discourse?
ii. As the teacher uses different language functions, what meanings do these language practices give to procedural and conceptual mathematical Discourse?
iii. How does the teacher explain the use of these language practices?

As described in detail in Sections 2.2.1. to 2.2.4, the study adopted a social practice perspective of language and thus focuses on the form (the language practices) and the function (the meanings) of language. For the latter, I used three of Pozzi's (2004) language functions (related to teacher's use of language) which are appropriate for exploring teachers' mathematical Discourse, namely, description of things and actions, asking of informational questions, and clarification of questions (Pozzi, 2004). I also used Gee's (2005) notion of Discourse, focusing on six of the seven-building tasks, which were building activities, building identities, building relationships, building politics, building connections, and creating sign systems and knowledge.

1.4 SIGNIFICANCE OF THE STUDY

The language landscape in South Africa is complex, with English holding significant power. While research endeavors to understand this complexity, certain contexts offer valuable insights, such as immigrant teachers' practices, which remain under-explored despite their relevance beyond their specific experiences. Understanding how these teachers navigate language practices, particularly in teaching specific mathematical topics, can provide valuable insights. These findings not only inform similar contexts where English additional language learners are taught mathematics by teachers who do not share their home language but also contribute to enhancing teaching practices.

Insights into the language practices employed by immigrant teachers and the meanings they construct can guide both pre-service and in-service teacher training programs, particularly regarding the integration of language practices for procedural and conceptual mathematical discourse development. The framework developed for this study holds potential for use by other researchers in similar contexts, while the tools derived from the theoretical framework can aid in designing effective training programs for teachers working in rural, informal settlements, and township settings. By sharing best practices, teachers can leverage these language strategies to enhance their mathematics teaching practices, ultimately improving learning outcomes.

1.5 STRUCTURE OF THE THESIS

The first part of Chapter Two focuses on the literature I review, where I look at the research studies about conceptualizations of the relationship between mathematics and language. I further look at the literature on the conceptualization of the procedural and conceptual mathematical Discourse. I then review literature that focuses on the creation of opportunities by the teacher for the development of procedural and conceptual mathematical Discourse. When looking at the research studies that focused on the development of procedural and conceptual mathematical Discourse, I explore the research debate about the role of teachers in multilingual mathematics classrooms. I then explore the literature on different language practices that mathematics teachers use and how they use them in multilingual mathematics classes, especially if the learners are taught by immigrant teachers whom they do not share the home language with.

The second part of Chapter Two describes my Analytical Framework in detail, explaining the theoretical concepts identified in the reviewed literature I used and why. I specifically explain how I use Gee's (2005) conceptions of Discourse and the six of his seven-building tasks about Pozzi's (2004) language functions on language use in multilingual mathematics classrooms.

In Chapter Three I describe the research design and methodology used in the study. The chapter also looks at the validity and reliability of the study. I also discuss ethical considerations for data collection processes.

Chapters Four, Five, and Six present the analysis of each of the three teachers' lessons and the language practices that they use while engaging the learners in mathematical Discourse. I present the findings about each teacher in separate chapters because they taught different mathematical topics. I use each chapter to focus on the specific context of each case and the concept taught by each teacher, using each chapter section to provide an in-depth reading of my analysis of each lesson and providing a clear understanding of the language practices that were used and how the teachers used them when they were using the three Pozzi's (2004) language functions. I use these three chapters to analyze a comprehensive understanding of how teachers created opportunities for the development of procedural and conceptual mathematical Discourse.

Chapter Seven presents the key findings from the analysis of the lessons presented by the three immigrant teachers from the three Gauteng province schools. The discussion in this chapter looks at how and why the three teachers used the language practices the way they used them when using Pozzi's language functions. It also looks the Gee's (2011) meaning they built while building mathematical knowledge.

1.6 CONCLUSION

This chapter has outlined the origins of my research and its location in the South African context. It also gives a rationale for the study as well as the research questions that guided the study. The chapter further highlights the significance of the study concerning the language practices used by immigrant teachers in English additional language mathematics classrooms in South Africa.

CHAPTER 2: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 INTRODUCTION

The study looks at the language practices that immigrant teachers use to enable procedural and conceptual mathematics in English additional language multilingual mathematics classrooms in South Africa. Given the focus of my study as stated in Section 1.2, in Section 2.2 in this chapter I review the literature on research studies about conceptualizations of the relationship between mathematics and language; the conceptualization of the procedural and conceptual mathematical Discourse; and the creation of opportunities by the teacher for the development of procedural and conceptual mathematical Discourse. I, thereafter, focus on the research debate about the role of teachers in multilingual mathematics classrooms in creating opportunities for the development of procedural and conceptual mathematical Discourse. Lastly, I discuss the different language practices that mathematics teachers use and how they use them in multilingual mathematics classes, especially if the learners are taught by immigrant teachers whom they do not share the home language with.

In Section 2.3 I describe in detail the theoretical concepts identified in the reviewed literature I use in my study, and I explain why. I describe the social practice perspective of language, focusing on the language practices that teachers use when enabling procedural and conceptual mathematical knowledge. I specifically explain how I use Gee's (2005) concept of Discourse and the seven-building tasks in relation to Pozzi's (2004) language functions as applied in my study of teachers' language use in multilingual mathematics classrooms. I also present my Analytical Framework which, as described in Chapter 3, I produced by using my selected theoretical concepts in relation to my data.

2.2 LITERATURE REVIEW

In this section, I present an account of the literature regarding the creation of opportunities for the development of procedural and conceptual mathematical Discourse in multilingual classrooms taught by teachers who do not share a home language with the learners, including immigrant teachers.

2.2.1 Research perspectives on the relationship between language and mathematics

Before the 2000s, much of mathematics education research was influenced by the dominant psychological or cognitive perspective, which underscored the importance of self-regulation in learning and independence from external support (Morgan, 2006). Learning mathematics was viewed primarily as a cognitive endeavor. Ojose (2008) contends that cognitive perspectives prioritize the development of mathematical thinking and reasoning skills, including critical thinking, logical reasoning, pattern recognition, and establishing connections between different mathematical concepts. Within this framework, teachers play a crucial role in guiding learners to discover concepts through investigation while encouraging self-checking, approximation, reflection, and reasoning (Ojose, 2008). Sawyer & Ranta (2001). argues that the cognitive perspective on language highlights the role of mental processes, cognitive structures, and internal representations in language acquisition, production, and comprehension. In mathematics, this perspective suggests that language is not merely a tool for conveying mathematical ideas but an integral component of the cognitive processes involved in mathematical thinking and problem-solving (Radford & Barwell, 2016).

In the late 1900s, there was a notable shift in mathematics education research from a cognitive perspective to a social perspective, termed by Lerman (2000) as the 'social turn', which viewed mathematics as a social practice. This perspective extends beyond language considerations, recognizing that mathematical understanding is deeply intertwined with social interactions and contexts. Lerman (2000) argues that the 'social turn' signifies a shift in understanding mathematical meaning, thinking, and reasoning as products of social activity, thus impacting learning. Social activity involves language in a distinct manner compared to cognitive perspectives. Lerman (2000) contends that mathematics should be viewed as deeply embedded within socially organized activities and systems of meaning within a community, emphasizing the importance of the person within social practice rather than in isolation (Lerman, 2000). Within this framework, language and other forms of communication play crucial roles within social environments, such as mathematics classrooms.

The relationship between language and mathematics within mathematics education research has also been produced by drawing on thinking from outside of mathematics education, for instance, Vygotsky (1987). Jeon (2000) argues that Vygotsky's sociocultural theory has been influential in shaping the way we think about the relationship between language and mathematics in mathematics education research. Vygotsky's (1987) theory emphasizes the importance of social interaction and cultural context in the development of mathematical concepts and skills. This perspective has led to a shift from a cognitive perspective to a social perspective in thinking about the relations between language and mathematics within mathematics education research. According to Vygotsky (1978), whose work has been used in mathematics education, once thought and language merge, social language is first internalized, and then later it is externalized as one converses with others.

In the field of mathematics education, there's a growing acknowledgment of the pivotal role language plays in learning, teaching, and mathematical engagement. Morgan et al. (2014) highlight a connection between the social perspective and language, viewing language as a social tool for both self-expression and communication. Their literature review points to a significant shift away from a purely cognitive perspective toward recognizing the significance of language in mathematical contexts. Moreover, research literature emphasizes increased participation in groups exploring the intersection of language and mathematics from social perspectives (Morgan et al., 2014; Planas & Pimm, 2024). Morgan et al. (2014) further emphasize the growing recognition, within classroom practice, professional discourse, and policy, of the crucial role of language-rich activities, often described as 'conversation', 'discussion', or 'discourse', in fostering mathematical learning (p. 2). The review indicates thatwithin mathematics education literature in social perspectives, language is conceptualized in each of the following ways:

> *dealing solely with words (referred to variously as natural language, verbal language,etc.) or including non-verbal modes of communication, especially (or indeed sometimesexclusively) mathematical symbolism, but also diagrams, graphs, and other specialized mathematical modes as well as gestures and other modes of communication used in a variety of settings* (Morgan et al., 2014; p. 3).

Morgan et al.'s (2014) review identified the multimodal nature of language which includes verbal and non-verbal language, which resonates with Gee's conception of a small 'd'. However, Gee's (2011) work is not specific to mathematics education. He views language as functional, where language is considered a social practice (see more details in Section 2.3) (Gee, 2011). Therefore, language has a role in mathematics teaching and learning because mathematics knowledge is constructed through social interaction which requires language.

Other researchers, such as Moschkovich (2007, 2012, 2015), Nkambule (2012), and Setati (2001), frequently rely on Gee (1999) for their language and mathematics research due to Gee's(1996) perspective of language as a social practice, aligning with the notion of Discourse. Moschkovich's

(2007) and Setati's (2001) studies, which incorporate Gee's (1996) differentiation between discourse and Discourse, exemplify a shift towards the social practice perspective in mathematics education. Moschkovich (2015) indicates that mathematical Discourse encompasses a variety of resources, including oral and written text, various modes of representation (such as gestures, drawings, and symbols), and different registers (including school mathematical language, home languages, and everyday language).

Moschkovich (2012) argues that in mathematical Discourse, there is an interaction of the three semiotic systems involved, which are natural language, mathematics symbol systems, and visual displays. Moschkovich's (2015) perspective draws on a comprehensive communicative and multimodal repertoire that includes not only written text but also other inscriptions, oral communication, gestures, and objects. This definition concurs with Gee's (2011) definition of Discourse which includes non-verbal 'stuff' which are gestures, objects, drawings, tables, graphs, symbols, etc. Setati (2001) uses Gee's definition of Discourse (but calls it 'discourse' when she describes mathematics communication that uses the capital letter 'D' for Discourse, an issue I discuss in Section 2.3).

According to Gee (1999), the capital letter 'D' refers to different ways in which human beings integrate language with non-language "stuff," such as the "forms of life which integrate words, acts, values, beliefs, attitudes, social identities, as well as gestures, glances, body positions, and clothes" (Gee, 1990, p. 142). The social practice perspective view of learning is also used by Pozzi (2004), where she talks about the form and functions of language for teachers (see details in Section 2.3). Like Gee (2011), Pozzi (2004) also views language as functional, implying that language has meaning through and in social practices.

The trend of rethinking the relationship between language and mathematics learning observed in international reviews during the late 1990s was reflected in South African research at that time. South African researchers, notably, have been significant contributors to this discourse on language. Adler's (1998) work is illustrative, discussing a shift towards participatory or learner-centered classroom practices in multilingual classrooms in South Africa. She argues that this shift entails more communicative and language-rich mathematics classrooms. Adler (1998) notes her growing interest in language within the context of mathematics learning as classrooms became more communicative and language-rich, particularly following the introduction of the National Curriculum Statement in South African mathematics education.

The introduction of the post-apartheid mathematics curriculum, Curriculum 2005, emphasized the importance of mathematical conversations in classrooms, highlighting that mathematical understanding is expressed, developed, and contested through language, symbols, and social interaction (Department of Education, 1997). This emphasis on language usecontinued in the more recent Curriculum and Assessment Policy Statement (CAPS), which underscores the importance of learners developing the correct use of mathematical language asthey learn to listen, communicate, think, reason logically, and apply mathematical knowledge (CAPS, Mathematics, Grade 4 to 6, 2011). These curriculum frameworks necessitate that teachers engage learners in mathematical conversations and teach formal mathematical language to all learners.

Some researchers, including Norén (2015), Planas (2011), Planas & Civil (2013), and Setati (2005, 2008), have incorporated a socio-political perspective into their exploration of mathematics and language as social practices (Barwell, 2016). In South African mathematics classrooms, particularly in the late 1990s, research began to examine language use in multilingual classrooms not only as a social but also as a political phenomenon (Adler, 1998; Setati, 2008). Setati (2008) argues that language use in South African mathematics classrooms holds political implications, as it affects learners' access to learning and participation in multilingual classrooms, where learners must engage with mathematics in a language, they arenot fluent in. English dominates these classrooms, as it is perceived as the language of opportunities (Adler, 1998; Robertson & Graven, 2019; Setati, 2008).

Barwell (2016) argues that there are differing perspectives on language in mathematics education research within the socio-political. Some researchers adhere to a more fixed view of language itself, which is regarded as a monoglossic view of language, while others adopt a more fluid perspective, such as heteroglossia. In a monoglossic view, languages are seen as distinct, separate, and fixed codes, each existing within its own bounded space, hence the common focus on code-switching as a language practice (Guzula, McKinney & Tyler, 2016). Barwell (2016) portrays code-switching as reflecting a monoglossic view of language, which overlooks the reality of multilingual individuals who frequently demonstrate the dynamic and fluid nature of language use. This monoglossic perspective aligns with earlier work like Adler's(1998) and Setati's (2005, 2008), in which the focus is on code-switching as a language practice.

More recently, mathematics education researchers within the socio-political perspective have moved towards a heteroglossic perspective of language, following Bakhtin (1981), for example, Essien & Sapire (2022), and Tyler (2016). In Barwell's (2016) view, language in education is not monolithic, consisting only of named language codes,but rather multifaceted, incorporating the language of teachers, the language of mathematics, regional dialects, and potentially other linguistic influences. According to Barwell (2016), this inclusive approach fosters an appreciation for linguistic diversity. It empowers individuals to engage with language in all its forms as the different linguistic varieties are not mutually exclusive but coexist within the same discourse or interaction (Barwell, 2016). Tyler's (2016) research in South Africa has also been approached using a heteroglossic perspective of language. She describes the heteroglossic perspective of language as fluid and dynamic, challenging the traditional notion of clear boundaries between linguistic codes (Tyler, 2016). Given this perspective, researchers adopting this perspective of language commonly refer to the language practice of translanguaging.

While much of the work I draw on has focused solely on the language practice of code-switching, in this study I look at a range of other language practices, such as formal and informal mathematical language, gestures (Chikiwa, 2021), previously learned mathematical concepts (Westaway, Chikiwa & Graven, 2019), different forms of questions, decomposition (Robertson & Graven, 2020), images, learners' everyday context (Chikiwa & Schäfer, 2019; Dhlamini, 2020) and revoicing (Robertson, 2017).

In this study, I have chosen to view my data using a monoglossic perspective of language, and hence the language practice of code-switching, Monoglossic, and heteroglossic perspectives of language can be associated with different named language practices. In this study, I use the earlier work of the researchers Setati, Adler, and Moschkovich, who adopted the use of code-switching as a language practice in mathematics education (and an implicit monoglossic perspective). I acknowledge that some of these researchers have also gradually shifted to translanguaging (underpinned by a heteroglossic perspective of language). This study can provide a strong theoretical foundation for understanding how language practices, such as code-switching, can be used in diverse classrooms in the contexts where my study was conducted. However, by adopting a monoglossic perspective, I may have missed opportunities to explore the fluidity of language use, including the rich practice of translanguaging that supports learning, as highlighted by Essien & Sapire (2022).

The theoretical framework I use is Gee's (2005) Discourse analysis, focusing on building tasks, one of which is 'building politics'. Building politics aligns with viewing language through social and political lenses, particularly in the context of code-switching. As indicated earlier in this section, code-switching reflects teachers' ability to navigate between languages, marking social boundaries and political power. I am following the work of the people who use a social practice and political perspective; therefore, I am aware that by taking this monoglossic perspective as a lens for my study, I may have missed the opportunities to study the fluidity of language use for meaning-making as well as interconnectedness and integrated language use in my study.

2.2.2 Procedural and conceptual mathematical knowledge

In this section, I first focus on the notion of discourse in a social practice perspective of language. Thereafter, I focus on how mathematical Discourse, in general, is conceptualized inmathematics education research. Lastly, I focus on the literature on procedural and conceptual mathematical Discourse individually, and then also, on how they are intertwined for mathematical meaning. I then indicate why in this study I used ‘Discourse’ with the capital letter D.

Moschkovich (2015) indicates that mathematical discourse “draws on hybrid resources and involves not only oral and written text, but also multiple modes, representations (gestures, objects, drawings, tables, graphs, symbols, etc.), and registers (school mathematical language, home languages, and the everyday register)” (p. 44). Moschkovich’s (2015) definition concurs with Gee’s (2011) definition of a big ‘D’. The reviewed literature discussed next in this section suggests that mathematics instruction is characterized by two key and interconnected discourses: procedural and conceptual. These have been defined by several researchers such as Kilpatrick, Swafford & Findell, (2001); Setati (2001); Österman & Bråting (2019) as well as Nahdi & Jatisunda, (2020). In this section, I review the key ideas in these different researchers’ definitions. I look at why procedural and conceptual mathematical discourses are significant and in what way. This allows me to locate my conceptualization in this study (see Section 2.3).

Setati (2001) defines conceptual understanding as the ability of learners to comprehend the procedures needed to solve a problem, along with understanding why, when, and how those procedures work. Procedural mathematical discourse, on the other hand, is described as the execution of procedures without a focus on understanding the underlying reasons for their effectiveness (Setati, 2001). This notion aligns with Stein, Smith, Henningsen & Silver’s (2000) concept of ‘procedures without connections’, where learners perform tasks using memorized procedures in a routine manner. Kilpatrick et al. (2001) define procedural fluency as part of a broader mathematical proficiency framework, which includes conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. They assert that procedural fluency emerges only after the development of conceptual understanding. In procedural fluency, learners possess the ability to execute procedures flexibly, accurately, and efficiently, thereby supporting conceptual understanding by linking concepts to procedures. Kilpatrick et al. (2001) emphasize that when learners grasp the concepts, they are equipped to determine which procedures to employ, when to use them, and how to utilize them effectively.

Kilpatrick et al. (2001) define conceptual understanding, which closely aligns with Setati's (2001) concept of conceptual mathematical discourse. While the terminology may differ, both concepts emphasize the importance of understanding mathematical concepts to support procedural fluency. If learners struggle to connect procedural and conceptual mathematical knowledge, they may lack the necessary resources to fully comprehend a mathematical topic (Nahdi & Jatisunda, 2020). Despite variations in terminology, researchers agree that both procedural and conceptual mathematical knowledge are essential for learning mathematics and they are interconnected for meaningful mathematical understanding (Kilpatrick et al., 2001 and Setati, 2001).

In this study, the mathematical Discourse I am referring to includes language that works in conjunction with non-language such as objects, actions, interactions, context, etc., which is beyond verbal interaction when constructing mathematical understandings, as defined by Gee (2011). For this study, I use the capital letter 'D' which relates to Gee's (2011) definition, which I will explain in detail in Section 2.3, where I discuss my theoretical framework in detail. I include Gee's (2005) building tasks that help me to conceptualize Discourse with a big 'D' as not just about speaking, writing, images, gestures,etc., and not just mathematical knowledge, but also about politics, identity, relationships, connections, sign systems, etc. So, as I continue with my literature review in this section, I will be using the capital letter 'D' when referring to 'Discourse.' In this study, I define procedural Discourse as being related to procedural fluency, as defined by Kilpatrick et al. (2001), and to procedures with connections, as defined by Stein et al. (2000). I define conceptual Discourse in line with Setati's (2001) and Kilpatrick et al.'s (2001) definition of conceptual understanding and procedural fluency (see my Analytical Framework in Table 2.1. Column 3 in Section 2.3).

2.2.3 The role of the teacher when creating opportunities for the development of procedural and conceptual mathematical Discourse

As discussed in Sections 2.2.1 and 2.2.2, all learners need to learn to use procedural and conceptual mathematical Discourse, and therefore a teacher has a role to play. The literature emphasizes the necessity for teachers to possess robust procedural and conceptual knowledge (Blömeke, Kaiser, König & Jentsch, 2020), enabling them to engage in productive mathematical conversations (Österman & Bråting, 2019; Pourdavood & Wachira, 2015; Stein et al., 2000) as discussed in Section 2.2.2. Teachers are encouraged to facilitate meaningful mathematical discussions by articulating concepts to learners and providing ample opportunities for dialogue to nurture conceptual understanding.

When facilitating conceptual mathematical discourse, teachers must use diverse questioning techniques (McCarthy, Sithole, McCarthy, Cho & Gyan, 2016). Effective questioning by teachers should provide learners with opportunities to formulate conjectures, justify their answers, engage in discussions, question, articulate, and agree or disagree on mathematical ideas to foster the development of crucial mathematical concepts (Setati, 2001; Siyepu & Ralarala, 2014; Stein, 2007). Building upon the literature's emphasis on the teacher's pivotal role, concepts from Pozzi's (2004) work are used, focusing on how teachers utilize language for specific functions. The significance of the teacher's role in shaping procedural and conceptual mathematical discourse, as discussed in Section 2.2.3, prompted an investigation into their language practices, considering both the form and the meanings they convey or the functions they serve, as outlined in Pozzi's (2004) language functions (Table 2.1, Column 1).

As outlined in Section 2.2.1, Pozzi (2004), researchers like Gee (2005), and those in mathematics education such as Adler (1998) and Setati (2008), adopt a social practice perspective of language, viewing it as having both form and function. Pozzi (2004) gives 23 language functions that are grounded in linguistic theories and educational research on language use in learning contexts, which was not using mathematics education. As much as most of the language functions can potentially be used in a mathematics lesson, I only chose three for this study: description of things and actions, asking informational questions, and clarification of questions. The focus of my study is on how teachers create opportunities for the development of procedural and conceptual mathematical Discourse. In multilingual mathematics classrooms, teachers describe mathematical concepts and procedures to bridge abstract concepts with practical applications, enabling conceptual understanding (Smith & Cekiso, 2020). Asking informational questions helps assess learners' understanding (Goos, Geiger, & Dole, 2023) and clarification of questions enabling full participation by removing barriers (Fuller, 2023). These language functions have been adapted for use in facilitating procedural and conceptual mathematical Discourse, as detailed in Section 2.3.1.

Part of the aspect for creating opportunities for the development of procedural and conceptual mathematical knowledge requires the teacher to describe things, which are mathematical concepts and actions, which are mathematical procedures in this study, to help learners visualize and comprehend abstract mathematical concepts. For instance, when describing things and actions, the teacher provides clear explanations and representations so that learners can make sense of complex information. Asking informational questions provides learners with an opportunity to think deeply about mathematical problems and concepts, thus promoting active participation that leads to deeper exploration of mathematical ideas, for instance, justification of answers. Clarification of questions by teachers helps them address misunderstandings in learners, ensuring correct and complete understanding of concepts and procedures, thus enhancing learning. The teachers' utilization of these language functions from Pozzi (2004) becomes particularly significant when learners are not studying mathematics in their home language, as discussed in Section 2.2.4.

2.2.4 The teaching and learning of mathematics in multilingual classrooms in the South African context.

In the South African context, particularly since post-1994 reforms, many classrooms have become multilingual, encompassing various contexts such as rural areas, informal settlements, townships, and urban areas. Before 1994, Gauteng province, like much of South Africa, was characterized by racial and linguistic segregation, with communities divided by race and language. Different areas were designated for specific ethnic groups, such as Zulu, Sotho, Setswana, and Xhosa sections. This segregation led to monolingual schools, as each school primarily served learners from the surrounding community, reinforcing the separation based on language and ethnicity (McKinney, 2020). In these multilingual classrooms, learners and teachers may speak a variety of first languages other than the Language of Learning and Teaching (LoLT) used from Grade Four, which could be English or Afrikaans (Guzula et al., 2016).

However, according to the Language in Education Policy (DoE, 1997), from Grade Four onwards, the LoLT in English additional language mathematics classrooms is English, while in Afrikaans medium schools, it is Afrikaans. Consequently, English additional language learners in these multilingual mathematics classrooms are expected to participate in mathematical discussions in English or Afrikaans as per the Curriculum and Assessment Policy Statement (CAPS) document (DoE, 2011). In this study, I focus on the language practices used by immigrant teachers in a South African context where learners are taught mathematics in English, which is not their home language.

The language functions that I have chosen have a significant role to play when teachers create opportunities for the creation of procedural and conceptual mathematical Discourse in multilingual classrooms. For multilingual learners, these descriptions often serve as a bridge between abstract mathematical ideas and their practical applications (Adler, 2002). Teachers may describe by simplifying and rephrasing instructions, making sure mathematical concepts are understood across languages (Setati, 2005). In a multilingual setting, the technique of asking questions often assists in assessing learners' understanding of concepts across language barriers (Adler, 2001). Clarifying questions may allow teachers to address confusion using strategies like code-switching, ensuring that learners from diverse linguistic backgrounds can fully participate in the Discourse (Adler & Setati, 2000).

Guzula et al. (2016) stress the complexity of multilingualism in classrooms, where the mix of languages used by teachers and learners varies. Despite this complexity, teachers are expected to address policy requirements and create opportunities for the development of procedural and conceptual mathematical Discourse for all learners. Additionally, teachers in these contexts, regardless of their own language resources, are tasked with the dual role of teaching language and content simultaneously in mathematics classrooms for English additional language learners (Tyler, 2016). This prompts the teachers to do more as they describe mathematical procedures and concepts, ask informational questions, or clarify questions, which resonates with Pozzi's language functions which I have explained in section 2.2.3.

Although the South African policy landscape favors multilingualism, as explained in Chapter One, the early exit from home language to English language instruction makes it difficult for English additional language learners to cope (Tshuma, 2017). Research shows that it is harder for some of these learners to cope with fluency because of English language challenges in these mathematics classrooms (Moschkovich, 2007; Nkambule, 2013; Setati, 2005). This is supported by Barwell (2018) who indicates that:

> *Multilingual students are too often found in disadvantageous situations, whether through a lack of recognition of their multilingual proficiency, a lack of infrastructure to support the use of multiple languages in mathematics classrooms, or the systematic suppression of students' home languages* (p. 166).

Setati, Chitera & Essien (2009) emphasize the challenge faced by mathematics teachers in multilingual classrooms, where mathematical concepts are typically taught in English without available translation resources into the African language, hindering mathematical understanding. Despite the language challenge, teachers are expected to creatively manage the interaction between English and learners' home languages while developing both procedural and conceptual mathematical knowledge (Maluleke, 2019) as described in Section 2.2.2. This highlights the importance of ensuring all learners, regardless of language background, actively engage in mathematical Discourse through speaking, listening, reading, and writing (Barwell,Chapsam, Nkambule & Phakeng, 2016; Setati, 2001; 2008).

As indicated in Section 2.2.1, in this study, I do not view language in the fluid way as Tyler (2016) does, but I see these language practices as isolated. I am actually looking for where teachers use the practice of code-switching, where I choose to see identifiable boundaries between languages used by teachers in their mathematics classes. In my study, while adopting a monoglossic perspective, like Moschkovich (2015), I am also looking at other aspects of language which include images and gestures and other wider perspectives on language practices (see Table 7.1, Column 2). I am also asking the reasons why teachers chose such language practices. My theoretical approach points to the need to explore meanings that were built while the teachers were building procedural and conceptual mathematical knowledge.

Adler (1998) emphasizes the challenges faced by teachers in multilingual mathematics classrooms, particularly regarding the code-switching dilemma. This dilemma arises from the need to balance developing learners' language of learning and teaching (LoLT) while ensuring comprehension of mathematical concepts. In her study, Adler (1998) identifies three key dilemmas, which were code-switching, mediation, and transparency that teachers encounter when navigating the teaching-learning process in English additional language classrooms. The evidence of a code-switching dilemma is exemplified by one teacher's struggle between using the learners' home language for comprehension and English for language mastery (Adler, 1998). Research in various multilingual contexts in South Africa has shown that teachers use various language practices, including but not limited to code-switching. With my social practice perspective, I explore a range of language practices, each discussed in detail in 2.2.5, in the next section. I am reviewing relevant research on what language practices teachers have been shown to use, as relevant to my context. I give a brief description of each and how it is used, especially to assist learners with both conceptual and linguistic challenges.

The literature reviewed highlights the complex role of language in multilingual mathematics classrooms, particularly focusing on South African contexts with English additional language learners. (Tyler, 2016). Teachers navigate diverse language practices to help learners access mathematics, shifting between different discourses to enable the development of procedural and conceptual mathematical Discourse. From a social practice perspective, as indicated in Section 2.2.3, the teacher plays a crucial role in creating opportunities for learners to participatein the Discourse of school mathematics. Teachers must plan effectively to address language challenges in the LoLT, ensuring that all learners can benefit from language practices from the use of language practices (Robertson & Graven, 2019).

Research has explored various language practices teachers use in South African mathematics classrooms, ranging from isolated language use to multimodal approaches incorporating code-switching, translanguaging, and visual aids (Tyler, 2016; Robertson & Graven, 2019, 2020; Chikiwa, 2021). These practices serve to enhance classroom interaction and promote learning opportunities for all students (Chikiwa & Schäfer, 2019).

2.2.5 The teachers' language practices when creating opportunities for the development of procedural and conceptual mathematical Discourses.

The focus on the teachers' use of language practices in mathematics classrooms is critical for understanding how they create opportunities for the development of both procedural and conceptual mathematical Discourses. Teachers play a key role in navigating between procedural and conceptual mathematical Discourses, using language as a tool to build mathematical knowledge.

In multilingual classrooms, where learners speak a different home language than the LoLT, teachers often rely on specific language practices to bridge mathematical gaps in understanding (Planas & Setati, 2009). By using various language practices teachers can help learners develop both procedural fluency and deep conceptual understanding and thus learners become able to engage more fully with the mathematical content, especially in diverse and multilingual settings.

While recognizing the importance of studies from various contexts and their global relevance regarding the use of language practices in mathematics classrooms, I acknowledge that there is a range of language practices. I have identified a range of language practices in the literature, from various contexts and their global relevance regarding the use of language practices in mathematics classrooms. I then worked with these language practices aligning with a monoglossic perspective of language., an approach which I have chosen to frame my study, informed by Adler (1998), Setati (2008), Planas & Setati-Phakeng (2014), Moschkovich (2007) and others' research work.

The key language practices discussed in the literature include the use of English language and formal mathematical language, informal mathematical language, code-switching, translanguaging, decomposition, different forms of questions, revoicing, gestures, images, previously learned mathematical concepts, as well as learners' everyday context. I then worked with these language practices in relation to the data, consistent with a monoglossic perspective of language, an approach I have chosen to frame the study. This approach is informed by the research of Adler (1998), Setati (2008), Planas and Setati-Phakeng (2014), and Moschkovich (2007), among others. Teachers draw on these practices to engage learners and create meaningful learning experiences in their mathematics classrooms. Only in Table 2.1, which is my Analytical Framework, and in Section 2.3.2, do I mention the language practices I chose from the three teachers' lessons and discuss these language practices in detail.

2.2.5.1 English language

In this study, a language practice termed 'English language' is defined as the use of English for words, discourses, and registers, predominantly used as the official LoLT for South African learners (Setati, 2008). English proficiency is essential for understanding and engaging with mathematical concepts in multilingual classrooms. English language as a language practice refers to the intentional use of English in teaching and learning environments, especially in multilingual classrooms where it may serve as the language of learning and teaching (LoLT) or as an additional language for learners. In this context, English is not just a tool for communication but a critical resource for accessing curriculum content, which is mathematics in this study. In various research studies, teachers use English language to strategically introduce, explain, and reinforce formal mathematical concepts, often alongside other language practices, such as code-switching or translanguaging, to support learners who are still developing their English proficiency (Adler, 1998; Setati, 2008, Maluleke, 2019).

Across multiple studies, there is agreement that learners with stronger English skills tend to perform better in mathematics. Moschkovich (2007) highlights that English proficiency is critical for grasping complex mathematical ideas and emphasizes the need to integrate both language and content learning for English language learners. Clarkson (2007) points out that limited English proficiency hinders learners' ability to understand mathematical terms, calling for language development support. This is supported by Riccomini, Smith, Hughes & Fries (2015) who stress the importance of explicit English language instruction to help learners understand mathematical meanings.

Maluleke's (2019) research in South Africa found that Grade Six mathematics teachers of English additional language learners indicated the importance of fluency in the language of mathematics instruction, as it correlates with better performance in mathematics and aids in articulating comprehension of concepts. Similarly, Ledibane, Kaiser & Walt (2018) highlights the significance of acquiring English as a second language in multilingual classrooms, asserting that mathematical learning is heavily reliant on English language acquisition. Furthermore, Riccomini et al. (2015) suggest that teachers may utilize English language to clarify formal mathematical terms and enhance learners' understanding of mathematical meanings.

Research conducted by Chikiwa & Schäfer (2014) and Mahofa & Adendorff (2014) reveals that some teachers prefer to use English language as a predominant language practice in their mathematics classrooms, despite teaching English additional language learners. In Chikiwa & Schäfer's (2014) study conducted in Grade Eleven mathematics classrooms in the Eastern Cape, where learners primarily spoke isiXhosa, teachers emphasized the importance of English due to its use in textbooks, as well as its role as the LoLT and language of assessment. Similarly, Mahofa & Adendorff (2014) found in their study with isiXhosa-speaking teachers in Grade Ten mathematics classes in the Western Cape that some teachers supported the use of English in their classrooms. They cited the need for English due to its usage in textbooks for describing mathematical concepts, despite acknowledging the usefulness of code-switching for enhancing learner comprehension (Mahofa & Adendorff, 2014).

2.2.5.2 Formal mathematical language in English.

Setati & Adler (2000) define formal mathematical language as the standard use of terminology, known as mathematics register, developed within formal educational settings like schools. Jourdain & Sharma (2016) further elaborate on formal mathematical language, describing it as a specialized form of language containing precise definitions for mathematical terms and concepts. They note its association with specific languages of instruction, such as English, Afrikaans, or the learners' home language, which serves as the Language of Learning and Teaching (LoLT) in South Africa.

Teachers across various research studies recognize the crucial role of formal mathematical language in supporting students' understanding and engagement with mathematical concepts. Setati & Adler (2001) argue for the importance of learners acquiring proficiency in both spoken and written formal mathematical language within mathematics classrooms. Moschkovich (2012) highlights that integrating formal mathematical language into instruction supports both content comprehension and language development, viewing it as essential for academic success. Schleppegrell (2007) and Barwell (2016) both emphasize that this language is vital for meaningful participation in mathematical discussions and effective learning, advocating for explicit instruction to enhance learners' comprehension and performance. Clarkson (2007) and Riccomini et al. (2015) also stress the importance of teaching formal mathematical language, noting its significant impact on learners' ability to understand mathematical terms and improve their overall performance.

Robertson & Graven (2019) emphasize the necessity of learners being proficient in their LoLT to comprehend concepts and excel in mathematics in South Africa. Additionally, Riccomini et al. (2015) advocate for the development of learners' vocabulary in the LoLT and mathematics to enhance their understanding of concepts. Dhlamini (2020) emphasizes the importance of teachers' understanding of formal mathematical language and its effective use in the classroom to prevent learner confusion. Learners are expected to learn formal mathematical language alongside mathematics, as it is crucial for the development of procedural and conceptual mathematical knowledge (Erath, Ingram, Moschkovich & Prediger, 2021; Barwell, 2013).

2.2.5.3 Informal mathematical language

Informal mathematical language in mathematics refers to language that may deviate from formal mathematical conventions but is commonly used for explanations and communication in teaching mathematics (Barwell, 2013). Barwell's (2016) research explores how learners and teachers in multilingual classrooms use informal, everyday language to engage with mathematical concepts, highlighting its role in bridging learners' understanding of abstract ideas. He emphasizes the value of informal language as a resource for making mathematics more accessible, particularly through strategies like code-switching and translanguaging, which connect home languages to formal instruction. Barwell (2016) advocates for teaching practices that integrate informal language into mathematical discourse, promoting inclusivity and deeper comprehension in diverse educational settings.

The informal mathematical language can be in either English or the learners' home language. For instance, the term 'ascending order' may be expressed as 'going up,' or 'nyulusetsa' in Setswana which could involve code-switching, which is also part of my study. Setati (2008) suggests that incorporating informal mathematical language assists in understanding abstract mathematical concepts. Teachers in Graven & Robertson's (2020) study conducted in South African classrooms revealed that using informal mathematical language helps bridge the gap between formal mathematical terminology and learners' linguistic backgrounds. Similarly, teachers in Chikiwa & Schäfer's (2019) study emphasized that informal mathematical language creates opportunities for learners to discuss mathematical ideas using their preferred language resources. Chikiwa (2021) and Chikiwa & Schäfer (2019) have investigated the role of informal mathematical language in promoting collaborative sense-making, especially in multilingual classrooms. Teachers often justify the use of simplified English when explaining mathematical concepts or clarifying questions, citing the complexity of mathematical content in the learners' home languages (Sikhondze & Goosen, 2010; Mahlambi & Mawela, 2021).

2.2.5.4 Code-switching between English and the learners' home language

Adler (2001) defines code-switching as a practice that is described as the use of two or more languages in the same statement or conversation. As explained in Section 2.2.4, researchers using a social practice perspective of language (commonly underpinned by a monoglossic perspective of language) have identified the use of code-switching in South African mathematics classrooms as a common practice (Guzula et al., 2016). Code-switching serves as an interactional resource for teachers to convey mathematical knowledge to learners who may struggle with expressing themselves solely in English within multilingual contexts (Maluleke, 2019; Robertson & Graven, 2019; Setati et al., 2009). Research conducted in South African English additional language classrooms reveals varied perspectives among teachers regarding the advantages of code-switching to learners' home languages. Robertson & Graven (2020) found in their study in multilingual mathematics classrooms in the Eastern Cape that learners' home languages were considered valuable resources for understanding questions, rather than hindrances.

Code-switching allows teachers to bridge everyday language and formal mathematical discourse, helping learners grasp complex concepts more effectively (Barwell, 2005; Moschkovich, 2002). Moschkovich (2007) highlights that teachers use code-switching to connect learners' home languages with the language of instruction, fostering a deeper engagement with mathematical reasoning. Similarly, Barwell (2005) explores how teachers in multilingual classrooms leverage code-switching to adapt instruction and support learners' learning processes, allowing them to make connections between their cultural and linguistic backgrounds and mathematical content.

Conversely, Chikiwa & Schafer (2014) observed in their research in English additional language classrooms, where isiXhosa was the home language, that teachers discouraged learners from using their home language, urging them to respond in English due to the language's dominance in textbooks and assessments. Similarly, teachers in Maluleke's (2019) study conducted in the Eastern Cape, South Africa, expressed concerns that code-switching hinders learners' proficiency development in English, their LoLT.

The teachers' contradicting opinions regarding language choices in these studies illustrate the dilemma faced by teachers regarding code-switching in multilingual classrooms, similar to the findings in Adler's (1998) study. Teachers in South African schools teaching mathematics in English additional language classrooms often find themselves torn between code-switching to learners' home languages and adhering strictly to English (Adler, 1998; Chikiwa, 2021; Chikiwa & Schafer, 2014; Robertson & Graven, 2019; Mahlambi & Mawela, 2021; Setati, 2005).

2.2.5.5 Translanguaging

Bakhtin (1981) posits that language is inherently heteroglossic, reflecting a diversity of voices and perspectives within discourse. Building on this foundational idea, recent mathematics education researchers operating within the socio-political perspective have increasingly embraced a heteroglossic view of language. For instance, researchers such as Essien & Sapire (2022) and Tyler (2016) explore how language in education is multifaceted, encompassing not only named language codes but also the language of teachers, mathematical terminology, regional dialects, and other linguistic influences. Barwell (2016) further emphasizes that this inclusive approach nurtures an appreciation for linguistic diversity, allowing different linguistic varieties to coexist and interact within the same discourse. Tyler (2016) echoes this sentiment, describing the heteroglossic perspective as fluid and dynamic, which challenges the traditional boundaries between linguistic codes. Consequently, researchers adopting this perspective often refer to the practice of translanguaging, which facilitates flexible language use in the classroom.

Barwell (2016) defines translanguaging as a language practice that facilitates learners' engagement in mathematical reasoning by using their full linguistic repertoire, supporting deeper cognitive processes and problem-solving abilities. He argues that translanguaging encourages an appreciation of linguistic diversity, recognizing that different language varieties that coexist and interact within the same discourse. Barwell (2016) argues that language in education should not be viewed as a fixed system of distinct language codes but rather as multifaceted, encompassing the language of teachers, mathematical terminology, regional dialects, and other linguistic influences.

This is a flexible, learner-centered approach, where teachers use home languages alongside English to enrich understanding in mathematics classrooms. It promotes equity by giving all learners, regardless of their linguistic background, access to mathematical discourse. By purposefully integrating different languages, educators create opportunities for learners to access and engage with complex mathematical concepts more effectively. This intentional use of translanguaging helps bridge language gaps, supports comprehension, and fosters deeper understanding in multilingual educational settings.

2.2.5.6 Decomposition

Decomposition in mathematics involves breaking down complex mathematical expressions, concepts, and definitions to enhance learners' mathematical understanding (Adendorff, Mntunjani, & Siyepu, 2018). In multilingual mathematics classrooms, decomposition, as a language practice involves breaking down mathematical problems or concepts into smaller, more manageable parts to enhance learners' understanding, particularly in diverse linguistic settings. This process also entails separating words into basic parts or elements, which can be done in either the LoLT or the learners' home language (Sleep, 2012). Robertson & Graven (2020) discuss a similar concept they term "unpacking," where complex mathematical concepts are broken down to facilitate understanding among Grade Four English additional language learners. This notion of decomposition aligns with the concept of informal mathematical language, as described earlier in Section 2.2.5.3.

Researchers such as Moschkovich (2002) and Planas & Civil (2013) have explored how decomposition is used in such environments to scaffold learning. They highlight decomposition as a method that supports learners' conceptual understanding in multilingual classrooms by allowing them to focus on each element of a problem in their home language before transitioning to the formal mathematical language, enhancing both comprehension and participation (Planas & Civil, 2013).

In their study conducted with grade six mathematics students in South Africa, Botes & Mji (2010) developed a tool to help learners connect English mathematical terms with terms in their own languages, facilitating comprehension and conceptual understanding. For example, as shown in my study, a teacher may describe the mathematical term 'input value' by decomposing it into the words 'in' and 'put'. The teacher can thereafter focus on the pre-fix 'in' first, which is a preposition in English, and thereafter focus on the meaning of the word 'in' in Setswana which is 'ka fa gare.'

2.2.5.7 Different forms of questions

Different forms of questions as a language practice involve teachers using various question types to guide, assess, and enhance learners' understanding. In multilingual mathematics classrooms, this approach may help bridge language barriers and support the development of conceptual and procedural mathematical Discourse. By varying their questions, teachers address students' linguistic needs, foster engagement with mathematical content, and encourage active participation, ultimately facilitating meaningful discourse in diverse settings. Teacher questioning is a fundamental strategy in mathematics classrooms, promoting critical-thinking skills and deeper learning (Monteleone, Miller, & Warren, 2023). When asking informational questions, teachers often utilize different question forms, such as closed-ended and open-ended questions (Mahmud, Yunus, Ayub & Sulaiman, 2020a). Closed-ended questions have fixed answers, typically 'yes/no' or predetermined options, limiting critical thinking (Pate, 2012). In contrast, open-ended questions allow for multiple correct solutions, encouraging creativity and critical thinking (Aziza, 2017). Research by Planas (2014) and Moschkovich (2007) also highlights the role of different forms of questions in supporting multilingual learners in mathematics classrooms. Their work shows how questioning strategies help engage students, bridge prior knowledge, and facilitate a deeper understanding of mathematical concepts by adapting to diverse linguistic needs.

Robertson and Graven (2019) caution against "right answerism" in teacher questioning, where excessive emphasis is placed on finding the correct answer, neglecting the learning processand critical thinking (p. 215). Closed-ended questions are often associated with the right answerism as they aim for a single correct response, potentially hindering critical thinking and exploration (Soysal, 2023).

2.2.5.8 Revoicing

Revoicing, as defined by Enyedy, Castellón, Mukhopadhyay, Esmonde, & Secada (2008), involves a teacher repeating or clarifying whatlearners have said in a preceding turn, to foster conceptual understanding through active learner participation. This research on revoicing is also supported by Moschkovich's (1999) study on revoicing, conducted in multilingual mathematics classrooms in the United States with a high population of Spanish-speaking learners, which found that revoicing played a crucial role in supporting learners' mathematical understanding. The study concluded that revoicing not only facilitated greater learners' participation but also supported the development of conceptual and procedural knowledge by making mathematical ideas more explicit and accessible to multilingual learners.

Robertson (2017) highlights that when affirming learners' responses through revoicing, teachers aim to clarify and ensure mutual understanding, either by repeating verbatim or reformulating. This practice can also support comprehension when combined with code-switching, repeating learners' statements in another language, such as their home language or the language of Instruction (Enyedy et al., 2008). In Webb & Webb's (2013) study conducted in an English additional language mathematics classroom in South Africa, in a township school in Port Elizabeth, focusing on teaching strategies in language-diverse mathematics classes, findings show that teachers revoiced learners' ideas from their home language to English language, which was their LoLT.

2.2.5.9 Gestures

Novack & Goldin-Meadow (2017) define gestures as non-verbal movements, actions, or bodily expressions that accompany speech to convey mathematical meaning, including hand movements, facial expressions, and body posture. Teachers can utilize gestures to illustrate translations or clarify questions, especially regarding concepts like 'flow diagram'. This practice has become crucial in instructing English additional language learners (Chikiwa, 2021; Kasmer & Billings, 2017). This finding emphasizes the significance of gestures as a vital semiotic resource in multilingual mathematics classrooms. Cohen (2017) argues that gestures facilitate communication and comprehension among bilingual learners by complementing verbal explanations of mathematical concepts.

In a study conducted in Tanzania, Kasmer & Billings (2017) on a group of English-first language immigrant secondary education pre-service teachers from the United States found that gestures help convey meaning to English language learners, providing additional clarification beyond verbal expressions. Stott (2017) interviewed South African learners who reported that teacher's gestures assisted in deepening their understanding of mathematical concepts, suggesting that teachers should speak slowly, simply, and repetitively while gesturing to facilitate comprehension. Gestures and verbal language, whether in the language of instruction or the learner'' home language, complement each other and enhance the clarity of mathematical concepts (Chikiwa, 2021).

2.2.5.10 Images

Different researchers use varying terminology to describe what is referred to as 'image' in mathematics classrooms. Jourdain & Sharma (2016) define images as encompassing drawings, manipulatives, and visual diagrams, while Setati (2001) identifies images as drawings and graphs. Mainali (2021) describes images (or visual representations) as combinations of signs, characters, diagrams, objects, pictures, or graphs used to teach and learn mathematics and enhance mathematical understanding.

Setati (2001) and Moschkovich (2007) advocate for the utilization of various forms of images, such as drawings and graphs, in mathematics teaching to ensure comprehensive understanding among learners. Images serve as valuable tools in mathematics classrooms to support learners in grasping abstract concepts intuitively (Makina, 2010). Jourdain & Sharma (2016) assert that images, particularly when used in multilingual classrooms, facilitate mathematical comprehension, thus providing non-linguistic cues that can make abstract concepts accessible to all learners. Chikiwa & Schäfer (2019), focusing on English additional language teachers in the Eastern Cape, South Africa, emphasize the utility of images in enhancing conceptual understanding in multilingual mathematics classrooms, especially when linguistic translations are challenging. This is supported by Smith & Cekiso (2020) who argue that images assist learners, especially those with language challenges, in understanding complex mathematical concepts by offering a universal form of communication. Botes & Mji (2010) explored the use of an 'aid' with different languages and visuals that would assist learners in relating mathematics terms and concepts in English with terms in their own languages.

2.2.5.11 Learners' everyday context

Brown & Redmond (2017) define 'learners' everyday context as everyday meaning, which involves connecting mathematical concepts and skills with familiar contexts relevant to the learners' daily lives outside the classroom. This connection may utilize verbal or non-verbal language, where verbal language may involve informal mathematical language in English or the learner'' home language (Sibanda, 2019), as outlined in Section 2.2.5.9. Non-verbal language could include images and gestures linked to the learners' everyday context (Naidoo, 2012). Planas and Civil (2013) emphasize that using learners' everyday contexts as a language practice in multilingual mathematics classrooms makes abstract concepts more accessible by connecting them to familiar experiences.

Teachers use learners' everyday context to provide multiple entry points to mathematics, making mathematical concepts more meaningful and facilitating conceptual mathematical understanding (Brown & Redmond, 2017; Widjaja, 2013). Chikiwa & Schäfer (2019) emphasize the importance of careful selection of language and images by mathematics teachers when utilizing learners' everyday context to precisely demonstrate intended mathematical ideas, especially when actual objects from the everyday context cannot be brought into the classroom. I am aware that teachers sometimes assume that learners are already familiar with the learned concepts and the context they refer to in class. However, there is a possibility that some of the learners in these classrooms may have never been exposed to the concepts and the contexts the teachers are referring to.

2.2.5.12 Learners' everyday context

Brown & Redmond (2017) define learners' everyday context as everyday meaning, which involves connecting mathematical concepts and skills with familiar contexts relevant to learners' daily lives outside the classroom to make concepts more relatable and understandable. In this study, I refer to learners' everyday context as the language practice used by a teacher when incorporating real-world situations into instruction. Since my study is not about how learners learn, I also do not assume that learners have necessarily been exposed to the context the teacher is referring to or learned it. In some cases, a teacher's interview talk pointed to an assumption that the learners were familiar with these contexts and the mathematical concepts. However, this may or may not have been the case.

Learners' everyday context in a mathematics class involves linking mathematical learning to the learners' lived experiences, making the subject matter more relevant and effective for diverse learners. This connection may utilize verbal or non-verbal language, where verbal language may involve informal mathematical language in English or the learners' home language (Sibanda, 2019), as outlined in Section 2.2.5.9. Non-verbal language could include images and gestures linked to learners' everyday context (Naidoo, 2012).

Setati (2001) highlights that learners' everyday context involves using informal language to express mathematical understanding, while Sepeng (2013) asserts that connecting classroom mathematics with this everyday knowledge through small group discussions not only deepens comprehension but also fosters an inclusive environment that values the diversity of learners. Teachers use learners' everyday context to provide multiple entry points to mathematics, making mathematical concepts more meaningful and facilitating conceptual mathematical Discourses

(Brown & Redmond, 2017; Widjaja, 2013).

For instance, a study by Sakurai, Sawatzki & Tout (2021) found that when teachers use examples and problems rooted in learners' everyday experiences, it not only increases engagement but also improves conceptual understanding. The study emphasizes that incorporating real-life contexts into mathematics instruction helps learners see the relevance of mathematics and encourages them to apply mathematical thinking outside the classroom. Another recent study by Gretčina & Ročāne (2024) highlights the role of daily life context in mathematics classrooms. The study looks into the importance of incorporating real-life problem situations into daily context-based teaching games to improve proficiency in mathematics. The findings reveal learners struggle to understand the relevance of mathematics in daily life. At the same time, teachers recognize the difficulties of connecting mathematical concepts to everyday problems, emphasizing the necessity for diverse teaching strategies to improve learning outcomes (Gretčina & Ročāne, 2024).

2.2.5.13 Previously learned mathematical concepts

In this study, I use the concept of previously learned mathematical concepts to mean the teacher's language practice of using the names of the concepts that were previously learned in earlier lessons or grades. For instance, when the teacher describes a concept and the teacher senses that learners do not understand, they may mention the name of the previous concept that links with the content that is being taught. These concepts form the foundation for learning more advanced mathematical topics, allowing learners to build upon their existing knowledge.

Research often highlights the importance of connecting new learning to what learners already know, as this is said to promote deeper understanding and retention of mathematical concepts. For example, research by Rittle-Johnson & Schneider (2015) emphasizes the role of prior knowledge in facilitating the acquisition of new mathematical skills and concepts, suggesting that when learners can relate new material to what they have previously learned, they are more likely to achieve a robust understanding.

In multilingual mathematics classrooms, utilizing content from previous lessons serves as a valuable language practice to enhance learners' comprehension and engagement with new mathematical concepts (Westaway, Chikiwa & Graven, 2019). By revisiting and reinforcing previously learned concepts and procedures, teachers facilitate the connection of new ideas with familiar ones, thereby establishing a strong foundation for further learning (Klosterman, 2018). For instance, teachers may reference concepts like the line of symmetry taught in previous lessons when introducing new topics, such as reflecting shapes. Rittle-Johnson & Schneider (2021) argue that previously learned mathematical concepts from earlier lessons can be revisited and connected to new content when the teachers describe mathematical concepts and procedures to build abstract mathematical knowledge.

2.2.5.14 Use of multimodal language practices

The implementation of multimodal language practices in multilingual mathematics classrooms involves using various modes of communication, such as spoken language, gestures, images, and written symbols, to enhance understanding and engagement among English second language learners. By incorporating multiple forms of expression, teachers can help learners better grasp mathematical concepts, bridge language barriers, and facilitate deeper discussions. This approach recognizes that learners may rely on different modes of communication to make sense of mathematical ideas, thereby promoting a more inclusive and effective learning environment.

While some studies focused on one language practices in the teaching of mathematics, various research studies focused on multimodal language practices in multilingual mathematics classrooms. Botes & Mji (2010) conducted a study on language diversity in South African mathematics classrooms across Grades Four, Five, and Six in 20 schools, involving 20 educators, exploring the impact of a visual multilingual learner companion on learners' mathematics performance. They developed an aid comprising various languages and visuals to help learners relate mathematics terms and concepts in English to terms in their own languages. Teachers reported that the learner companion resulted in improved learner performance and facilitated the connection between mathematics terminology in English and learners' native languages (Botes & Mji, 2010).

Chikiwa & Schafer (2014, 2019) mainly foregrounded code-switching, which included visual or mental images, gestures, and verbal languages, whether in LoLT or the learners' homelanguage. In these studies, they found that learners were more dependent on the use of non-verbal language practices, these language practices also improved their conceptual mathematical knowledge (Chikiwa & Schafer, 2014, 2019). Robertson & Graven's (2020) study involved Grade Four teachers with hands-on experiences and concrete resources, who were teaching isiXhosa home language learners, and focused on research on more than one language practice. They highlight that teachers were unpacking the complex mathematical concepts in their paper titled ‘Language as an including or excluding factor in mathematics teaching and learning’ conducted in a Grade Four class of English additional language learners and the learner performance improved.

Robertson’s (2017) study involved Grade Four teachers instructing isiXhosa home language learners, utilizing hands-on experiences and concrete resources. The findings revealed limited verbal interaction in the classroom, with most learners responding in isiXhosa rather than English. To facilitate learner participation, teachers encouraged the use of gestures and images, predominating in interactions by allowing learners to respond through gestures and concrete objects (Robertson, 2017). This is supported by Gate (2018) who argues that describing concepts and procedures using a multimodal approach has the potential to support learners from less affluent backgrounds who may well have a more limited linguistic experience by the time they transfer to secondary school. Moschkovich (2002) discusses how teachers use decomposition alongside informal language practices and code-switching to help bilingual students transition from everyday language to formal mathematical discourse. This process allows students to engage more deeply with mathematical concepts by making them accessible in steps that align with their linguistic abilities.

2.2.6 Multilingual classrooms taught by immigrant teachers

Many mathematics classrooms worldwide have become multilingual due to increased migration (Krause, Wagner, Redder & Prediger, 2022). South African classrooms, as noted by Horne & Ferreira-Meyers (2017), have long been multilingual and diverse due to factors suchas migration, resulting in various languages being represented among teachers and learners. As indicated in Chapter One, some immigrant teachers in South Africa address mathematics teacher shortages. Individuals may have different legal statuses, including refugees, illegal migrants, or those with working visas or temporary residence permits (Motha, Ramadiro & Vally, 2005; Mweni, 2017).

Immigrant teachers in these contexts may face challenges in understanding and sharing the experiences of learners, including their home language and cultural contexts. While research has been conducted on immigrant teachers’ working conditions and professional adjustment in South Africa (De Villiers & Weda, 2018; Makonye, 2017; Ranga, 2013), there is limited focus on enabling mathematics learning or language practices in multilingual primary schools. Studies conducted in other countries, such as Canada, highlight discrimination as a barrier for immigrant teachers, not directly related to mathematics teaching and learning (Schmidt, 2010).

Studies on immigrant mathematics teachers in South Africa primarily also focus on their reasons for migration, working conditions, and challenges faced, rather than on their teaching practices or language use in the classroom (Ranga, 2013; Anganoo, 2014; De Villiers & Weda, 2018). Ranga (2013) found that economic challenges in their home country, Zimbabwe, motivated teachers to migrate to South Africa. Anganoo (2014) reported that immigrant teachers in Johannesburg experienced frustration due to learner discipline issues, temporary contracts, xenophobia, discrimination, and inefficiencies at Home Affairs. De Villiers & Weda (2018) highlighted immigrant teachers' need for support in obtaining legal documentation, and financial assistance and addressing safety and xenophobia challenges.

Makonye's (2017) study examined the contributions of immigrant mathematics teachers to learner performance in South Africa, without focusing on language practices. Despite challenges related to feeling marginalized as foreigners, teachers expressed the need to adapt to the South African curriculum despite being trained in another country. They also appreciated the quality of the curriculum and believed they positively contributed to mathematics teaching and learning in South Africa.

The findings from studies on immigrant teachers in South Africa highlight challenges such as the lack of mentoring and induction programs, hindering their professional identity reconstruction (De Villiers & Weda, 2017). Immigrant teachers expressed the need for fair contracts, curriculum support, classroom management assistance, and professional to encourage them to remain, especially given their roles in teaching critical subjects (De Villiers & Weda, 2018; Vandeyar, 2014; Vandeyar et al., 2014). None of the reviewed studies specifically focused on language practices in mathematics or other subjects. In the subsequent section, I outline the theoretical framework used in this study, detailing the Analytical Framework developed to address the research questions. The next section, which is 2.3, focuses on the Analytical Framework used in this study, which is framed by Gee (2011).

2.3 THEORETICAL AND ANALYTICAL FRAMEWORK

Language is essential in multilingual mathematics classrooms for facilitating communication and understanding of mathematical concepts (Chikiwa & Schäfer, 2019). Gee (2011) argues that language is a resource to communicate information, highlighting that "language allows us to do things, it allows us to engage in actions and activities" (p. 2). This study investigates the language practices employed by immigrant teachers to foster the development of procedural and conceptual mathematical Discourse among English additional language learners. It focuses on observing full lessons comprising both full-class and small-group interactions. Informed by a socio-cultural perspective of language, which views language as a social practice with specific functions in various contexts, particularly the mathematics classroom, this study emphasizes the significance of language in facilitating communication and understanding of mathematical concepts in multilingual settings (Chikiwa & Schäfer, 2019). Gee (2011) argues that language is a resource to communicate information, highlighting that "language allows us to do things, it allows us to engage in actions and activities" (p. 2).

In this section, I describe the key theoretical socio-cultural perspective from Gee (2011, 2005) and identify how I use these concepts. The Analytical Framework in Table 2.1 presents the concepts I use in my analysis. It was developed by working between Pozzi's (2004) language functions (Column 1), language practices (Column 2) as well as Gee's (2011) building tasks, with a focus on the building of procedural and conceptual mathematical knowledge (Column 3). I then worked with these language practices in relation to the data relevant for my monoglossic approach, which I have chosen for this study, informed by Adler (1998), Setati (2008), Planas & Setati-Phakeng (2014), Moschkovich (2007) and others. The key language practices discussed in the literature include the use of English language and formal mathematical language, informal mathematical language, code-switching, decomposition, different forms of questions, revoicing, gestures, images, previously learned mathematical concepts, as well as learners' everyday context. Teachers draw on these practices to engage learners and create meaningful learning experiences in their mathematics classrooms.

Table 2.1, which is my analytical framework, integrates the information on language functions (Column 1: Section 2.3.1), language practices (Column 2: Section 2.3.2), and Gee's (2005) building tasks (Column 3: Section 2.3.3). The table shows the relationship between language functions, language practices, and building tasks, which are essential for developing both procedural and conceptual mathematical knowledge (bottom of Column 3: Section 2.3.4). By using this analytical framework, I conceptualize how teachers use language functions, such as describing mathematical concepts and procedures and asking and clarifying questions. Teachers describe mathematical concepts and procedures, ask informational questions, and clarify them using various language practices, including the use of gestures, images, code-switching, translanguaging, drawing on prior learning experiences, and many others. The use of these language practices and language functions gives meaning to Gee's (2005) seven building tasks: identity, activities, connections, politics, relationships, sign systems, and knowledge. By strategically utilizing these language functions and language practices, teachers get to create opportunities for learners to engage with and develop a robust mathematical Discourse. This Discourse is not merely about understanding mathematical procedures but also about connecting these procedures to broader conceptual mathematical knowledge. In Table 2.1 I only included the language practices I identified in the three lessons.

More details will be explained in the rest of this section as well as in Section 3.6 in Chapter Three where I describe how I used my Analytical Framework to produce the results presented in Chapters Four to Six.

Table 2.1: Analytical Framework: Examples from my study

Pozzi's (2004) language functions	Language practices	Gee's (2005) six of the seven building tasks with related questions
a) Description of things and actions by the teacher How the teacherdescribes things andactions. • Things are mathematical concepts, for example, transformations, decimal fractions. • Actions refer to mathematical actions such as adding, rotating, and finding a rule. **b) Asking informational questions by the teacher** How the teacher tries to obtain information from the learners when asking questions regarding mathematical concepts, and actions. **c) Clarification of questions.**	**What language practices do the teachers use whenthey:** • Describe things and actions. • Ask informational questions. • Clarify questions. **English language**: (Setati, 2008) • "English language" is defined as the use of English for words, discourses, and registers, predominantly used as the official LoLT for South African learners. **Formal mathematical language**: (Barwell, 2013) • Using the "mathematics terminology in more formal settings such as schools." (p. 2) e.g., using mathematical language that is in the mathematics register e.g., 'multiplication' instead of 'times'. **Informal mathematical language**: (McGinn & Booth, 2018). • Using informal mathematical language that learners use in real-life situations to communicate their mathematical understanding e.g. using 'plus' instead of 'add,' **Code-switching**: (Adler, 1998; Chikiwa, 2016) • Use of more than one language as alternation e.g., Code-switching a word from English to Setswana. **Decomposition** (Adendorff, Mntunjani & Siyepu, 2018; Planas & Civil (2013).	When the teacher… o Describes things and actions. o Asks informational questions. o Clarifies questions. …what function do the language practices perform concerning building activities, identities, social relationships, connections, politics, and sign systems and knowledge? **Building activities:** specific social activities or activities in which the participants are engaging. Discourse Analysis Question: "What is the larger or main activity (or set of activities) going on in a situation?" (Gee, 2005, p. 111) **Building identities:** the positions the teacher identifies for him/herself and the learners: Discourse Analysis Question: "What identities (roles, positions) with their concomitant personal, social, and cultural knowledge and beliefs (cognition), feelings (affect) and values seem to be relevant (and irrelevant) in the situation?" (Gee, 2005, p. 111). **Building relationships:** the social relationships that seem to be relevant to, taken for granted in, or under construction in the classroom. Discourse Analysis Question: "What sort of social relationships seem to be relevant to, taken for granted in, or under construction in a situation?" (Gee, 2005, p. 111). **Building politics (distribution of social goods):** the kind of social goods (e.g., status, power) that are relevant and irrelevant. Discourse Analysis Question: "What social goods (e.g., status, power, aspects of gender, race and class are relevant (and irrelevant) in this situation? How are they made relevant (and irrelevant)? In what ways?" (Gee, 2005, p. 112). **Building connections:** the sorts of connections, within or outside the classroom in order to make interaction meaningful. Discourse Analysis Question: "What sorts of connections are made to previous or future interactions, to other people, ideas, texts, things, institutions and Discourses outside the current situation" (Gee, 2005, p. 112).

How the teachers make the questions clearer to the learners whenever they realize that learners do not understand the informational questions.	• Separating words, mathematical terms, or concepts into basic parts or elements, which can either be in LoLT or the learners' home language. e.g. Decomposing the term 'output' by focusing on the prefix 'out'. **Different forms of questions: (**Chikiwa, 2016; Planas, 2014 and Moschkovich, 2007) • Closed questions: ✓ Asking questions requiring "yes" or "no" answers. ✓ Asking questions that require answers to procedures, focusing on what procedure was used e.g., if you add 0.6 and 0, 2 what will be the answer? • Open-needed questions: ✓ Asking questions that focus on how and why procedures were used i.e., how did you get 11? why did you say the answer is 11? **Revoicing:** (Brodie, 2011; Moschkovich (1999) • The teacher repeats or rephrases the learner's response or comment. • Repeating some or all of what has been said by the learner(s) in a preceding turn e.g., exact copy or as a reformulation. e.g., After the learners say 'kamohari' in Setswana, the teacher revoices it in Setswana and English as 'in'. **Gestures**: (Chikiwa, 2021; Cohen 2017). • Using visible bodily activity in conjunction with or without speech, helping an element of an utterance.	**Building significance of sign systems and knowledge:** in any situation one or more sign systems, and various ways of knowing are operative, oriented to, or valued and disvalued in certain ways" (Gee, 2005, p. 112). Discourse Analysis Question: **Sign systems: "**What sign sytems are relevant or irrelevant in the situation (e.g., speech, writing, images, and gestures)? How are they made relevant and irrelevant, and in what ways?" (Gee, 2005, p. 112). Discourse Analysis Question: **Knowledge:** "What systems of knowledge and ways of knowing are relevant (or irrelevant) in the situation and how are they made relevant (and irrelevant), and in what ways?" (Gee, 2005, p. 112) Procedural and conceptual analytical tool based on Pozzi's language functions with examples. **Procedural mathematical knowledge: what procedure and how the procedure is done/which steps to follow**. • The teacher **describes** how to perform a mathematical action, e.g., how to do an action of rotating on a grid. • The teacher **describes** the use of an action in a way that encourages memorization, e.g., telling the learners the procedure for translation. • The teacher **describes** the use of an action by giving a clue to the learners e.g., just look at the operational signs if you want to take the opposite direction. • The teacher **asks** the learners to complete an action, e.g., complete the table by representing this fraction in the form of a diagram. • The teacher **asks** for the answer to a calculation e.g., adding two to nine in the number patternto get to the next number in the pattern. • The teacher **asks** a question that requires the learners to recall a memorized procedure e.g., whatis an inverse operation for 'add'. • The teacher **asks** a question that requires a 'yes' or 'no' answer focusing on action, e.g., did I rotate 90 degrees clockwise? • The teacher **asks** the learners to describe the action they have used e.g., how they got to the next number in the pattern. • The teacher **clarifies** a question by giving a clue for finding the correct procedure to the learners e.g., just look at the headings in the place value notation column and you will know the name of the decimal fraction. • The teacher **clarifies** a question by using another similar mathematical term e.g., using number patterns to clarify the question about how the rule works in flow diagrams. • The teacher **clarifies** a question by using another procedural question in a different way e.g., Question 1: why do we call this transformation a turn? Question 2: Am I still facing the same direction?

	e.g., The teacher moves from one tile to another to demonstrate 'translation' in transformation geometry. **Images:** (Moschkovich, 2007; Chikiwa & Schäfer, 2019) • Tools that aid in concretely representing abstraction. • Using visual images to display the appearance, structure, or workings. e.g., The teacher uses a 10-square diagram to describe the concept of tenths. **Learners' everyday context**: (Chikiwa & Schäfer (2019)). • Using informal strategies which are 'experientially real' for the learners i.e., using examples based on the learners' everyday activities. e.g., The teacher uses a mirror to clarify a question about the concept of 'reflection.' **Previously learned mathematical concepts:** (Westaway, Chikiwa & Graven, 2019) • Using content from the previous lessons to enable understanding of the new knowledge, e.g., using the example of symmetry when describing the action of reflecting.	• The teacher **clarifies** a question by describing the action e.g., Question: what is a clockwise turn? Clarification: you need to look at how the arms of the face clock turn. • The teacher **clarifies** a question by repeating the question to the learners e.g., Question: "do we have thousands?" Clarifying question: do we have a thousand column? **Conceptual mathematical knowledge: meaning of mathematical concepts and their relations represented using terms, visuals, and so on, and 'when' and 'why' to use mathematical procedures.** • The teacher **describes** the meaning of a mathematical concept by focusing on one component of the concept, e.g., when describing the meaning of 'input' the teacher focuses on the meaning of the word 'in'. • The teacher **describes** how one mathematical concept relates to another. e.g., the relationship between 'input value' and 'output value'. • The teacher **describes** why a particular procedure has to be followed, e.g., "When we rotate clockwise we have to follow the clock". • The teacher **asks** a question that requires a 'yes' or 'no' answer focusing on the meaning e.g., Is this a rotation? • The teacher **asks** the learners to explain why they used a particular action, e.g., Why is the image facing the opposite side of the object? • The teacher **asks** the learner to explain the meaning of mathematical concepts, e.g., explain the meaning of 'transformation'. • The teacher **asks** the learners to represent mathematical concepts in different ways, e.g., Show rotation using triangles on a grid, • The teacher **asks** a question that encourages learners to compare, contrast, and integrate related concepts, e.g., What is the difference between tenths and hundredths? • The teacher **clarifies** a question by describing the meaning of the mathematical concept e.g., Question: what does the word 'transformation' mean? Clarification: 'change' okay. • The teacher **clarifies** a question by asking another question that focuses on the meaning of the concept that is being taught. After asking a question about the meaning of 'flow diagram' the teacher clarifies the question by asking about the meaning of the individual word 'flow.' • The teacher **clarifies** a question by giving a clue on why the action has to be done, e.g., Question: "Why are we turning this way?" Clarification: "look at the hands of a clock." • The teacher **clarifies** a question by describing how an individual mathematical concept relatesto another, e.g., Question: why do we write 0.16? Clarification: let us count the squares in the big diagram i.e., 'hundredths?' • The teacher **clarifies** a question by comparing and contrasting related concepts, e.g., Question: "Let us turn 90 degrees clockwise". Clarification: "ok let's first turn clockwise, like a clock".

2.3.1 Language functions when the teacher builds mathematical knowledge

Pozzi (2004) has twenty-three language functions. These language functions focus on how language is used to achieve various communicative purposes. However, in this study, I explore how these language functions are used by teachers for the creation of opportunities for the development of procedural and conceptual mathematical Discourse. Though Pozzi's (2004) work on language functions is not on mathematics education, I have used them to provide a framework for understanding how mathematical concepts and procedures are developed and communicated in the classroom. Out of the twenty-three language functions Pozzi (2004) mentions, I am choosing the three which are: description of things and actions, asking informational questions, and clarification of questions as briefly indicated in Section 2.2.3. Pozzi’s (2004) language functions are crucial for teachers to use when facilitating learning (Column 1) thus developing proficiency in learners; for example, comparing, contrasting, drawing conclusions, defining, generalizing, evaluating, etc. Description of mathematical concepts, asking questions, and clarifying them, among others, help to shape interactions between teachers and learners, mainly when used in conjunction with certain language practices. English language, formal and informal mathematical language are mostly used to describe (concepts) and (procedures) (Moschkovich, 2015; Sfard, 2008; Schleppegrell & O'Halloran, 2023). Effective use of language functions, such as those identified by Pozzi (2004), helps teachers create an opportunity for the development of procedural and conceptual mathematical Discourse.

The first language function chosen for my study is the description of things and actions, which examines how teachers utilize language practices to describe mathematical concepts (things) and procedures (actions) to foster the development of mathematical Discourse. For example, in my study, the concepts may be functions, transformations, decimal fractions, and their mathematical representations, which may be flow diagrams and number patterns. Actions refer to mathematical procedures such as adding decimal fractions and rotating objects on the grid. In this study, the ‘things’ which are mathematical concepts are aligned with Setati’s (2001) description of a concept and Kilpatrick’s (2001) description of conceptual understanding. ‘Actions’ are aligned to Stein et al.’s (2001) description of procedures with connections and without connections and Kilpatrick’s description of procedural fluency as explained in section 2.2.3. Describing mathematical concepts enables learners to articulate their thought processes, which is essential for developing mathematical Discourse (Setati, 2005). When teachers describe things and actions, they help learners visualize and understand abstract mathematical concepts through clear explanations and representations. This assists teachers in logically organizing thoughts, making complex ideas easier to grasp by the learners (Smith & Cekiso, 2020).

Asking informational questions is pivotal for assessing learners' mathematical development and reasoning (McCarthy et al., 2016). When teachers ask informational questions, they encourage deep thinking and active participation in learners, thus stimulating curiosity and critical thinking for deeper exploration of mathematical ideas (Goos, Geiger, & Dole, 2023). Teachers skillfully ask informational questions using different forms of questions (Boaler, & Chen, 2023). Furthermore, asking informational questions helps the teachers to probe deeper into the learner's thinking, thus encouraging critical thinking, and helping learners to connect new information to prior knowledge (Adler, 1998).

The clarification of questions focuses on exploring how teachers use language practices to clarify questions when learners encounter difficulties in understanding informational questions. Clarifying questions plays a vital role by prompting learners to refine their understanding and articulate their thoughts more clearly, thereby enhancing classroom discussions and collaborative learning (Watanabe & Evans, 2015). Clarification strategies aim to resolve confusion, address misconceptions, and eliminate ambiguity in learners' understanding of the questions. For instance, diagrams, and images are mostly used when clarifying questions (Mudaly, 2021; Moschkovich, 2007). Tofade, Elsner & Haines (2013) identify rephrasing the question or adding clarifying comments as ways teachers may use to assist learners in understanding the meaning of the question. Clarification of questions by teachers helps them identify and address misunderstandings, ensuring correct and complete understanding of concepts and procedures by the learners, thus enhancing learning (Fuller, 2023).

All these three language functions are used in conjunction with various language practices, for instance, , code-switching, gestures, decomposition, etc, when teachers create opportunities for the development of procedural and conceptual mathematical Discourse. When teachers skillfully use these language functions, they create opportunities for learners to actively participate in the learning process, thus improving comprehension of complex mathematical concepts. The teachers' utilization of these language functions from Pozzi (2004) becomes particularly significant when learners are not learning mathematics in their home language, as discussed in Section 2.2.4.

2.3.2 Language practices when building procedural and conceptual mathematical knowledge.

When teachers perform the three language functions (Column 1), they use particular language practices (Column 2), to create opportunities for the development of procedural and conceptual mathematical Discourse (Column 3). Language practices are versatile tools that teachers use to provide a foundation for mathematical understanding when building procedural and conceptual mathematical knowledge (Krause, Adams-Corral, Maldonado Rodríguez, 2022). As defined by Setati (2001) and Moschkovich (2007), some of these language practices are non-verbal, for instance, gestures and images.

In my Analytical Framework, which is Table 2.1, I only included the language practices that are aligned with the perspective I am using for this study. Given the work between the literature and my data, I focus on the following language practices, with the stated definitions as described in Column Two and in Section 2.5: English language, formal mathematical language, informal mathematical language, decomposition, code-switching, different forms of questions, revoicing, gestures, images, concepts and actions from the previous lessons, as well as learners' everyday context. English language is utilized as the primary medium of instruction to facilitate effective communication between teachers and learners in mathematical contexts (Mulwa, 2015). Formal mathematics language refers to the specialized terminology and conventions specific to mathematical Discourse, typically developed within formal educational settings (Barwell, 2013). Informal mathematical language involves the use of everyday language or expressions to convey mathematical concepts, which can be presented in either English or the learners' home language (McGinn & Booth, 2018). Code-switching is the practice of alternating between multiple languages within a conversation or instructional context, allowing for flexibility in communication (Adler, 1998). Decomposition involves breaking down complex mathematical terms or concepts into simpler components or basic elements to enhance understanding (Adendorff, Mntunjani & Siyepu, 2018).

The other language practice is different forms of questions, which looks at how teachers employ either closed-ended questions, eliciting specific responses like "yes" or "no," or open-ended questions, encouraging diverse explanations and reasoning (Chikiwa & Schäfer, 2019). Revoicing refers to teachers repeating or rephrasing learners' responses to enhance understanding and promote mathematical discourse (Brodie, 2011). Gestures refer to non-verbal communication involving visible bodily movements used to convey mathematical concepts (Kendon, 2004; Sime, 2006). Images refer to visual representations such as diagramsor pictures that aid in illustrating abstract mathematical concepts (Smith & Cekiso, 2020). Learners' everyday context refers to informal strategies incorporating examples from learners' daily experiences to contextualize mathematical concepts (Gravemeijer & Doorman, 1999; Widjaja, 2013). Concepts and actions from previous lessons refer to the utilization of prior knowledge and experiences to scaffold new mathematical understanding (Westaway, Chikiwa & Graven, 2019). These language practices contribute to effective communication and conceptual development among learners when teachers create opportunities for thedevelopment of procedural and conceptual mathematical Discourse.

2.3.3. Meanings built when building procedural and conceptual mathematical knowledge

I further looked at the meanings the language practices gave to language, based on Gee's (2011) building tasks (activities, significance, politics, connections, identity, relationships, sign systems), when teachers were using these different language practices and Pozzi's (2004) language functions to build mathematical knowledge. Gee's (2011) building tasks are concepts I am using as a lens to look at the functions that language practices play when teachers build mathematical knowledge. As explained in Section 2.2, Gee (1996, 2011) is not specifically talking about school mathematical Discourse. His tools have been used for different Discourses in a range of social contexts, and some researchers have applied them to mathematical Discourse, for instance, Moschkovich (2007), Nkambule (2013), and Setati (2001). Gee (2011) states that when using language "we always and simultaneously build one of seven things or seven areas of ''reality"through words and deeds" (p. 88). The seven areas of reality, which he names building tasks:

> *in any situation where language is used will involve activities where people take on certain identities, develop relationships with one another, and use sign systems and forms of knowledge. In such a situation, certain things are given status, and people, or things take on meaning and significance and these things are connected or not to one another (*Gee, 2005, p. 97).

Gee (2011), like Pozzi (2004), subscribes to a social practice perspective of language which states that language use is never neutral; it is functional, and it always occurs within a context and is thus used from a particular perspective, as explained in Section 2.2.1. I use two key concepts from Gee (2011) which are the notion of Discourse, and the notion of building tasks. As noted in Section 2.2.1, Gee (1996, 2011) differentiates between'discourse' and 'Discourse' (signifies using lower-case 'd' and upper-case 'D'). The term 'discourse' refers to verbal communication, gestures, images, etc., where speakers communicate with listeners, following a particular sequence. Gee (1996) then describes the capital letter 'D' as "…a socially accepted association among ways of using language, other symbolic expressions, and artifacts, of thinking, feeling, believing, valuing, and acting that canbe used to identify oneself as a member of a socially meaningful group or “social network” (Gee, 1996, p. 131). Based on Gee’s (1996) definition, discourse’ is, therefore, part of ‘Discourse’.

Gee’s ideas developed over time, consistently. I have worked across Gee (2005) in some instances and Gee (2011), using the concepts that were most relevant and productive for my study. In Table 2.1, I used Gee's (2005) version because the questions for each building task were fit for the mathematical Discourse. In the 2011 version, I use Gee’s description, where he refers to building tasks as things being built that give different meanings. These concepts (building tasks) are operationalized in Gee’s (2005) particular method of Discourse analysis, which I allude to here and demonstrate further in Chapter Three. In this study, I only use six of the seven Gee’s (2011) building tasks I have found productive for the mathematical Discourse, one of which is ‘knowledge’ building task, which I will explain later in this section.

One of Gee’s (2005) building tasks that I am not using in this study is ‘building significance’, referring to the way in which language is used to give meaning or importance to certain things, actions, people, or ideas within a particular social context. It is the use of language that shapes perceptions by emphasizing or minimizing the importance of elements, thus influencing how events and experiences are interpreted and valued. According to Gee (2005), people often build significance in subtle, implicit ways that may not be immediately obvious. They might emphasize certain concepts through tone, repetition, or the use of specific examples, rather than overtly stating. Based on my interpretation of ‘building significance’, when teachers emphasize building knowledge, relationships, politics, identity, and connections, I deduce that they are attributing value to these functions. As I worked with the data, I found ‘building significance’ cross-cutting through all other building tasks except ‘building activities’. Because I was not focusing in depth on the teachers’ tone or repetition in the Discourse analysis when analyzing how they were building mathematical knowledge, I, therefore, found ‘building significance’ not necessary as a separate building task in my analysis.

In Gee’s (2005) Discourse analysis framework, he also presents 26 questions designed to help researchers analyze language and social practices within various Discourses. These questions guide the analysis of how language functions in building identities, relationships, and systems of knowledge within specific contexts. When focusing on the building of mathematical knowledge, not all of Gee’s (2005) 26 questions may be directly relevant. Mathematical Discourse is unique because it involves specialized language, symbols, and practices that are integral to constructing and communicating mathematical concepts. Therefore, only a subset of Gee’s (2005) questions were applicable to this specific context. The seven questions I have selected focus on aspects of Discourse that are crucial for understanding how mathematical knowledge is constructed, conveyed, and understood in educational settings.

When selecting Gee’s (2005) seven questions for analyzing how teachers build procedural and conceptual mathematical knowledge, I focused on questions that directly related to how language is used when they create opportunities for the development of procedural and conceptual mathematical Discourse. I selected these questions based on their ability to identify the meanings when conceptual and procedural mathematical knowledge is being built, and their relevance in multilingual mathematics classrooms. The ones that I left out do not contribute to the creation of opportunities for the development of procedural and conceptual Discourse.

Next, I present Gee’s (2005) description of the six building tasks and the question/s asked in each building task that I chose (refer to Table 2.1). I discuss and give a detailed introduction to Gee’s (2011) building tasks. I explain the selection process for the seven questions and their relevance to mathematical Discourse. I explain the criteria for their selection and their relevance to multilingual mathematics classrooms. Lastly, I give examples to clarify the application of these six of the seven building tasks, namely, activities, politics, connections, identity, relationships, sign systems and knowledge.

- **Building Activities**

For building activities, I looked at the key activities when the teachers were using language functions and language practices to build mathematical knowledge, which led me to select this question to ask about the data.

Discourse Analysis Question: “What is the larger or main activity (or set of activities) going on in a situation?” (Gee, 2005, p. 111)

In this study, this building task involves how the teacher uses language to organize and structure activities, shaping what is happening within those activities when building mathematical knowledge. In mathematical Discourse, this could relate to how mathematical discussions are framed.

The criterion for the selection and relevance to multilingual mathematics classrooms: It helps me to recognize specific mathematical activities in which the teacher is engaging the learners when using language while building mathematical knowledge. I look at how smaller tasks and discussions contribute to the understanding of the concept being taught. When building activities, I explore how teachers guide learners through mathematical tasks, considering how descriptions, questioning, and clarifications differ depending on the language, when mathematical knowledge is being built.

Example: In an activity about the difference between rotation and reflection, the teachers may start by breaking it down into smaller, manageable steps. He may start by focusing on the meaning of rotation and how rotation can be represented on a grid. If the learners do not understand his description, the teacher can use the learners' home language to enhance conceptual understanding. He may do the same with the concept of reflection and later compare the different representations.`

- **Building identities**

Regarding building identities, I looked at the various roles and identities that teachers assume through the use of language while building mathematical knowledge, which led me to this question to ask about the data.

Discourse Analysis Question: "What identities (roles, positions) with their concomitant personal, social, and cultural knowledge and beliefs (cognition), feelings (affect), and values seem to be relevant and irrelevant in the situation?" (Gee, 2005, p. 111)

In this study, this building task relates to how the teacher uses language to construct identities within a particular Discourse. In the context of mathematics, this could involve how the teacher makes learners see themselves as mathematicians or how they make the learners' home language useful to build mathematical knowledge.

The criterion for the selection and relevance to multilingual mathematics classrooms: It helps me to look at the positions the teacher identifies for him/herself and the learners when using language while building mathematical knowledge. Here, I look at how teachers use language to encourage learners from different linguistic backgrounds to contribute and how language reinforces or challenges their identities when mathematical knowledge is being built.

Example: In an activity, a teacher might decide to explain the mathematical concept in the learners' home language when learners do not understand. This suggests that the teacher takes the identity of learners when building mathematical knowledge, thus building identity.

- **Building relationships**

Regarding building relationships, I looked at how the teachers' use of language functions and language practices shaped and assumed certain relationships while mathematical knowledge was being built, which led me to this question to ask about the data.

Discourse Analysis Question: "What sort of social relationships seem to be relevant to, taken for granted in, or under construction in a situation?" (Gee, 2005, p. 111)

In this study, this building task involves how teachers use language to establish and maintain relationships between participants in a Discourse. In mathematical Discourse, this could involve the relationships between teachers and learners.

The criterion for the selection and relevance to multilingual mathematics classrooms. This question helps me to look at the social relationships that seem to be relevant to, taken for granted in, or under construction in the classroom when the teacher uses language while building mathematical knowledge. Teachers could use language, including code-switching, to build rapport with learners from diverse linguistic backgrounds.

Example: In an activity, when teachers choose to use the learners' home language to clarify questions. instead of clarifying in English which is LoLT. Here teachers are using language to show a supportive relationship with the learners, ensuring that language does not become a barrier to the understanding of mathematics, thus building relationships.

- **Building politics (distribution of social goods)**

For building politics, I looked at how the teachers' use of language functions and language practices assumed certain power dynamics in the classroom while mathematical knowledge was being built, which led me to this question to ask about the data:

Discourse Analysis Question: "What social goods (e.g., status and power are relevant (and irrelevant) in this situation? How are they made relevant (and irrelevant)? In what ways?" (Gee, 2005, p. 112).

In this study, this building task refers to how teachers use language to build or reinforce power dynamics, norms, and values within a Discourse. In mathematical Discourse, this could involve how certain ways of thinking/ languages are valued over others

.

The criterion for the selection and relevance to multilingual mathematics classrooms: It helps me to explore the kind of status or power that is relevant and irrelevant while the teacher uses language when building mathematical knowledge, using language. I explore how teachers' language choices, such as using English versus home languages, privilege or disadvantage learners in building mathematical knowledge.

Example: In an interview with the researcher, the teachers may clearly indicate that they prefer to use English language when describing mathematical procedures and concepts because grade six learners will be assessed in English language. This statement reinforces the value placed on the English language over Setswana, thus building politics.

- **Building connections**

For building connections, I looked at how the teachers' use of language functions and language practices connected learners' everyday contexts and previously learned mathematical concepts while mathematical knowledge was being built, which led me to this question to ask about the data:

Discourse Analysis Question: "What sorts of connections are made to previous or future interactions, to other people, ideas, texts, things, institutions, and Discourses outside the current situation" (Gee, 2005, p. 112).

In this study, this building task involves how teachers use language to connect mathematical concepts, or experiences across different contexts. In mathematical Discourse, this could relate to how new mathematical concepts are linked to prior knowledge or real-world applications.

The criterion for the selection and relevance to multilingual mathematics classrooms: It helps me to look at the sorts of connections, within or outside the classroom when the teacher uses language to make interaction meaningful while building mathematical knowledge. I look at how teachers use language to link mathematical concepts to learners' everyday context and previously learned mathematical concepts. Connections sometimes become clearer in learners' home languages, which may enhance mathematical understanding in multilingual classrooms when mathematical knowledge is being built.

Example: In an activity, when clarifying a question about inverse operations in functional relationships, a teacher might remind learners about the operational signs and which one is the opposite of the other as he taught them in the previous grade. This connects prior learning to new content, helping learners integrate their knowledge, thus building connections.

- **Building significance of sign systems and knowledge**

Regarding building Sign systems, I looked at how the teachers' use of language functions and language practices led to the use of various modes of communication and representation while mathematical knowledge was being built, which led me to these questions to ask about the data:

Discourse Analysis Question: Sign systems: "What sign systems are relevant or irrelevant in the situation (e.g., speech, writing, images, and gestures)? How are they made relevant and irrelevant, and in what ways?" (Gee, 2005, p. 112).

In this study, this building task involves how teachers use language to highlight the importance of particular sign systems (like mathematical symbols, gestures, images, terminology, or notation) when building mathematical knowledge.

The criterion for the selection and relevance to multilingual mathematics classrooms: It helps me to look at the sign systems like symbols, diagrams, gestures, graphs, and formal mathematical language when the teacher uses language in multilingual mathematics classrooms, as these sign systems provide tools to bridge language barriers and help learners understand abstract mathematical concepts without solely depending on verbal explanations in the language they are not proficient in.
Example: in an activity, the teacher may decide to use fractions in the form of a diagram when asking informational questions about tenths and hundredths.

Regarding the building of knowledge, I looked at the ways in which procedural and conceptual mathematical knowledge was made relevant (or irrelevant) in the situation.
Discourse Analysis Question: Knowledge: "What systems of knowledge and ways of knowing are relevant (or irrelevant) in the situation and how are they made relevant (and irrelevant), and in what ways?" (Gee, 2005, p. 112).
In this study, this building task involves ways in which the teachers use language to describe mathematical concepts and procedures to the learners.

The criterion for the selection and relevance to multilingual mathematics classrooms: it helps me to explore the kind of mathematical knowledge that is being built where the teacher can combine verbal and non-verbal mathematical tools such as gestures, input-output tables, and diagrams, teachers ensure learners can follow and engage with functional relationships even if they are less proficient in the LoLT.
Example: in an activity, the teacher describes the concept of reflection, indicating to the learners that each point of the object is equidistant from the line of reflection, thus building mathematical knowledge.

2.3.4 Building procedural and conceptual mathematical knowledge.

In this study, I am interested in meanings built in a mathematics classroom. However, Gee's (2011) notion of knowledge was not designed for that, and therefore I had to explore the mathematics education literature reviewed in Section 2.2 to relate it to procedural and conceptual mathematical knowledge. Gee's (2011) building tasks assist with the meaning-making of a situation using grammatical clues. Within the three language functions, a teacher would, based on Gee (2011), be building seven meanings. In his method of Discourse Analysis, he provides a total of twenty-six questions to identify the building tasks when analyzing text (Gee, 2005). Out of the twenty-six questions, I only chose seven that were relevant to my study. These questions were selected based on the six building tasks I have chosen and because of their relevance to my study in multilingual mathematics classrooms. I needed to adapt all of the building tasks chosen for my mathematics study but in particular the knowledge building tasks (Table 2.1, Column Three) to the building of procedural and conceptual mathematical knowledge.

In Table 2.1, the third column outlines the key tools from Gee's (2005) method of Discourse analysis, excluding 'building significance'. Initially, the decision was made not to include it in the study after working with seven tasks in the data. As teachers engage in describing actions, asking questions, and providing clarifications (Pozzi, 2004), the focus lies on the meanings conveyed by the language practices they employ for building activities, identities, social relationships, connections, politics, and sign systems, and knowledge (Column Three). Additionally, at the bottom of Table 2.1, further details are provided on procedural and conceptual mathematical knowledge, distinguishing between them. While both are essential for mathematical Discourse, a conceptual separation was deemed necessary for analytical purposes (Column Three) to examine how language practices contribute to the construction of procedural and conceptual mathematical knowledge, as elucidated in Section 2.2.2. (Gee, 2005; Pozzi, 2004).

Procedural mathematical knowledge involves how teachers guide learners in executing specificactions or procedures, such as solving calculations. Teachers may provide clarification of questions on procedures through rephrasing or offering alternative explanations. Conversely, conceptual mathematical knowledge pertains to the understanding and application of mathematical concepts, as outlined by Kilpatrick et al. (2001) and Setati (2001). Overall, when building mathematical knowledge, I looked at how teachers use verbal and non-verbal language practices when creating opportunities for the development of procedural and conceptualmathematical Discourse.

2.4 CONCLUSION

In this chapter, I have examined the shift from a cognitive to a social perspective in understanding language in mathematics education. Researchers like Morgan et al. (2014), Moschkovich (2007), and Setati (2001) have highlighted the importance of various forms of communication in mathematical

Discourse. In South Africa, the post-apartheid curriculum promotes language-rich, multilingual classrooms, reflecting a heteroglossic view of language as dynamic. However, this study adopts a monoglossic perspective, focusing on code-switching within its social and political context while acknowledging the limitations of capturing language's fluidity.

I explored mathematical Discourse through a social practice lens, drawing on Moschkovich's (2015) and Gee's (2011) definitions of big 'D' Discourse. Procedural Discourse, related to procedural fluency and 'procedures with connections,' and conceptual Discourse, related to understanding mathematical concepts, are both crucial for meaningful mathematical understanding. Teachers play a key role in fostering these discourses through effective questioning and diverse language functions. In multilingual South African classrooms, where the language of instruction often differs from students' home languages, teachers face challenges in creating meaningful mathematical Discourse. They must manage language transitions and address learners' needs despite policies supporting multilingualism. Immigrant teachers, who help address teacher shortages, face additional challenges such as understanding home languages, economic difficulties, and discrimination. Despite these obstacles, they positively impact mathematics education and seek better support. Lastly, I outlined my theoretical concepts, using Gee (2011) and Pozzi (2004) to develop my Analytical Framework for studying multilingual mathematics classrooms.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the research design and its rationale. It briefly covers the qualitative methodology, as well as the selection of the cases for the study of the language practices of immigrant teachers in selected schools of the Gauteng Provence in South Africa. It explains who the participants were, the sampling methods utilized, and why they were selected. Then, it explains the data collection methods adopted, which were classroom observations and interviews. An explanation is also given of how the transcripts were prepared in line with the Analytical Framework which is Table 2.1 in Chapter Two. The categories that were used to analyze the collected data are briefly outlined. Also, the chapter indicates how rigor is ensured, as well as ethical considerations. The chapter highlights the unique approach of closely collaborating with immigrant mathematics teachers and South African English additional language learners.

However, as described in Section 1.3, while my interest was always in the language practices of English additional language mathematics teachers in Gauteng because of the Language policy regarding LoLT in multilingual primary schools (Section 1.1 in Chapter 1), my original focus was not specifically immigrant teachers. It was in the pilot for my initial proposal that I sparked my interest in the study of immigrant teachers. I give more details about how the cases were selected in Section 3.2.

3.2 RESEARCH DESIGN

3.2.1 Qualitative methodology

A qualitative research method is used to provide rich and in-depth descriptions of complex phenomena (Sofaer, 1999). Denzin & Lincoln (2005) argue that "qualitative researchers study things in their natural settings, attempting to make sense of or interpret, phenomena in terms of the meanings people bring to them" (p. 3), thus minimizing bias. This was a study that followed a qualitative empirical approach, and it involved three immigrant teachers. The qualitative approach assisted in providing in-depth descriptions of what and how, and also why immigrant teachers used language practices in their classroom practice. It also provided in-depth descriptions of the meanings their language practices give to procedural and conceptual mathematical knowledge.

3.2.2 Case Study Research

Maxwell (2012) defines a case study as a thorough examination of a particular individual, group, or phenomenon within its real-life context. It involves a detailed analysis of specific instances or cases and their relationships, aiming to answer "how" and "why" questions. According to Maxwell (2012), case studies allow for in-depth exploration of complex phenomena, emphasizing multiple data sources like interviews, observations, documents, and artifacts to provide a comprehensive understanding. This approach facilitates empirical inquiry into contemporary issues, offering insights into underlying mechanisms and reasons behind observed phenomena (Maxwell, 2012).

As indicated in Section 1.2.7, given the research problem and my related research questions, the criteria for what constitutes a case in my study were as follows: schools from three different contexts, which were rural, township, and informal settlements. In these schools I focused on Grade Six mathematics classrooms of English additional language learners who were taught by English additional language immigrant teachers; Setswana speaking learners who do not share their home language with their immigrant teachers. I did not embark on the study, aiming to focus on particular topics. Rather, the three topics taught were determined by the Annual Teaching Plans stated for each mathematical concept in the CAPS document and the Annual Teaching Plans (ATPs). Each teacher taught a mathematics topic as per the Gauteng Department of Education (GDE) Annual Teaching Plan (ATP), as required by the GDE Research Protocol for Higher Education Institutions (HEIs). The Gauteng Department of Education Research protocol indicates that when researchers collect data through classroom observation, they should not disturb the fixed programme prescribed in the ATPs. Therefore, at the time of my data collection, I focused on the topic that was prescribed for that class on that particular day, hence the different mathematical topics.

3.2.2.1 Case One and how it was selected

I identified the first school, which was an informal settlement, through convenience sampling because I worked there as a principal before I joined the Provincial Department of Education. After getting approval from the Gauteng Department of Education, I requested ethical approval from the principal, the teacher, and the learners at the informal settlement school so I could pilot my instrument. Before embarking on my actual study, I identified schools from three different contexts, namely, informal settlement, township, and rural schools. I then sought consent from the three teachers, the principals, and the learners.

When the principal at the informal settlement schools requested the Grade Six mathematics teachers to volunteer for me to pilot my lesson observation instrument, a teacher from Zimbabwe, who was teaching mathematics in a class of Grade Six English additional language learners whose home language was Setswana, volunteered. The pilot study involved assessing language practices, teacher-learnerinteractions, and learner engagement. After looking at the observations, I produced interesting findings that I would not have seen from observing South African teachers concerning the use of language practices. The pilot findings made me shift my decision to focus the study on immigrant teachers, particularly English additional language teachers who were teaching English additional language learners. Though I decided to focus on immigrants I still needed to select the informal settlement school as one of the three cases in my study.

I decided to negotiate with the principal to allow me to work with another immigrant teacher within the same school, not the one who was involved in my pilot study. I needed a different teacher to the pilot study, because the first teacher may have already been influenced by the pilot study. He might have potentially wanted to alter his teaching approach or responses during the main study I was focusing on because of our previous engagement during the pilot study. I needed to observe a teacher that I had never engaged with, hence my decision to choose another teacher. The principal agreed and I also sought permission from the teacher. He also agreed (See Section 3.6 on ethical considerations).

3.2.2.2 Case Two and how it was selected

My next step was to think about two more schools to complete the three-school sample, where I had to get immigrant teachers, and not South African teachers anymore. I had not decided to work specifically with Zimbabwean immigrant teachers at that time, but I was simply wanting to include immigrant mathematics teachers. From the day the first immigrant teacher from the first school agreed to work with me (Case 1), I realized that it was not going to be easy to look for a school first before finding an immigrant teacher because not all the schools that matched my criteria had immigrant teachers. I decided to look for immigrant teachers from rural schools and township schools. I need to indicate that part of my long struggle was that there were immigrant teachers I was finding, however, they were not teaching mathematics in Grade Six.At the first rural school that I found, the principal seemed uneasy that I wanted to come and observe teaching. I decided to withdraw because of the principal’s hesitancy, as I was supposed to get the principal’s permission first before I could finalize the ethical considerations with the immigrant teacher. I decided to go back to the first immigrant teachers from the school whereI did my pilot study (and subsequently Case 1 in this study). I asked the two immigrant teachers(the pilot teacher and the Case One teacher) from the informal settlement school if they knew any immigrant teachers that I could work with from a rural school. They reminded me of a teacher who used to work at their school, whose contract had ended, indicating that he had moved to the rural school. After they had given me his details, I called him, and he agreed to participate in my study. I then sought permission from his principal to observe a lesson at the school and she agreed. I was then left with one school to choose a township school. The processby which I found the second case for my study was therefore through snowball sampling.

3.2.2.3 Case Three and how it was selected

When I struggled to get a teacher from the township, I decided to ask the teachers from the informal settlement and rural schools if they knew any immigrant teacher who taught Grade Six in a township school. They gave me the contact details of one of their acquaintances from Zimbabwe, who was teaching mathematics to Grade Six Setswana-speaking learners in a township school. I contacted him, and he agreed to be my participant. I then communicated with the principal, who also agreed. At that stage, my interest in immigrant teachers remained a key criterion for school selection, with the ultimate goal of understanding language practices when teaching English additional language learners. The three cases were, therefore, found through snowball sampling.

When I found the third teacher, I realized that they were all Zimbabwean immigrant teachers. However, I did not have a problem with that because they still met the criteria for my cases, which were immigrant teachers who were teaching Grade Six mathematics classrooms in an informal settlement, a township, and a rural school. They were also teaching English additional language learners whose home language was Setswana. The only difference was that the three teachers were now coming from the same country, which did not impact negatively on my criteria.

Naderifar, Goli & Ghaljaie (2017) indicate that in snowball sampling, the existing participants assist in recruiting future participants among their connections. Manohar, MacMillan, Steiner, & Arora (2018) argue that it becomes much easier for researchers to recruit people whom they already know as participants (Manohar et al., 2018). Greene (2014) indicates that it is imperative that the participants trust and accept the researchers before they can be allowed to conduct research in their space. I worked with people I was familiar with because I was also the principal in that region before I joined the Provincial Education offices as a researcher. Based on my status as an official of the

Department of Education, I had to assure the principals in these three sampled schools that I was coming as a researcher from the university, and not as a Departmental official, because of the power relations at work (see Section 3.6, ethical considerations).

3.2.3 Data collection

Maxwell (2012), in his work on qualitative research methodology, emphasizes the depth and detailed examination of a small sample in qualitative research. The qualitative method involves exploring the complexities and nuances of a particular phenomenon within its real-life context. He encourages researchers to focus on a small, purposefully selected sample to gain a rich understanding of the subject of study where researchers delve deeply into the experiences, perspectives, and context of a limited number of participants or cases (Maxwell, 2012). This often involves using multiple data collection methods such as interviews, observations, and document analysis. When collecting data, I wanted to know what language practices the three teachers used and for what meanings, therefore observation was needed. I also wanted to explain the choices and the reasons for the choices of the language practices used, so a questionnaire and interviews were needed. Therefore, data were collected through pre-observation questionnaire, classroom observation, individual reflective interviews, and focus group interviews. As a researcher, I was able to observe these teachers' daily teaching, however, I started by piloting the classroom observation instrument as explained in Sections 1.2 and 3.2.3.1.

3.2.3.1 Piloting the data collection tools

As indicated in Section 3.2.2.1, while testing the observation instrument for my first proposal, an immigrant teacher from Zimbabwe volunteered to pilot the instrument. My pilot study findings identified a deeper need than the one I initially thought of. During classroom observation and when looking at the results of the pilot study, I realized the language complexities that may be affecting the teaching and the learning of mathematics in multilingualism classrooms that are taught by immigrant teachers (Robertson & Graven, 2020; Setati, 2001). I realized that there is a particular need for knowledge about immigrant teachers in this context (and would be of interest in other relevant contexts). My instrument was able to respond to myresearch questions as I was able to see the immigrant teacher's use of language practices when he was creating opportunities for the development of procedural and conceptual mathematical Discourse, and so what is described in this chapter built on that initial pilot.

3.2.3.2 Pre-observation questionnaire

To explore the teachers' views on language and language use in multilingual mathematics classrooms in South Africa, I prepared a structured pre-observation protocol/questionnaire. (Appendix I). My questions focused on the teachers' descriptions of their current school types, schools' locations, the learners' home languages, each teacher's nationality, home language, as well as their educational and professional backgrounds. The pre-observation teacher questionnaires were given to each teacher, after piloting (as described in Section 3.2.3.1), about a month before collecting data through classroom observation. The information was obtained via the study questionnaires I used to understand their backgrounds. (see the summary in Table3.1). Knowing their background could assist in understanding the reasons for the choices of their language practices.

Table 3.1: Participants' details and classroom-related information

Type of school and LoLT	**Schools Location**	**Teachers** (pseudonyms)	**Nationality and teachingbackground**	**Teachers' home language**	**Teachers' Language fluency**	**Learners' Home Languages in the classroom observed**	**Languages teachers not fluentin.**	**Teachers' qualification**
School A **Public** **LoLT: English**	Rural school	Mr. Ndlela	Zimbabwe Previously taught maths in Zimbabwe					Four-year Diploma in education majoring in maths. Degree, majoring in mathematics in Zimbabwe
School B **Public** **LoLT: English**	Township school	Mr. Dubazana	Zimbabwe Previously taught maths in Zimbabwe	Ndebele	Ndebele Zulu English	Setswana	IsiXhosa Setswana	Four-year Degree in education majoring in mathematics in Zimbabwe.
School C **Public** **LoLT: English**	Informal settlement	Mr. Zikode	Zimbabwe Previously taught maths in Zimbabwe					Four-year Diploma in education majoring in maths, in Zimbabwe. Postgraduate qualification in South Africa

Table 3.1. shows that all three teachers were qualified in Zimbabwe to teach mathematics at the primary school level and all three were employed in primary schools. All of them were from Zimbabwe, and their home language was IsiNdebele, not South African IsiNdebele but Zimbabwean IsiNdebele, as indicated in Section 1.2.7. They all came to teach in South Africa as explained in

Chapter One and Circular 02/2016. They were not fluent in Setswana, which was the learners' home language, but they indicated that they could understand some verbal Setswana. At the time of data collection, all three teachers had been teaching mathematics for less than five years. All of them were given pseudonyms, Mr. Ndlela from the rural school, Mr.Dubazana from the township, and Mr. Zikode from the informal settlement. Mr. Zikode was also teaching IsiZulu because there was a shortage of isiZulu teachers at the time of his arrival at the school. He was appointed as a mathematics teacher and isiZulu teacher because the Zimbabwean isiNdebele language is almost similar to isiZulu. They all had some similarities, such as sharing their home language and that they were from the same country.

3.2.3.3 Classroom observation

The mathematical topics foci in each of the lessons were: functional relationships for Mr. Ndlela, transformational geometry for Mr. Dubazana, and addition and subtraction of decimal fractions for Mr. Zikode. Data was gathered by observing what happened in the three mathematics classrooms. I prepared the observation sheet (see Appendix J) and used a video recorder to collect data during classroom observation. I, personally, video-recorded the lessons and also jotted down descriptive notes using the observation sheet. According to Maxwell (2012), video recording enables researchers to observe multiple aspects of the lesson, such as verbal and non-verbal communication, learner engagement, teacher feedback, and classroom environment. It also allows researchers to review and replay the lesson multiple times and focus on different details each time. Data were, therefore, gathered by observing the interactions between the teacher and the learners in the mathematics classrooms, focusing on what the teacher was saying and doing when describing mathematics concepts and procedures, and asking and/or clarifying questions. Setati (2003) indicates that the decisions about how data should be recorded in research are influenced by what the researchers perceive as meaningful data, based on their theoretical perspective and the research purpose.

Qualitative data is verified and validated using multiple data collection techniques (Maxwell, 2012). Maxwell (2012) further argues that when the researcher uses a video recorder and/or takes descriptive notes, these tools assist in capturing the information that will respond to the research questions. In her research paper on data re-presentation, Setati (2003) indicates that avideo recorder in the data collection process provides a moving record of the interaction. By using a video recorder, the researcher manages to record both the oral and the visual aspects ofthe interactions, which are the teachers' and the learners' utterances and their body language, including what they write on the board

(Setati, 2003). When using the video recorder and the observation sheet for data collection, the research questions guided me to write down the language practices and language functions the teachers were using when building mathematical knowledge.

During the classroom observation process, I concentrated on small-scale levels of social interactions between the teachers and the learners so that my focus would be on the content that was responding to my research questions (Maxwell, 2012). This involved gathering information by listening to what the teachers described, and how they asked or clarified questions, in an interaction with the learners. In a nutshell, my study explored these behaviors in their natural settings while considering that they (behaviors) are shaped by social groups, cultures, and institutions (Gee, 2011).

3.2.3.4 Reflective interviews

On the same day of the lesson presentation, I used reflective interviews after classroom observations to explore the reasons behind the teachers' language practices. I interviewed each teacher, using the notes I captured during the lesson observation. I made this arrangement with them before I visited their schools. The interviews were conducted during the break because I did not want to disturb the periods that came after the lessons I had observed. I conducted a semi-structured, individual teacher reflective interview immediately after a lesson presentation by each teacher (on the same day). My semi-structured interview schedule (see the reflective interview protocol Appendix K) and probing mostly focused on the language practices used by the teachers, why they used them, and what it means to use them when creating opportunities for the development of conceptual and procedural Discourse. For instance, the Researcher: "When you were explaining the concept of reflection you decided to use a mirror as an example, why?" The interview helped me validate my assumptions and interpretations were then communicated once again with the teachers where necessary, being guided by the participant's responses (Opie, 2004). While interviewing the teachers, I tried to probe gently, maintaining space and being non-judgmental (Opie, 2004). I talked less in the interviews to allow the participants to talk more, mainly to avoid a situation of imposing my views on the language practices used. All three interviews were voice-recorded. The reflective interviews provided insights into the teachers' perspectives, thoughts, and motivations so that I could understand the reasons behind their choices. This approach allowed me to explore their intentions and the context behind their decisions which were not evident during the lesson observations.

As I interviewed the teachers some of their responses disagreed with some of my assumptions. I am however aware of the possibility of missing some essential information because of my interviewing and listening skills, which adds to the limitation of my study. I realized after the interviews that I missed an opportunity to ask about some of the teachers' language practices, which could have made my findings richer.

3.2.3.5 Focus group interview

Maxwell (2012) indicates that focus group interviews as a qualitative research method involve a moderated discussion among a group of participants and are valued for their ability to generate rich, interactive data. He asserts that this is a dynamic interaction that can stimulate discussion, generate diverse perspectives, and uncover shared or conflicting viewpoints within the group (Maxwell, 2012). The focus group interview was done face-to-face at School A, the school in the informal settlement. I chose this because it was the nearest venue for all three teachers during the school holidays. Through this interview, I managed to gather views from the three teachers as a collective, regarding the language practices they used, and why they were used. Focus group interviews were conducted after I had done the initial analysis of the classroom observation data (see Section 3.2.3.4), almost a year after data was collected from the three participants as described in Section 3.6. The purpose of the focus group interview was to make the discussions trigger participants' thinking and encourage them to reflect on their experiences based on the language practices they used and why. My questions also looked at what it means to use those language practices when creating opportunities for the development of conceptualand procedural Discourse. The interview helped me validate my initial data interpretation because my assumptions and interpretations were then communicated once again with the teachers.

The participants in the focus group interview were the three teachers from the schools where Idid classroom observations. I selected the episodes on Pozzi's (2004) language functions which were the description of things and actions, asking informational questions, and clarification of questions and the language practices they used. At the beginning of the focus group interview (see Appendix L, which is my Focus Group Interview Protocol), I presented different episodes about each teacher's language practices, taken from each of their reflective interviews. The three teachers' responses to the questions guided the conversation throughout the interview process. I did not have to take notes because the audio recorder captured the conversation from the beginning of the interview until the end.

3.3 DATA PRODUCTION

The focus of this section is data production, which is about transcribing video material and audio-recorded material, translating the text into questionnaires, as well as organizing such data. I am presenting the process I followed to 're-present' (following Setati, 2003) data collected for my research study. I have argued that the re-presentation of data is "a process of reality construction" (Setati, 2003, p. 299). Setati (2003) says that transcripts are a re-presentation, which is "a presentation of the actual interaction in a different form" (p. 294). She defines a particular process for data re-presentation which shows different levels that move as follows: 'from actual experience to transcription, from transcription to translation and from translation to interpretation'. According to Setati (2003), data re-presentation is unavoidably selective, and the new structure is informed by theory, research questions, tools of analysis, and the purposes of re-presenting the data.

Before I could analyze my data, I transcribed (and translated as necessary) into written texts all the video recordings of classroom observations and audio recordings of interviews (both reflective and focus group). In this section, I describe this process, which I conceptualize as a form of data production, or in Setati's (2003) terms, 're-presentation' of data. Data re-presentation was transcribed based on my research questions and the rationale for my study.

3.3.1 Translation from the pre-observation questionnaires

I first looked at the questionnaires and identified the key ideas I needed to answer my questions. I selected relevant segments that were responding to my research questions. I aligned the responses from the questionnaires based on my research questions and the rationale for my study. I converted the raw data from the questionnaire into understandable and meaningful insights in a tabular form. This data focused on the schools' contexts, backgrounds, experiences, and resources of the three teachers involved in the study (Table 3.1).

3.3.2 Transcription of the videos of the lessons observed

Firstly, I worked alone to carefully listen to and repeatedly watch video recordings of the mathematics lessons observed in the three teachers' classrooms, in preparation for transcription. While watching, I noted down my initial thoughts on any language function and language practices they seemed to use when they were building mathematical knowledge. Using my jotted notes, I then decided to watch one video at a time, in detail, specifically focusing on identifying places where each teacher was using different language practices, the language functions, the building tasks as well as the opportunities for the development of procedural and conceptual mathematical Discourse that I could have missed. Before I did any transcription, I presented what I found from the three video recordings to my supervisors. The purpose was to check if the video recordings re-presented data that would answer the research questions (Setati, 2003).

I then transcribed the three videos in full, noting in an electronic document what the teacher said and did, and what the learners said and did as transcripts are a re-presentation of the actual interaction in a different form (Setati, 2003). For instance, guided by my conceptual tools, I noted when the teachers used a grid to ask informational questions about the action of translating. For example, 'Teacher: "When I slide to this position, have I turned around?"'. To signify an obvious pause or incomplete sentence, I used this notation: **"….".** I numbered each utterance so that I could be able to refer to them whenever I needed to provide evidence in my data analysis. I considered an utterance as a constant piece of speech that begins and ends witha clear pause. Setati (2003) argues that an utterance gives a "clue of the meaning of what is being said" (p. 295), which is also how I identify an utterance in my study. After numbering the utterances in the transcripts, I segmented them into different activities, as described by Gee (2011). I give details about what I call 'activity' in this study in Section 3.4.3.

For non-linguistic messages such as gestures and laughs, I used comments regarding that particular action where possible. This means that when transcribing all the recordings, I included linguistic and non-verbal details to make the transcript closer to what transpired in the classrooms. When transcribing the video recordings, I found it difficult to hear when teachers and learners pronounced certain words. This was time-consuming because I had to rewind now and then to figure out what was said. Where I couldn't hear clearly, I wrote "not clear" in the transcript. Having the Analytical Framework (Table 2.1) helped me avoid focusing on every utterance. Any word or phrase that was not uttered in English language (Setswana or isiZulu) was translated to English using brackets and italics, for example, Mr. Ndlela: "…. kamohari kaSetswana akere. (*inside, isn't it*)". The translation was done to help the reader who may want to use my transcript or the reader of your research but does not know Setswana and isiZulu.

3.3.3 Transcriptions of individual reflective interviews and focus group interview

After audio recording each teacher's reflective interview and the focus group interview for all three teachers, I listened to the voice recordings between the teachers and me before transcribing the data. I listened to the reasons the teachers gave about the language practices they used and why they used them. I then transcribed from the voice recorder, focusing on the utterances between the three teachers and me, as a researcher, re-representing the actual interaction in a different form (Setati, 2003). Here, I define utterances the same way as Setati (2003) does as stated in Section 3.3.2. I was not interested in the non-verbal language expressed by the participants because my interest was in them telling me why they used the language practices they did.

Each utterance was also numbered as I did with the lesson observation transcripts. Here, I give an example of how I facilitated the reflective interview: Researcher: "But when you say it's a flip, not a reflection, do you think most of them know what a flip is? Why?" Example from a focus group interview: Researcher: "Oh you say you demonstrate; do you like to demonstrate when you teach? Why?" I transcribed everything as per all the utterances from the voice recorder in English, Setswana, or isiZulu. I then translated the Setswana and isiZulu words to English, using italics within the brackets, just as I did when transcribing the video lessons of the three teachers. For example, Mr. Ndlela: "….kamohari ka Setswana akere. (*inside, isn't it*)" Where I could not clearly hear I indicated by writing "not clear" in the transcript. The Analytical Framework (Table 2.1) assisted me in not focusing on every utterance. Because I was interested in the teachers' reasons for using the language practices they used, I chose to include the information that was responding to my research questions.

3.4 DATA ANALYSIS

In this section, I explain how I systematically analyzed what the data I collected from the three teachers were saying, and also how I interpreted and theorized it (Yin, 2009). Data were analyzed in two stages. The first process took place before the focus group interview. The second process which was more systematic took place after I had done the focus group interview.

Before I could talk about language practices that the teachers used as my key question, it was important for me to ensure that I was able to analyze the pre-observation questionnaires first so I could understand the background of the three teachers. As explained in Section 3.2.3.2, I re-presented data for the pre-observation in the form of a table (Table 3.1), identifying key information, which is the consolidation from the three questionnaires in a tabular form. This data is key because the language practices the teachers use in their classrooms are shaped by certain things (Gee, 2005). I drew up other tables where I categorized the three teachers' lessons (Tables 4.1, 5.1, and 6.1). It was also important for me to ensure that I was able to use lesson transcripts effectively to answer the research questions. I had to interpret data to produce results, taking my theoretical concepts as a lens to the data I had re-presented in the transcript (Table 2.1).

In the analysis, the differences in lessons were considered by focusing on how each teacher used language practices specific to the mathematical topic they taught: one addressed functional relationships, another taught transformational geometry, and the third focused on decimal fractions. This allowed for an exploration of how the use of language functions in conjunction with the use of language practices varied depending on the mathematical content, rather than comparing the lessons directly. It also allowed for an exploration of the meanings that were built (according to Gee (2005) as the teachers were using various language practices to build mathematical knowledge when teaching different mathematical topics

3.4.1 Selection of episodes according to Pozzi's (2004) language functions

To answer my main research question, which was to find the language practices that the teachers used, I needed to look at the three Pozzi's (2004) language functions that the teachers used when building mathematical knowledge. It was important for me to look at the teachers'role because, as explained in Chapter Two, their role is particularly important in enabling conceptual and procedural Discourse (Setati, 2001; Moschkovich, 2007). I coded the interaction in different colours, focusing on Pozzi's (2004) language functions (Column 1 in Table 2.1). For instance, I highlighted 'description of things and actions' focusing on mathematical concepts and procedures. I also highlighted instances where the teachers were 'asking and clarifying questions' in different colours. For example, I have an episode where the teacher is describing the meaning of 'input' and 'output' values in a 'flow diagram,' or where the teacher is asking informational questions about 'the difference between the object and the image' in isometric transformations, or where the teacher is clarifying questions about'the concept of tenths and hundredths'.

3.4.2 Language practices used when the teacher builds conceptual and procedural mathematical knowledge

Within the episode transcripts arranged by activities, when the teacher was using language functions, I had to look at the language practices (Table 2.1, Column 2, Section 2.3.3) the teacher used when creating opportunities for the development of conceptual and procedural mathematical Discourse. In my study, an activity is when a 'concept' or a 'mixture of representations' is being described, or questions are being asked and clarified about that particular concept or representation. An activity may focus on one or more properties of a concept. For example, 'a description of an input value' or 'relations or differences between two or more concepts, or the description of the 'difference between the translation and reflection.' An activity can also be seen when a teacher describes a procedure for example on 'how a slide is represented on a grid.'

I discuss the teachers' language practices used when they described things and actions when they asked informational questions, and when they clarified questions. For instance, language practices are seen when the teacher uses his gestures to describe anticlockwise rotation, whichis the action or procedure for rotating; or the other teacher uses a hundred square diagram to clarify a question about the conceptual meaning of 'hundredths,' or a teacher is using code-switching to describe the meaning of the mathematical term 'output value' by using the Setswana word 'kontle' for 'out.' I highlighted different language practices that the teachers used, for instance, 'images,' 'code-switching,' or 'gestures,' and how they were used (Column2 in Table 2.1).

3.4.3 Identification of Gee's (2011) six of the seven building tasks for mathematical Discourse in my study

Gee (2005) refers to 'certain things' that are being built when language is being used, which he calls 'building tasks'. In this study, while building mathematical knowledge, the teachers use the three language functions that I have chosen (Column 1) with a range of language practices (Column 2), which include, gestures, images, code-switching, and drawing on learners' everyday context, and previously learned mathematical concepts. When using these language functions and language practices when building mathematical knowledge, certain meanings, according to Gee (2005) are being built, which are building tasks (Column 3), and encompass identity, activities, connections, politics, relationships, sign systems, and knowledge. In my study, I am interested in how utilizing these language functions and language practices, teachers create opportunities for learners to engage with and develop a comprehensive mathematical Discourse.

I coded Gee's (1996, 2011) six of the seven building tasks I identified, looking at how the three teachers used language to build 'activities,' 'politics,' 'connections,' 'identity,' or'relationships' as well as 'sign systems and knowledge' with their learners (see Section 2.3.3). For instance, building identity was when the learners' home language was used by the teacher to clarify questions, for example, by saying 'kamohari' to describe the mathematical concept input value (Column 3 in Table 2.1). The numbering of utterances in my episodes is the same as in the transcript. I then indicate the utterances covered by each activity and the utterances covered by each episode. In this case, an episode comprises an activity or more activities.

In the context of building procedural and conceptual mathematical knowledge, in my study 'activity' is has a defined structure (with a beginning and an end) and often involves the description and application of mathematical concepts and procedures. This definition aligns with the notion of 'building activities', which is one of Gee's (2011) building tasks (see Column 3 in Tables 4.1, 5.1, and 6.1).

These activities could include a description of mathematical concepts and procedures. An activity starts with a purposeful action and ends when the intended goal is achieved or abandoned within a socially recognizable context. These activities could include a description of mathematical concepts and procedures. This definition aligns with the notion of 'building activities', which is one of Gee's (2011) building tasks (see Column 3 in Tables 4.1, 5.1, and 6.1).

In this study, an episode comprises carefully identified relevant segments of data that reflect particular themes, interactions, or patterns connected to the study's objectives. It is a sequence of utterances from a transcript I chose to present my analysis in Chapters Four, Five, and Six, and it played an analytical function in the research. It is chosen to focus on particular aspects of the lesson, which in this study, is related to a specific language function stated in Section 2.3.1. By dividing the transcript into these episodes, I managed to organize the data for analysis.

When the teacher was using language practices to build mathematical knowledge (when the teacher uses previously learned mathematical concepts like 'symmetry' to clarify his questions) I looked at some sorts of connections that were made within and across utterances. When building mathematical knowledge, using language practices, I looked at the sign systems that were made relevant, for instance, images and gestures, and how the teachers made them relevant when clarifying questions (when the teacher uses a grid with triangles with dots to clarify a question about the action of translating). I also looked at the kind of mathematical knowledge the teachers were building, which was procedural and/or conceptual mathematical knowledge when using language practices (when the teacher uses different procedures for finding the output value to build conceptual mathematical knowledge about functional relationships).

3.4.4 Identification of procedural and conceptual mathematical knowledge built by the teachers when using language practices

The three of Pozzi's (2004) language functions that I focused on in this study were 'the description of things and actions', asking of informational questions, and clarification of questions (Table 2.1, Column 1). Things refer to mathematical concepts and representations and actions refer to mathematical procedures (Table 2.1, Column 3). The three teachers were using language practices to build procedural and conceptual mathematical knowledge through the use of language functions (Section 2.3.1.3). In the last column of Tables 4.1, 5.1, and 6.1,I indicate the kind of knowledge the teachers built as defined by Gee (2011), which was either conceptual and/or procedural mathematical knowledge.

As indicated in Section 3.4.2, I differentiated between procedural and conceptual mathematical knowledge by using the analytical tool (see Appendix M). This tool assisted when analyzing the mathematical knowledge built by teachers when using language practices in Sections 4.5, 5.5, and 6.5. Specifically, the tool was designed to get an insight into how the three teachers used language practices when creating opportunities for the development of procedural and conceptual mathematical Discourse. It helped to identify the procedural and conceptual mathematics knowledge built by the teachers when using language practices through the use of language functions. When building procedural mathematical knowledge, for example, the teacher describes how to perform a mathematical action (how to do a procedure of rotating on a grid). When building conceptual mathematical knowledge, for example, the teacher describes how one mathematical concept relates to another.

3.5 DATA QUALITY

Data quality is an important part of research, ensuring that the information obtained is accurate, reliable, and valid (Maxwell, 1992). Maxwell (1992) argues that data quality is a fundamental aspect of research, ensuring that the information collected is trustworthy and fit for analysis. It was important to ensure quality in the process I used to capture, manage, and analyze data so that I could develop a rich understanding and maximize consistency and accuracy thus minimizing the risk of bias. In my account, I am convincing the reader that my account can be trusted (Maxwell, 2012).

3.5.1 Validity in maintaining the integrity of research

In this qualitative study, it should be noted that not everything that the teachers and learners do is possibly useful, credible, or legitimate, as highlighted by Maxwell (1992). To aim for rigor and trustworthiness in this qualitative research, I therefore used Maxwell's (1992) categories of validity. According to Maxwell (1992), data validity is an important factor in qualitative research to ensure the trustworthiness of the findings. He believes that qualitative research relies on various types of validity, including descriptive, interpretative, theoretical, construct, and evaluative validity. In this study, I used descriptive validity, interpretive validity, and theoretical validity. Since I was not evaluating the teachers' practices, evaluative validity doesnot apply. I provided evidence from the transcripts and backed up my claims by using literature (Maxwell, 1992).

3.5.1.1 Descriptive validity

According to Maxwell (1992), this kind of validity is demonstrated when the researcher accurately describes the study participants' words or actions. In this study, this refers to how I collected and produced data in the classroom observation and teacher interviews. To ensure descriptive validity in my study, I used a video recorder for classroom observation and an observation sheet to jot down some notes while recording. I then transcribed and translated the data, as indicated in Section 3.6.2. When analyzing, I constantly worked between the lesson videos. I noted down what I was noticing during the interactions, trying to make sure I did not miss key parts of the lessons that were related to the purpose of the study during the lesson presentation. For the reflective and the focus group interviews, I also used voice recorders to account for this particular context, as explained in Section 3.5. The use of a video recorder helped me to get evidence about the interpretations and the descriptions because it was easy to see non-verbal features in the video, which I could not see in the observation schedule. All the transcripts of the data I collected were directed by the purpose of my research study.

3.5.1.2 Interpretive validity

Maxwell (1992) argues that interpretive validity is an extent to which meaning is attributed tothe research participant's behavior and the perspective of the individual whose behaviors arebeing measured. Maxwell (1992) indicates that interpretive validity is concerned with the levelat which the researcher portrays the research data (Maxwell, 1992). In my interpretation of data, I focused on answering the research questions I was interested in the teachers' language practices and therefore the videos focused on what the teachers were saying and doing. My selection of the clips was informed by Pozzi's language functions, looking at how the teachers described procedures, or how he asked or clarified informational questions. With video-recording, I was following scenes where I observed the use of language practices. Thereafter, I managed to voice-record the teachers' interpretation to capture what was going on in the lessons and why they used those particular language practices through reflective and focus group interviews. The reflective interview and the focus group interview recordings were guided by the third research question.

3.5.1.3 Theoretical Validity

Maxwell (1992) argues that theoretical validity focuses on the alignment of our findings with existing theories or frameworks, citing that it "goes beyond concrete description and interpretation and explicitly addresses the theoretical constructions that the researcher brings to, or develops during, the study" (p. 50). Maxwell (1992) also emphasizes the importance of theoretical categories when planning the categorizing analysis for the research study as they assist in presenting the research results. To address the theoretical validity of this study, I worked between the existing theories and the concepts of mathematical Discourse to develop an Analytical Framework (Table 2.1), as described in Section 2.3. I looked at the literature (Section 2.2) to see what concepts for procedural and conceptual mathematical Discourse otherpeople are using, and what language practices other people have used. I had to review the past research studies on teaching and learning mathematics in multilingual classrooms as well as on building procedural and conceptual mathematical knowledge during the emergence of mathematical Discourse.

Firstly, I designed the analytic tools in Table 2.1 to operationalize the theoretical concepts. I chose certain theoretical concepts which are Pozzi's (2004) language functions, and Gee's (2011) notion of Discourse analysis, looking at his building tasks as explained in Sections 2.33.4.1, and 3.4.3.

When the teachers use certain language practices, they use certain language functions. I, therefore, chose those that are related to mathematics for my study because during teaching and learning the teachers must describe certain concepts, they must ask some questions, and also clarify them if or when the learners do not understand. As explained in Section 2.3, I did not need all of Gee's (2005) 26 generic questions and seven building tasks. Ionly took those that were interrelated with my data and with the language practices that I drew from the literature.

Out of the language functions, language practices, and building tasks, I produced the Analytical Framework (Table 2.1). The focus of my study was on the use of language practices when there is a 'building of mathematical knowledge,'. I therefore developed a conceptual and procedural analytical tool (Table 2.1) to help me identify the kind of knowledge the teachers were building when using language practices and different language functions. My Analytical Framework also shows the key mathematical aspects I am referring to when the teacher is building procedural and conceptual mathematical knowledge.

I worked between data and tools to finalize the analysis. I got feedback on my systematic use of the analytic tools for the analysis of the data by getting regular input from my supervisors which helped me adapt my Analytical Framework. Consequently, I have a clear Analytical Framework that I refer to when analyzing data. I have specific questions that guide me concerning Gee's (2011) six-building tasks that I chose (Section 2.3.4). This helped me to givea good account of what happened in the classrooms concerning the research questions.

The categories of analysis in Table 2.1 in Section 2.3 show three of Pozzi's (2004) language functions the teachers used when creating opportunities for the development of procedural and conceptual mathematical Discourse. They show the language practices the teachers used when building mathematical knowledge using Pozzi's (2004) language functions. They also show Gee's (2005) six building tasks that emerged when the teachers were building mathematical knowledge when using different language practices. I presented questions to my supervisors for feedback, just to check if there was coherence within the Analytical Framework.

3.5.1.4 Generalizability

Generalizability is the degree to which the results of a study can be applied to other contexts, situations, or populations (Maxwell, 2021). Generalizability helps to compare the actual findings to other results from similar situations. Qualitative research studies, however, seldom make obvious claims about the generalizability of their accounts because each set of populations wherever a research study is conducted has its own unique demographic, sociological, psychological, and cultural characteristics (Maxwell, 1992). Maxwell (1992) argues that while we cannot claim to generalize in qualitative research studies, these positive features make qualitative research studies highly valued in the education community.

Maxwell (2021) argues that qualitative research findings may not be generalizable to any specific population unless there is a piece of evidence that shows similarities in the targeted contexts. My study was attached to three particular contexts. Therefore, by providing a written description of the contexts in which the analysis was carried out, I am presenting the readers with the opportunity to decide whether the results resonate with their own contexts or not. The study focuses on learners who are not fluent in the language of teaching and learning and the teachers who do not share the home language with learners. The cases I selected delved deeply into exploring the language practices the teachers used, looking at how and why they used them while giving meanings to procedural and conceptual mathematical knowledge, aiming to understand that phenomenon in detail, and therefore findings may not be generalizable. My study, therefore, cannot represent all similar groups or situations.

3.6 ETHICAL CONSIDERATIONS

Bhandari (2022) indicates that researchers should ensure that they adhere to a particular code of conduct when collecting data from participants, such as protecting the rights of the participants and their identities. Research ethics are critical for scientific integrity, human rights, and dignity, and therefore researchers should ensure that participation in the study is voluntary, informed, and safe for all participants (Bhandari, 2022). Researchers must also ensure that they have consent from the participants before embarking on the research study (Cohen, Manion & Morrison, 2002). The issue of respect for human dignity, and the integrity of all the schools and the participants is also very important while gathering information. Therefore, the rights of the participants should be considered (Cohen, et al., 2002).

In my study, I had to consider the institutions involved in this study, namely, a university, the Education Department as well as three primary schools. I also had to consider that teachers and learners were involved. I ensured that I applied for ethical clearance (Clearance number:

EDNREC2017-05-01) from the Ethics Clearance Committee at the University of Cape Town (UCT), before embarking on this research study and also sought an ethics approval letter from the Gauteng Department of Education.

In the next sections (Sections 3.6.1 to 3.6.5), I provide details of my positionality, how I got informed consent from the participants, and how I addressed the issues of confidentiality, anonymity, recognizability, and doing no harm.

3.6.1 My positionality

Positionality in research refers to the perspective and position that a researcher holds in relation to their study. The researchers' positionality may have an impact on their choice of processes as well as on the interpretation of outcomes because "researchers are inescapably part of the social world that they are researching" (Hammersley & Atkinson, 1983, p. 14). Considering the possibility of the impact of my position as a researcher in the provincial Department of Education under whose jurisdiction the schools fell, it was therefore important for me to ensure mutual trust between the study participants and myself.

My manner of approach towards the immigrant teachers who were my potential participants was also very crucial because of their employment status as explained in Section 1.3 in Chapter One. I had to assure them that the research findings would not impact their employment contracts. I also had to ensure that my analysis and writing did not lead to interpretations that may impact negatively on the teachers' image as they are employees of the Gauteng Department of Education (GDE). (Adler & Lerman, 2003). I also addressed my positionality beyond the consent process taking as many steps as possible to mitigate/address/minimize the effects, ensuring that my participants were fully informed and voluntarily agreed to participate. For instance, when interpreting data, as the GDE researcher, I did not focus on the identification of the intervention gaps in the GDE mathematics framework in my writing. I adhered to my research questions based on the rationale for the study and my informed consent.

3.6.2 Approach to selecting the cases

As explained in Section 3.2.2.1, after talking to the principal I found an immigrant mathematics teacher from the informal settlement through snowball sampling. I prepared the consent letters for the three principals from the three schools (rural, township, and informal settlement), seeking permission to work with the immigrant teachers in their schools. I also prepared the consent letters for the three immigrant mathematics teachers from the three schools (rural, township, and informal settlements), seeking permission to work with them in my research. I also sought permission from the learners' parents in the three mathematics classrooms that were taught by the immigrant teachers in my study. I also adhered to the GDE research coordination processes.

3.6.3 Informed consent

Bhandari (2022) indicates the importance of finding a way of negotiating and establishing a research relationship with the participants. I, therefore, followed proper ethical procedures to ensure that I got permission from the three teachers. Bhandari (2020) further indicates that the researcher should obtain parental consent when dealing with children. Before collecting data,I first sought permission to collect data from the principals, teachers, parents, and the learners at the three schools. These are the learners in the classes of the selected immigrant teachers, and therefore, I had to seek permission from their parents/ guardians. I prepared detailed information letters together with the consent forms (see Appendices A to H) to be signed by the principals, the three teachers, the parents, and the learners. Regarding the consent forms formy participants, I drew on the ones that were initially developed and used in my Masters programme (Tshabalala, 2007).

I read and explained the contents of the letters to the participants (the three principals, the three immigrant teachers, the Grade Six learners, and their parents) from the three schools that were selected. The teachers helped me distribute the information letters and consent forms to the learners so that they could take them home to request permission to participate in the study from their parents/guardians. The letters also clarified that the participation of their children in the study was voluntary. The information letters for the participants covered the following information:

- research topic
- the purpose of the research study
- the use of the video recorder during lesson presentations
- the use of a voice recorder for the teacher interview schedule
- participation in the study is purely voluntary.
- ensuring a high level of confidentiality and anonymity.
- a reply slip with a set of tick boxes by the participants

I also indicated that the participants had the choice to participate and that they would not be victimized in any way if they decided to withdraw from the study. This was part of ensuring that my research was standard, moral, and fair (Aluwihare-Samaranayake, 2012). All learners returned the letters after they and their parents/guardians had signed. All my participants consented to participate in my study.

3.6.4 Confidentiality

I addressed the issue around the confidentiality of results. The agreement of confidentiality is primarily maintained to protect research participants from harm (Kaiser, 2009). I assured the participants that their information would be treated confidentially. I also outlined how data would not be shared with anyone without their consent. To ensure a high level of confidentiality in my research process, I did the transcription of the videos and voice recording for the three teachers so that other people who may know them might not have access to their video-recorded lessons and interviews (Cohen et al., 2002). I ensured that video recordings were only viewed by myself and my supervisors. My supervisors also could not identify the three teachers in mystudy. I did not share the lesson videos or video recorder that had the data I collected during the lesson presentation as well as the interview voice recordings I got after the lesson presentations. I thereafter stored the videos and the recorders in a secured place.

3.6.5 Anonymity

In my negotiation with the participants, I assured their anonymity through information letters. I ensured that they remained anonymous, and I made every effort to comply with those wishes (Kaiser, 2009). I assured these three teachers, learners, and their principals that their identities and the schools' identities would be protected by using pseudonyms. I assured the participants that I would remove identifying information from the research reports and would use pseudonyms for them and their schools. I referred to the schools as School A, School B, and School C (Table 3.1). I assured them that their responses and data could not be traced back to them. In my thesis recorded information in such a way that it would not be easy to link responses to specific individuals.

I also ensured that the related data: the lesson videos, audio data of the reflective interviews, and the recording of the focus group interview were stored in a safe place where it could not be accessed by other people (Manohar et al., 2018).

3.6.6 Recognizability and doing no harm

It is the responsibility of the researchers to protect all participants in a study from potentially harmful concerns that may affect them because of their participation (Sanjari, Bahramnezhad,Fomani, Shoghi & Cheraghi, 2014). Although I could commit to and make steps towards ensuring anonymity and confidentiality as described in the previous Section, I cannot ensure that schools and participants are not recognizable because of the detailed, qualitative case study research. I am aware that despite my attempt not to disclose my participants' identities, the schools and teachers may be recognizable, given the fact that other colleagues do know that they participated in a study at some point. Other people may know that I conducted my study at those schools.

To avoid any potential harm, I therefore had to take other steps in my research, all of which were based on my broader commitment to avoid harm by this research. I chose and posed the interview questions carefully, ensuring that my questions and my writing practices did not harm my participants. I used the appropriate language that was not judgmental.

Though they may be recognizable, I wrote my report in such a way that I was not evaluative, focusing on advancing knowledge without causing harm. In my writing, I considered the consequences of the research by ensuring that the findings do not impact negatively on teachers. Therefore, my language use in my thesis writing was guided by the theoretical perspective I developed. I explained to the teachers that I was conducting the study because I wanted to learn about their resourcefulness, and how they worked in a context with multiple language practices. When explaining teachers' practices, I wrote respectful descriptions and was not evaluative.

3.7 CONCLUSION

In this chapter, I outlined the research design and its rationale concerning the teachers' language practices. I indicated how the study followed the qualitative approach and how the cases were selected. I explained the sampling process, indicating how the participants were found and selected. I further explained the data collection process. I then explained the data production process, looking at the transcripts of the pre-observation questionnaires, transcripts of video recordings of the mathematics lessons observed, transcriptions of individual reflective interviews and of the focus group interviews as well as reflecting on the transcription process. I further explained how data was analyzed and packaged in the analysis chapters in relation to my Analytical Framework.

Lastly, I explained the ethical considerations in my study. I explained my positionality when selecting the case, my approach when selecting the cases, informed consent, confidentiality, and anonymity as well as recognizability and doing no harm. The next chapter is the first of my analysis chapters, focusing on the first teacher, Mr. Ndlela.

CHAPTER 4: LANGUAGE PRACTICES OF MR. NDLELA

4.1 INTRODUCTION

This chapter and the next two chapters, five and six, present my analysis of the three teachers' language practices when creating opportunities for the development of procedural and conceptual mathematical Discourse. In each analysis chapter, I start by discussing the Curriculum topic as explained in the mathematics CAPS document, I thereafter give a table that shows all the activities the teachers built, aligned with my analytical framework. In Sections 4.4, 5.4 and 6.4. I analyze the teachers' use of each of the three language functions and the meanings built while teachers were using various language practices to build mathematical Discourse. In Section 4.5 and subsequently Sections 5.5 and 6.5, I focus in more detail on the building task of mathematical knowledge. I focus specifically on knowledge building and present the full lesson to give the reader a sense of the flow of a lesson as the teacher was building procedural and conceptual mathematical knowledge. Specifically, I explore what and how the teacher uses language practices to create opportunities for learners to develop both procedural and conceptual mathematical Discourse. Then, the last sections present the analysis of the teacher interviews to understand why they used the language practices they did (Sections 4.6, 5.6, and6.6). As noted in Section 2.3, Table 2.1, for this study, I chose the following language functions: description of things and actions, asking of informational questions as well as clarification of questions.

In this chapter, Mr. Ndlela focused on the concept of functional relationships (Section 4.2). To orient the reader to how each lesson unfolded, I use Gee's (2005) building task of activities to give a brief description of each lesson (Sections 4.3, 5.3, and 6.3).

4.2 FUNCTIONAL RELATIONSHIPS IN GRADE SIX IN CURRICULUM AND ASSESSMENT POLICY STATEMENT (CAPS)

Mr. Ndlela's lesson as a whole was on the description of functional relationships focusing on their representation in flow diagrams, number patterns, and tables. The particular focus was on finding the input value, output value, and the rule, using inverse operations. The preceding lesson was on number patterns. The lesson can be located in the curriculum content section: Patterns, Functions, and Algebra. In grade six, learners need to find the rule from a given pattern. They also need to find the input and output values from a given rule. While finding input value they will use inverse operations that also include multiplication and division. The teacher is encouraged to use representations in the form of number patterns, tables, and flow diagrams (DBE, 2011, p18).

The CAPS document (DBE, 2011) employs the terms ‘function diagrams’ and ‘function machines’ to refer to diagrammatic representations such as tables and flow diagrams. According to the document, teachers are advised to initially establish a rule with one operation, presented in a table, before progressing to more complex examples involving rules with two operations. Learners are instructed to engage with multiplication and division, using flow diagrams to grasp inverse operations (DBE, 2011, p. 182). Additionally, learners are expected to understand how multiplication can verify division calculations and vice versa, although the term ‘inverse operation’ is not explicitly used in the curriculum (DBE, 2011).

4.3 MR NDLELA’S LESSON ON FUNCTIONAL RELATIONSHIPS

This was a grade six lesson observed at the rural school. There were 33 learners in that mathematics class. This is lower than the average teacher-learner ratio which is supposed to be1:40 in Gauteng schools and is typical in rural schools. All learners were learning Setswana as their home language, but the official language of teaching and learning at the school was English. They were taught mathematics by Mr. Ndlela, an immigrant teacher from Zimbabwe, whose home language was isiNdebele. This was a double period, each period being forty minutes long.

The preceding lesson was on number patterns, focusing on finding the rule to complete and extend patterns. To orientate the reader on how the lesson on proper fractions in decimal form unfolded, Columns One to Three of Table 6.1 are a summary of the activities that Mr. Ndlela built in his lesson. The detailed analysis of the activities summarized in Columns 4 to 6 is presented in Sections 4.4 and 4.5. For most of these activities (Activities 1 to 16), Mr. Ndlela stood in front of the class while all the learners were seated facing the front. He only moved from his position to facilitate small group work in Activities Nine and Fifteen.

Table 4.1: Mathematics taught throughout Mr. Ndlela's lesson.

MR. NDLELA: LESSON ON FUNCTIONAL RELATIONSHIPS					
Activities	**Utterances** (With Episode analyzedin Section 4.4)	**Language functions (Pozzi, 2004)**	**Language practices**	**Building tasks (Gee, 2011)**	**Procedural and conceptual Knowledge**
1	1 to 10	Asking questions on mental mathematics focusing on the action of addition and subtraction of two and three-digit whole numbers.	English language Formal mathematical language Revoicing Forms of questions	Politics Knowledge	Procedural Conceptual
2	11 to 17 Figure 4.1 (Episode 1, Utterance 11 to 17)	Describing a 'flow-diagram' for representation of the concept of a functional relationship	English language Formal mathematical language Images Gestures Revoicing	Politics Knowledge Sign system	
3	18 to 22 (Episode 1 Utterance 18 to 22)	Describing the meaning of the word 'flow' to describe the meaning of the concept of functions	English language Formal mathematical language Learners' everyday context Gestures Revoicing Forms of questions Decomposing	Politics Knowledge Sign system Identity Relationship	
4	23 to 38 Figure 4.2 (Episode 2 Utterance: 23 to 37)	Describing the meaning of the concept input value	English language Formal mathematical language Images		Procedural and conceptual

			Revoicing Code-switching Gestures Forms of questions Decomposing		
5	39 to 49 Figure 4.3 (Episode 3 Utterance 39 to 49)	Describing the meaning of the concept output value	English language Formal mathematical language Images Revoicing Code-switching Gestures Image Forms of questions Decomposing		Procedural and conceptual
6	50 to 95 (Episode 3 Utterance 50)	Asking questions about the meaning of the word 'rule' and clarifying it using the example of cooking porridge, relating that to the concepts of input value, rule, and output value.	English language Formal mathematical language Images Everyday context Forms of questions	Politics Knowledge Sign System Connections Identity Relationship	Procedural and conceptual
7	96 to122 (Episode 4 Utterance 98 to 122)	Asking questions about the action of finding the rule for a functional relationship is linked to the action of completing number patterns	English language Formal mathematical language Images Previously learned mathematical concepts Forms of questions	Politics Knowledge Sign System Connections	Procedural and conceptual
8	123 to 129 Figure 4.4 (Episode 4 Utterance: 123 to 129)	Asking questions about how the four operational signs work in the action of finding the rule for a functional relationship linking	English language Images Formal mathematical language	Politics Sign System Knowledge	Procedural and conceptual

		it with 'going up' and 'going down' to give meaning to the concept of the rule.	Informal mathematical language Forms of questions		
9	130 to 152 Figure 4.5 (Episode 4 Utterance 130 to 132)	Describing how to find the output value using a given rule with two operational signs in tables, Using the group work task, relating that to the example of cooking porridge.	English language Formal mathematical language Images Learners' everyday context Forms of questions	Politics Sign system Knowledge Connection Identity Relationship	Procedural and conceptual
10	153 to 161 Figure 4.6	Describing the action of finding the input value using a given rule with two operational signs in a table using the word 'backward' for the concept of inverse operations.			
11	162 to 189 Figure 4.4 Figure 4.6 (Episode 5 Utterance 185 to 189)	Describing the concept inverse function, using the words 'forward' and ''backward,' 'opposite' when asking the learners to find the input value, using a table	English language Formal mathematical language Informal mathematical language Images Forms of questions	Politics Sign system Knowledge	Procedural Conceptual
12	190 to 220 Figure 4.6 (Episode 5 Utterance 190 to 197)	Asking questions about how the operational signs change, using terms 'plus and minus,' 'multiply and divide,' and 'opposite,' using a table, while describing the concept of inverse functions.			
13	221 to 227 Figure 4.7 (Episode 6 Utterance 222 to 227)	Asking questions using a task requiring learners to find the rule where the input and output values are given, using a table, with an arrow in the place of the rule.	English language Formal mathematical language		

14	228 to 256 Figure 4.7 (Episode 6 Utterance 228 to 232)	Clarifying questions about the action of finding the rulewhere the input and the output values are given, using a table.	Images Forms of questions		
15	257 to 300 Figure 4.7 (Episode 7 Utterance 280 to 300)	Clarifying questions about how to find the rule where input and output values are given and only one part of the rule is given to give meaning to inverse functions, also using the word 'backward' while learners work in groups.	English language Formal mathematical language Informal mathematical language Images Code-switching Forms of questions	Politics Knowledge Sign systems Identity Relationships	Procedural Conceptual
16	302 to 303	Asking learners to find the rule where the input and the output values are given, using a table through classwork and homework from the textbook.	English language Formal mathematical language Images Forms of questions	Politics Sign System Knowledge	

At the beginning of the lesson, Mr. Ndlela conducts a mental mathematics activity, focusing on the action of addition and subtraction of two and three-digit whole numbers before presenting the topic for the day (Activity 1). Then, the lesson focuses on the notion of functionas a rule.

As shown in Table 4.1, in Activity Two, Mr. Ndlela introduces the key term ‘flow diagram’ to name a representation of the concept of functional relationships, asking the learners to read it aloud. He pastes flashcards on which the words were written, one at a time on the chalkboard, while describing (Figure 4.1 to Figure 4.3).

Figure 4.1: Introduction of ‘flow’

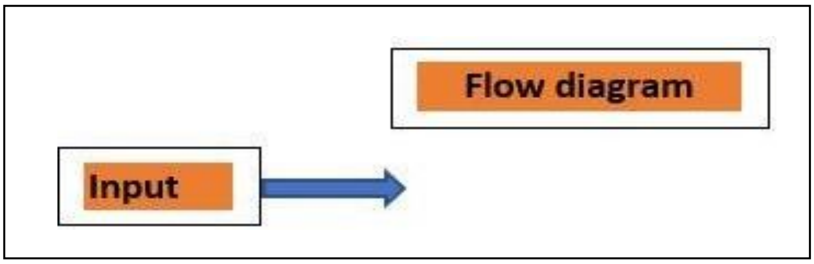

Figure 4.2: Introduction of ‘input’

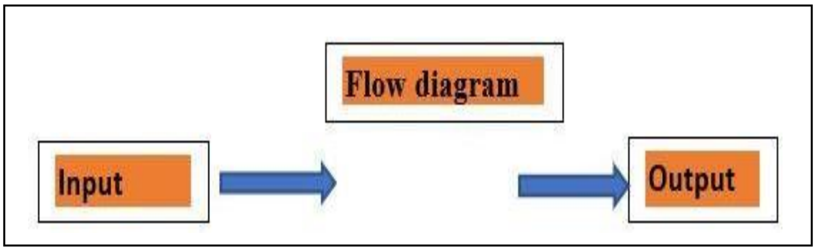

Figure 4.3: Introduction of ‘output’

After introducing the flow diagram representation, Mr. Ndlela describes the meaning of the word ‘rule,’ using the example of cooking porridge to relate the concepts of input value, rule, and output value (Activity 6). He thereafter describes the action of finding the rule for a functional relationship, using a number pattern 3;5;7;9; -; - (Activity 7).

In the next activity, Mr. Ndlela describes how the four operational signs (addition, subtraction, multiplication, and division) work in the action of finding the rule for a functional relationship. He links the operational signs with ‘going up’ and ‘going down’ to give meaning to the concept of the rule. In this activity, he uses a table to represent a function in which the rule has two operational signs (Activity 8, Figure 4.4).

Input	Rule		Output
2	+3	x2	?

Figure 4.4: Activity Eight with the input and the rule with two operationalsigns requiring output value.

In Activity Nine, after describing the rule with two operational signs, he adds more rows, with the same rule. He then asks the learners to work in groups on a task on how to find the output value using a given input value and rule with two operational signs in tables (Figure 4.5), a groupwork task.

INPUT	RULE		OUTPUT
3	+3	x2	?
5	+3	x2	?
6	+3	x2	?
7	+3	x2	?
9	+3	x2	?

Figure 4. 5: Groupwork Task for finding the output values.

Next, Mr. Ndlela uses a table with the same two-operation rule as Figure 4.5 for Activity Ten (Figure 4.6), but this time to describe the action of finding the input value using a given rule and the output value in a table.

INPUT	RULE		OUTPUT
3??	+3	x2	12
5	+3	x2	16
6	+3	x2	18
7??	+3	x2	20
9	+3	x2	24

Figure 4.6: Task for finding the input value when the rule and the output value are

given.

He describes the concept of inverse function using the words 'forward' and 'backward,' and 'opposite' when asking the learners to find the input value, using a table in Figure 4.6 (Activity11). In Activity Twelve, he again uses the table format to describe the concept of inverse functions. He focuses on how the operational signs change in an inverse function, using terms'plus' and 'minus,' 'multiply' and 'divide,' and 'opposite,' (Figure 4.6). He thereafter tests, together with the learners if the rule in the function is working the same way in the second row in Figure 4.6.

In Activity Thirteen, Mr. Ndlela gives learners a task that requires them to find the rule with a single operation, where the input and output values are given, (Figure 4.7).

Input values	Rule	Output values
1	⟶	7
3	⟶	21
5	⟶	35
7	⟶	49
9	⟶	63
11	⟶	77

Figure 4.7: Table requiring the learners to come up with a rule in the placeof an arrow.

He encourages the learners to talk about the rule in the tables, and how they found it. He thereafter describes the action of finding the rule in Figure 4.7 (Activities 14 and 15). He refers the learners to another table (Activity 16, Figure 4.8) requiring them to work in groups and describe how to find the two-operation rule, where input and output values are given and only one operation in the rule is given. When the bell rings, Mr. Ndlela decides to give learners homework that requires them to find the rule, referring them to the second row in Figure 4.8 (Activity 16).

Input values	Rule		Output values
1	⟶	+4	6
3	⟶		10
5	⟶		
7	⟶		
9	⟶		
11	⟶		26

Figure 4.8: Homework task at the end of the lesson

4.4 MR. NDLELA'S LANGUAGE PRACTICES

In this section, I provide an analysis of what language practices Mr. Ndlela used and how he used them in the activities described in Section 4.3. In the building task on 'building activities' in Table 4.1, I specifically focus on his use of these practices to perform each of the three language functions (Pozzi, 2004) when building the tasks named by Gee (2011) as, identities, relationships, connections, sign systems, and knowledge. I use evidence from the transcript of his lesson to validate my argument, referring to activities 1 to 16 in Table 4.1 (Columns 4 and 5). In each subsection that follows, I first present the transcript extracts and thereafter follow with my analysis. These episodes have been selected because they are rich in demonstrating how Mr. Ndlela used language for the three language functions across these activities. I give more details about building mathematical knowledge in Section 4.5 (Table 4.1, Column 6).

Regarding the use of language practices, I note that Mr. Ndlela uses English language in his whole class discussions and for all three language functions in this lesson (Activities 1 to 16). He uses Setswana occasionally, specifically allowing the learners to respond to his informational questions in their home language (Activities 4 and 5). His predominant use of English language in these language functions suggests that he is building politics as he makes Setswana less important.

4.4.1 Description of Things and Actions

In this lesson, the 'things' I refer to, in Pozzi's (2004) terms, are the concepts of the functional relationship, input value, output value, and inverse functional relationship. 'Things' also include the mathematical representations of these concepts, which are flow diagrams, number patterns, and tables. In Pozzi's (2004) terms, the 'actions' I am referring to are the actions for adding, subtracting, multiplying, and dividing as well as the action for finding the rule. This includes finding a rule between the input value and the output value, completing a pattern, and using operational signs in the rule. These things and actions are featured in Mr. Ndlela's descriptions (presented here), informational questions (Section 4.4.2), and clarification of questions (Section 4.4.3).

To support my argument about how Mr. Ndlela describes things and actions, I focus on three selected episodes (Episodes 1, 2, and 3). I provide evidence that, when describing things and actions in these episodes, Mr. Ndlela uses images, learners' everyday context, gestures, English language, code-switching, revoicing, decomposing, previously learned mathematical concepts, and formal mathematical language to build the following meanings in Gee's (2011) terms, which are identities, relationships, connections, sign systems and knowledge (as summarized in Table 4.1, Columns 4 and 5).

Episode 1

Introducing 'flow diagram' for the representation of functional relationships. Describing the meaning of the word 'flow' to describe the meaning of the concept of functional relationship (Activities 2 and 3)

11. … (Teacher pastes flashcard written 'flow diagram' on the chalkboard)

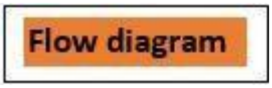

Figure 4.1: Introduction of 'flow'

12. Teacher: who can read that word for us? (Pointing at the 'flow diagram;' he looks around with a smile) Yes!
13. Learner A: flow diagrams
14. Teacher: let's say flow diagram, all of us (he uses his hand to show flow)
15. Learners: (chorus) flow diagram
16. Teacher: flow diagram
17. Learners: flow diagram
18. Mr Ndlela: can someone tell me, anything that you know that flows? Anything that flows which you know?
19. Learner B: water
20. Teacher: where does water flow?
21. Learners: in the river
22. Teacher: in the river, that it means it moves from one direction and flows to another direction (using his hand to show how the river flows). So, we are going to be looking at flow diagrams okay!

Episode 2

The teacher is describing the meaning of the concept input value focusing on the meaning ofthe word 'in' (Activity 4).

23. Teacher: I have got one here that I want us to look at (he pastes a flashcard on 'input' on the chalkboard)
24. Learners: yes

7. … (Teacher pastes another flashcard written 'input' on the chalkboard)

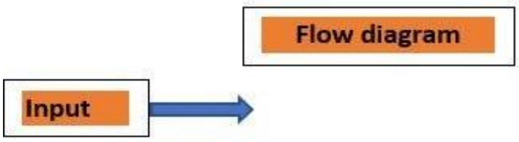

Figure 4.2: introduction of 'input'

26. Learner: input
27. Teacher: input, can you see the word 'input,' 'input' (repeating the word input)
28. Learners: yes
29. Teacher: who can tell us what they know about the word 'input'? (Learners are quiet) what do you know of 'input'? Or is there any part of that word 'input' you know? (The teacher still asks even when the learners are quiet)
30. Learners: (learners are quiet)

31. Teacher: I think I know the word ‘in,’ who doesn’t know the word ‘in’? (The teacher demonstrates the word ‘inside’ by moving his hand as if he is putting something inside a container, looking around at all thelearners)
32. Learners: (learners are quiet)
33. Teacher: in, in means…. Kamohari ka Setswana akere, (inside in Setswana, isn’t it?) inside, alright? (the teacher demonstrates the word ‘inside’ by moving his hand as if he is putting something inside a container)kamohari, (inside) in.
34. Learners: yes
35. Teacher: so, it means when we say input, you are putting something …….
36. Learners: inside
37. Teacher: inside, alright?

Episode 3

The teacher is describing the meaning of the concept output value focusing on the meaning of the word ‘out’ (Activity 5)

39. Teacher: in …put, the other one that we need to look at is this (pasting the flashcard ‘output’ on the chalkboard) who can read it for us? Yes?

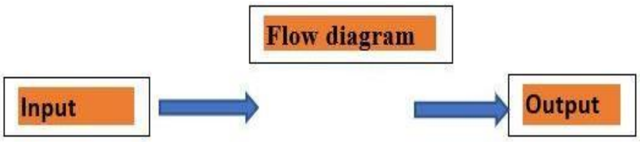

Figure 4.3: introduction of ‘output’

40. Learner: output
41. Teacher: output, output, what word comes into your mind when you hear that word ‘output’?
42. Learners: (learners are quiet)
43. Teacher: what comes into your mind, when you say ‘out’?
44. Learner: kontle (out)
45. Teacher: kontle (out), it’s out, alright?

46. Learners: yes
47. Teacher: it is out, out means you going, it means when I am opening the door here, I am going outside, (walking towards the door) that's output.
48. Teacher: Now when I look at the flow diagrams there is what we call 'input', and there is what we call 'output' (Referring learners to Figure: 4.3
49. Learners: yes
50. Teacher: what happens in-between?
51. Learners: quiet
52. Teacher: have you ever cooked pap?

In Episode One, Mr. Ndlela introduces the concept of functional relationships by using a representation of a flow diagram, using images. These images are in the form of individual flashcards with the words 'flow diagram' (11, Episode 1, Figure 4.1), 'input' (25, Episode 2, Figure 4.2), and 'output', written on them, pasting them one at a time on the board. He also uses images in the form of arrows (39, Episode 3, Figure 4.3) that show the direction from the'input' to the 'output' (25, 39, Episode 2 and 3). At this moment in the lesson, it appears that he is using the arrangement of the flashcard images in the representation named 'flow diagram'to introduce the key concepts and their relations (39, Episodes 3). Thus, he is building mathematical knowledge through sign systems, using flashcards and arrows, attempting to describe the 'flow' from the input value to the output value.

Mr. Ndlela supplements his use of images as a language practice with gestures such as using his hands to describe the meaning of the words 'flow' in 'flow diagram,' 'input' and 'output,' in functional relationships. For example, when focusing on the word 'flow diagram' he uses his hand to show how a river flows from one direction to another, attempting to show the relationship between the input and output value in functional relationships (14). In Episode Two, he uses his fingers to describe the mathematical concept of input value by pointing inside something and showing the inside (31, 33). In Episode Three he also describes the meaning of the output value by walking towards the door (47). With these gestures he builds sign systems, aiming to build mathematical knowledge, specifically, that there is a relation between the input value and the output value.

As noted, Mr. Ndlela predominantly uses English in his talk with learners in whole-class discussions. However, he uses the language practice of decomposing in English and Setswana and code-switching, supplemented with revoicing, when describing the meaning of the individual mathematical concepts input and output value. In Episode Two the teacher is the one who comes up with the Setswana word "kamohari[1]" (33), which is an informal mathematical language in Setswana, and thereafter revoices it in English language as "inside" (33) when attempting to describe the term 'input'. In Episode Three he accepts the learners' Setswana use of the word "kontle[2]" for 'out' (45) when attempting to describe the term 'output'. Revoicing the word "kontle" which is an informal mathematical language in Setswana, in English language as "outside" suggests that the teacher is building politics as he wants the learners to know the meaning of this Setswana word in English language. By decomposing 'output' and 'input' and code-switching the two prepositions 'in' and 'out' which is informal mathematical language in English, he is also building mathematical knowledge, wanting the learners to know the difference between the concepts input value and output value in functional relationships. When he uses Setswana words, he is building identity and relationships because he chooses to describe the words in the learners' home language even though he is not fluent in it.

4.4.2 Asking informational questions

In this section, I show how, when asking informational questions, Mr. Ndlela uses English language, different forms of questions, images, previously learned mathematical concepts, and informal mathematical language to build the following meanings: identities, relationships, connections, sign systems and knowledge (Table 4.1, Columns 4 and 5). For the evidence of my argument, I use mainly Episodes Four and Five but also draw on Episodes One and Three (Section 4.4.1).

Episode 4.

Asking questions about the action of finding the rule in functions and the action of completing number patterns using the four operational signs to give meaning to the 'rule' (Activities 7, 8, and 9)
98. Teacher: when we talk about the rule, if you are given a series of numbers or number sequence you have to establish a rule to find the number which is next, like for an example, let's say I have got {3; 5; 7; 9; __} (number pattern on odd numbers written on the board) what will be our next number? (Opening his eyes wider) Yes, my dear (pointing at one girl in class)
99. Learner: eleven
100. Teacher: how did you find out it is eleven? (Quietness in class) Can someone tell me? (Looking around as if he is expecting other learners to support learner 8) How did you find out the next number is eleven? Yes, my dear
101. Learner: by checking the first two numbers
102. Teacher: how did you check the first two numbers?

[1] Some of the Setswana words are somewhat colloquial. The teacher used "kamohari" instead of "kafahare".
[2] Colloquial Setswana word "kontle" instead of "kwantle".

103. Learner: by adding or subtracting
104. Teacher: you add or subtract, so what did you do?
105.Learners: (not clear) I
106. Teacher: what did you do? Yes
107. Learner: add 3 (learner gives incorrect answer)
108. Teacher: I mean these numbers, the first two number? What did you do to these first two numbers? Yes, my dear, tell me.
109. Learner: 5 minus 2
110. Teacher: you said 5 minus 2, what did you get?
111.Learner: 3
112. Teacher: you got 3, alright, and then you came here between five and seven you did the same thing and what did you get?
113. Teacher: and then you said 9 minus 7
114.Learners: 3
115.Teacher: and then you told yourself that the next number here, if you subtract 3 you are going to get….
116.Learners: (mumbling)
117. Teacher: if you subtract three from that number that we don't know, if you subtract 3, you going to get what? You see, that's not it my dear. Now what's our last number? (The teacher is making the learners aware that 3 is incorrect)
118. Learners: 9
119. Teacher: if we go up and our answer is?
120.Learners: 11
121. Teacher: 11, now what is our rule? Can you see these numbers, 3, 5, 7, 9 are they going up or down? (He does not give the learners a chance to come up with the correct answer i.e., 2)
122. Learners: up
123. Teacher: are they going up or down?
124.Learners: up
125.Teacher: If they are going up, what are we doing?
126.Learners: we add
127.Teacher: we add, if they are going down, we subtract or divide,
(Teacher draws a table and focuses the learners' attention on it, he no longer focuses on the incorrect answer 3 which was given as the difference in the number patterns)

Input	Rule		Output
2	+3	x2	?

Figure 4.4: Activity Eight with the input and the rule with two operational signs requiring output value.

….in this case we are adding 3 (writing +3 next to 2), that is our rule, okay?

129. Learners: yes
130. Teacher: now I would like to write, to put the inputs there, (referring to Figure 4.4**)** and then I will give you the rule, and then you will work out what our output is going to be. Now let me get my ……, now if I write two here and then here, I say plus three (writing two as input and write plus three, multiplied by two in the rule) What is our rule? (Add the diagram)
131. Learners: plus, three times two (chorus)
132. Teacher: which means you add ……., multiplied by ……… (Pointing at +3 and x2 in the flow diagram)

Episode 5

Asking questions about how the operational signs change when describing the inverse functions in a functional relationship represented in a table (Activity 12,13).

185. Teacher: very good, now we don't have anything (pointing at the blank space of the second input on the table drawn on the chalkboard). So, if we don't have anything it means we are going to start with the output going backwards.
186. Learners: backwards
187. Teacher: going?
188. Learners: backwards

189. Teacher: and when we are going backwards what happens to these signs, these operational signs? Who can tell us? We are now going backwards, what happens to them?
190. Learner: they change
191. Teacher: how do they change?
192. Learners: they become opposite
193. Teacher: plus becomes?
194. Learners: minus
195. Teacher: and times will be?
196. Learners: divide
197. Teacher: (the teacher writes five different input values to be used on the table, learners have to put the output values). Let's try and see; this is the second one, this is............ ? (Pointing at output value 12 in the first row)

INPUT	RULE		OUTPUT
3??	+3	x2	12
5	+3	x2	16
6	+3	x2	18
7??	+3	x2	20
9	+3	x2	24

Figure 4.6: Task for finding the input value when the rule and the output value are given.

When asking informational questions in these episodes, Mr. Ndlela uses different forms of questions. For instance, he uses closed questions requiring 'yes' or 'no' such as "have you ever cooked pap?" (52, Episode 3). He also uses questions that require short, numerical answers such as "what will be our next number?" (98, Episode 4), expecting the learners to come up with an action of finding the next number in the pattern. Sometimes his closed questions require that learners should complete his sentences with numerical answers, for example, "if you subtract 3 you are going to get ……?" (116, Episode 4). He is building mathematical knowledge by asking a question that requires an answer to a calculation. Mr. Ndlela also asks open-ended questions that require learners to explain or justify the action they have used. For example, he asks, "how did you find out it is eleven?" (100, Episode 4), "how did you check the first two numbers?" (102), or "What did you do to these first two numbers?" (108, Episode 4). In Episodes Three and Four, Mr. Ndlela is building mathematical knowledge by using these forms of questions that require learners to describe the rule for the functional relationship. He wants the learners to examine the relationships between the terms of the number pattern so that they may be able to make predictions about the next number.

In Episode Four, Mr. Ndlela uses informal mathematical language as a language practice when asking informational questions saying, "are they [the numbers] going up or down?" (124) "if they are going up, what are we doing" (126). In Utterance 126, Mr. Ndlela is asking an open-ended question about the rule that requires learners to describe a pattern in functional relationships. When going up in this case learners can use addition or multiplication signs, and when going down, they can use subtraction or division signs. The teacher is building mathematical knowledge, expecting the learners to observe the number pattern and think about the operational sign that needs to be used when the pattern is either “going up” or “going down”, using informal mathematical language (124, Episode 4). In Episode Five he asks closed questions using informal mathematical language saying: “plus becomes?” and “times will be?”instead of using the formal mathematical terms ‘addition’ and ‘multiplication’ (193 to 195). In this episode, he is introducing informal mathematical language to build mathematical knowledge, specifically attempting to describe the meaning of inverse functional relationships.

Mr. Ndlela also uses images in the form of number patterns, arrows, and tables as language practices when asking informational questions (Figures 4.4 and 4.5). In Episode Four, he writes a number pattern on the board and asks a closed question saying, “let’s say I have got; 5; 7; 9;__; what will be our next number?” (98). He asks another closed question saying, “are they [the numbers] going up or down?” (124) “If they are going up, what are we doing?” (126) still referring to the number pattern. He is building a sign system to build mathematical knowledge, using informal mathematical language. In this case, the question is closed-ended because the learners should observe the image, which is in the form of a number pattern, and identify whether the pattern is in an ascending or descending order and find the rule. In Episode Five, Mr. Ndlela refers the learners to the table with the output value, the rule, and the question marks as placeholders for the missing input value (Figure 4.5). He asks a closed question saying, “divide by two and you get ….?” (203), also using formal mathematical language. His focus is on the first row of the table, pointing at the output value which is 12, moving to the input value. He is building mathematical knowledge through sign systems to give conceptual meaning to inverse functions.

When asking informational questions, Mr. Ndlela uses previously learned mathematical concepts as a language practice. For instance, when introducing the rule in Episode Four he says, “last week we were talking about the number patterns…. What will be our next number?” (98) asking a closed question. Here the learners need to think about the rule for finding the next number in a pattern. He asks another closed question such as, “What did you do to these first two numbers?” (108). Learners must think about the operational sign they need to use between the first two numbers to determine what the rule is. He is building mathematical knowledge, using images in the form of number patterns to help introduce the action of how the rule works in functional relationships. His question helps learners to come up with an action of getting to the next number in number patterns, which is similar to the rule of moving from the input value to the output value in flow diagrams (Activity 7, Episode 4).

Mr. Ndlela uses revoicing in English and Setswana as a language practice when asking informational questions. In Episode One, after asking a closed question saying, “where does water flow?” (20) learners respond by saying “in the river”, the teacher revoices by also saying “in the river” (21). Here, he is attempting to describe the meaning of the functional representation ‘flow diagram’ using revoicing to affirm the learners’ response. In Episode Three, when attempting to describe the mathematical term “output” Mr. Ndlela asks an open-ended question, saying, “what comes into your mind when you say ‘out’?” (43) also using informal mathematical language. The learners respond in Setswana saying “kontle (out)” which is an informal mathematical language in Setswana and the teacher revoices in Setswana and English language saying “kontle (out), it’s out, alright?” (45). By revoicing in Setswana and English, the teacher is attempting to remind the learners that the language of teaching and learning is English. Here, Mr. Ndlela is building multiple meanings. These examples show that he is attempting to build mathematical knowledge by using formal and informal mathematical language to give meaning to the mathematical terms ‘flow diagram,’ and then the ‘output value.’ He is also building identity and relationships by using the learners’ home language to give conceptual meaning to the mathematical terms ‘output’ and ‘flow diagram’ using informal mathematical language. He is also building politics by revoicing the Setswana words in English language.

4.4.3 Clarification of questions

The analysis in this section explores how Mr. Ndlela attempts to make his informational questions clearer to the learners whenever he realizes that they do not understand the informational questions. In this section I show how when clarifying questions, he uses English language, images, code-switching, previously learned mathematical concepts, gestures, decomposition, and informal mathematical language to build the following meanings which in Gee’s (2011) terms are activities, identities, relationships, connections, sign systems and knowledge (summarized Table 4.1, Columns 4 and 5).

Mr. Ndlela clarifies questions in different ways at different times. For example, after asking a question sometimes he describes a particular concept or action. At other times, he asks an informational question, either a closed or open-ended question, and then clarifies it by repeating the question more slowly, rephrasing it, or asking the question in a different way. Here, I present the findings with evidence from some of the utterances selected in Episodes Six and Seven. I also refer to earlier episodes discussed in Section 4.4.1. and 4.4.2.

Episode 6

Clarifying questions to helping the learners understand how the rule works as the inputand output values are given, using arrows, reminding the learners about moving forward and backward when working with inverse operations (Activity 14, 15)

222. Teacher: very good, now let’s come here, here I gave you the input values (teacher draws a table below). Can you see the input values?

Input values	Rule	Output values
1	→	7
3	→	21
5	→	35
7	→	49
9	→	63
11	→	77

Figure 4.7: Table requiring the learners to come up with a rule in the place of an arrow.

223. Learners: yes
224. Teacher: and the output values, can you see my arrows, which direction are they going?
225. Learners: forward
226. Teacher: are these arrows going backwards?
227. Learners: no
228. Teacher: all of them are going forward (showing them the arrows under the rule), so what are you going to do? Can you please talk, I will just give you two minutes to talk, what are you going to do to get here? (Pointing at the output value 7 in Figure 4.7). You ‘ve got to, you do something to one to get seven (referring the learners to the table)
229. Teacher: And remember your rules must apply to all the levels, it must be one rule, yes what must we do
230. Teacher: (the teacher goes to different groups to see how they work)
231. Teacher: Yes, what did you do, ok let me see (talking to one group) what your rule is
232. Learner in a group: times seven
232. Teacher: times seven

Episode 7

Clarifying questions by showing learners the importance of the rule and how the inputshould be corresponding with the output (Activity 15)

280. Teacher: it must apply in all, it must be the same rule, okay it must be a rule e tshwanang (which is the same), so what do we do here? Think about all the four operations. Play around with them. What did you do? Right let me tell you (referring to the first row in Figure 4.8)
281. Learner: (going to the chalkboard)

Input values	Rule		Output values
1	→	+4	6
3	→		10
5	→		
7	→		
9	→		
11	→		26

Figure 4. 8: Homework task at the end of the lesson

282. Teacher: eh! Don't give us the answer, tell us how you got it.
283. Learners: one times two,
284. Teacher: ah! Ah! We don't know the times two, we don't know hore ke (that it is) times two, so explain to us how you got that answer.
How did you get, because akere rebatla (isn't that we want) times two, fine, how did we get it? (The learner is struggling to explain; the teacher decides to call another learner). Anyone who can explain, come and help your friend, (with a smile) I know he knows the answer, yes.
285. Learner from the group: (goes to the board to explain) I said 6 minus four is two
286. Teacher: now if you say ten minus four, we don't get two, wa bona (you see) (referring to the second row of Figure 4.8)
287. Learner: yes
288. Teacher: how did you do it? (Pause, referring to Figure 4.7), alright thank you, sit down. Let me explain something, now let us use the second output, it's ten. So, it's ten, because we are going backwards it's ten minus ….
289. Learners: four
290. Teacher: and we are going to get
291. Learners: six,
292. Teacher: **but don't put six here,** you will ask yourself **what did you do to three (the input) to get six**
293.Learners: we multiplied it by two
294. Teacher: we multiplied it by….
295. Learners: two
296. Teacher: which means our ruling will be a multiplication by ….
297. Learners: two
298. Teacher: it must be the same for all these values, is there anyone who doesn't understand? Lea tlhaloganya, (do you understand?)
299. Learners: yes
300. Teacher: do you all understand?

Mr. Ndlela uses English language and decomposition as language practices when clarifying the question about the meaning of the formal mathematical language "input" and "output" (29, Episode 2 and 43, Episode 3).

Here he decomposes 'input' by focusing on the prefix 'in' also using informal mathematical language. In Episode Three, he first asks a closed question saying, "who can tell us what they know about the word input?" (29). When the learners are quiet, he decides to clarify the question by asking another closed question saying, "Or is there any part of that word 'input' you know?" (29), suggesting that the word "input" can be decomposed. When the learners are still not responding, he no longer asks them, but instead, he decomposes the word "input," saying "I think I know the word 'in'" (31), focusing on a preposition that is informal mathematical language in English language. Next, in Episode Three he asks another open-ended question saying, “what word comes into your mind when you hear that word ‘output’?” (41). When the learners are quiet, he clarifies his questions by asking them differently, decomposing the word “output” saying, “what comes into your mind, when you say ‘out’?” focusing on the preposition ‘out’ only (43) which is informal mathematical language in English. With these clarifications, he is building mathematical knowledge, attempting to help the learners understand the meaning of the mathematical terms ‘input’ and ‘output’ by decomposing them and focusing on prepositions in informal mathematical language in English. He is also building connections with English language as a subject, focusing on prepositions.

As noted in the previous example, he clarifies questions by using informal mathematical language. Another example is in Episode Seven, when the learner says the answer is two for the first row in Figure 4.7, he asks an open-ended question “How did you do it?” (288), asking the learner to explain how he got to the input value in the first row. When the learners are quiet, he clarifies by saying “Let me explain something, now let us use the second output, it’s ten.” (288) He is referring to the second row in Figure 4.8. He says, “So it’s ten, because we are going backwards, it’s ten minus?” (288). Here he clarifies his question by using the words “going backwards” to remind the learners that they are supposed to move from the output value to the input value. Thus, he is building mathematical knowledge by attempting to give meaning to the concept of inverse operations by describing how to move from output value to input value.

In Episodes One, Two, and Three Mr. Ndlela uses gestures as a language practice to clarify his questions about the mathematical terms “flow diagram,” “input” and “output”. He first asks a closed question about a “flow diagram” saying “can someone tell me, anything that you know it flows? Anything that flows which you know?” (18), only focusing on the word “flow” in the term “flow diagram”. When the learners are quiet, he clarifies his question, as discussed earlier, by using his hands to show how the river flows. He is building mathematical knowledge about the concept of functional relationships through a sign system, that is, by using gestures to relate the river that flows with the word ‘flow’ in flow diagrams. He is supporting gestures by also using English language, decomposition by focusing on the word ‘flow’ only, as well as informal mathematical language in English.

In Episode Two he asks an open-ended question saying, “who can tell us what they know about the word ‘input?’” (29). After repeating the question for some time in Episode Two, he clarifies it by saying “I think I know the word ‘in,’ …?” while using his finger gesture as if pointing inside something (31,33), supporting the gesture with informal mathematical language in English. For the term “output” in Episode Three, he asks an open-ended question saying, “what word comes into your mind when you hear that word ‘output’?” (41). He thereafter clarifies his question by walking to the door, demonstrating the preposition ‘out’ supporting the gesture with informal mathematical language in English, saying “out means you going, it means when I am opening the door here, I am going outside” (47). He is building mathematical knowledge through sign systems (that is, by using gestures), attempting to help the learners understand the meaning of the mathematical concepts input and output value represented in a flow diagram.

Mr. Ndlela uses images in the form of a number pattern, tables, and arrows as language practices to clarify his questions to the learners. For example, in Episode Three, when asking for the rule in the first row of Figure 4.7, he asks an open-ended clarifying question saying, “so what are you going to do?” (228). When the learners are quiet, he clarifies his question by saying “You‘ve got to, you do something to one to get seven,” pointing at the input, the arrows, and the output values in the table (Figure 4.7). While the learners are still quiet, he clarifies again saying “And remember your rules must apply to all the levels…” (229) pointing to all the rows in the table (Figure 4.7). He is building sign systems by using images to build mathematical knowledge, as he expects the learners to look at the input value, the direction of the arrows, and the output value and deduce the action to be followed when finding the rule. In Episode Seven he asks an open-ended informational question saying, “how did you do it?” asking for the missing rule in the first row (288, Figure 4.7). When the learners are quiet, he clarifies his question by using the second output value in the second row of the table, saying “now let us use the second output, it’s ten. So, it’s ten, because we are going backward, its ten minus …?” (288) asking a closed question, supporting the use of a table with informal mathematical language in English. Here he is building mathematical knowledge by describing the action of inverse operations to find the rule, to give conceptual meaning to inverse functions.

In Episode Seven, Mr. Ndlela also clarifies questions by using code-switching to Setswana as a language practice. After giving the learners, the rule for the first row in Figure 4.8 he asks a closed question about the second row, saying “then our rule is…?” (278). When the learners are quiet, he clarifies the question by saying “it must apply in all, … okay it must be a rule etswhanang, (it must be the same rule)” thus giving the learners a clue that all the rows in the table use the same rule (280, Episode 7, Figure 4.8). He is building mathematical knowledge by describing to the learners how the action for finding the rule works in functional relationships that are represented in table format. He is building identity and relationship by using the learners' home language to describe the action for finding the rule in functional representations.

Mr. Ndlela uses previously learned mathematical concepts as a language practice when clarifying questions. For example, in Episode Seven, after asking a closed question saying, "then our rule is…?," asking the learners to find the rule in a function where one operational sign of the rule is not given (Figure 4.8), learners do not respond. When the learners are quiet, he clarifies his question by referring them to the four operational signs, saying "think about all the four operations, play around with them. What did you do?" (280). He is building connections with the previously learned mathematics concepts, which are the four operational signs. He is also building mathematical knowledge by reminding learners that something must happen to the operational signs when moving from output value to input value in inverse functions (284, Episode 7).

4.4.4 Summary of the language practices used.

The analysis of Mr. Ndlela's lesson highlights his use of diverse language practices across all three language functions to build mathematical knowledge. The lesson focuses on two main areas: firstly, defining concepts in functional relationships and secondly illustrating procedures for determining rules through various representations (Activities 7 to 17). While employing language functions and practices to develop mathematical knowledge, Mr. Ndlela integrates different meanings, with his language practices complementing each other. This indicates that multiple language practices are used to support formal mathematical language, demonstrating their interconnectedness.

In this lesson, Mr. Ndlela mostly uses informal mathematical language, gestures, and images to clarify questions, thus building sign systems while building mathematical knowledge. For example, when Mr. Ndlela clarifies a question about a new concept, he uses decomposition, informal mathematical language in English and Setswana (building politics and identity), and gestures (building sign system) as language practices. When he describes or clarifies questions about the action for finding the rule, he uses images, formal and informal mathematical language, code-switching, revoicing, previously learned mathematical concepts, and learners' everyday experiences. However, English language is the most dominantly used language practice than all others.

4.5 HOW MR. NDLELA CREATE OPPORTUNITIES FOR THE LEARNERS TO ENGAGE IN PROCEDURAL AND CONCEPTUAL MATHEMATICAL DISCOURSE?

In this section, I look in further detail at the building task 'mathematical knowledge' in the analysis, as identified first in Section 4.4. This involves exploring how Mr. Ndlela creates opportunities for the development of procedural and conceptual mathematical knowledge when he describes things and actions, asks informational questions, and clarifies his questions.

Regarding the procedural mathematical Discourse, as set out in the Analytical Framework (Table 2.1, Column 3) and the conceptual and procedural analytical tool (Appendix M), I focus on what and how the teacher describes how to perform a mathematical action, how he requires the learners to complete an action, how he asks for the answer to a calculation and how he requires that the learners memorize some of the rules. Regarding conceptual knowledge, as noted in Table 2.1, I look at how the teacher describes the meaning of mathematical concepts for understanding and communicating mathematical ideas, how he asks the learners to explain and justify why they used a particular action, and also how he encourages learners to compare, contrast and integrate related concepts (Also see Appendix M, which is my analytical tool).

While Section 4.4 is structured using Pozzi's functions, this section is structured according to the flow of the lesson. This structure brings into view how Mr. Ndlela, in the lesson as a whole, attempts to build procedural and conceptual Discourse. I use the activities in Table 4.1 to structure the analysis in this section. For ease of reading, I repeat the key figures already analyzed in Section 4.3.

4.5.1 Describing the representation 'flow diagram' to describe themeaning of the concept of functional relationships (Activities 2 and 3)

Mr. Ndlela introduces his lesson on functional relationships by using the representation named 'flow diagram,' and not naming the concept it represents, that is, the concept of functional relationships. He asks a closed question saying, "who can read that word for us?" pointing at the word 'flow diagram' written on a flashcard pasted on the chalkboard (Figure 4.1).

Figure 4.1: Flashcard pasted on the chalkboard.

After the learners have read the term “flow diagram” aloud, Mr. Ndlela focuses on its conceptual meaning by directing the learners’ attention to the word ‘flow.’ He does this by asking the learners to tell him if they know anything that flows, “Anything that flows which you know?” asking an open-ended question. At first, he asks a question that focuses on the conceptual meaning of the word ‘flow’ in informal mathematical language, not attaching it explicitly to mathematics. When the learners are quiet, Mr. Ndlela clarifies the question by asking another conceptual question saying, “where does water flow?” When the learners say, “in the river” he describes the meaning of ‘flow’ again by saying “it means it moves from one direction and flows to another direction” shown by using his hand gesture. He thereafter combines it again with the word ‘diagram’ thus focusing on the mathematical concept flow diagram.

Thus, he is aiming to build conceptual mathematical knowledge, associating the meaning of the term ‘flow’ in a ‘flow diagram’ with how water moves from one direction to the other in the river. He does this using learners’ everyday context, gestures, different forms of questions, images in the form of flashcards, and English language as language practices.

He thereafter continues with his description of functional relationships saying, “there are three things that we look at when we are dealing with a flow diagram.” What follows may suggest that he is using the flow diagram as a representation, as described here, to introduce how the rule between the input value and output value works in a functional relationship.

4.5.2 Describing the meaning of the mathematical concepts input and output value (Activities 4 and 5)

Next, Mr. Ndlela pastes another flashcard on the chalkboard written ‘input.’ He thereafter focuses on the conceptual meaning of the word ‘input’ by asking closed questions and clarifying them while the learners are quiet, saying, “we have this, who can read this? Who can tell us what they know about the word input.....Or is there any part of that word input you know?” referring to Figure 4.2.

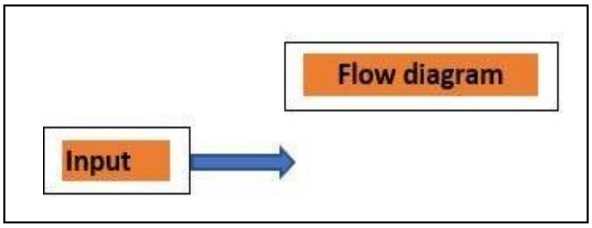

Figure 4.2: Focus on the term 'input'

Thereafter, Mr. Ndlela decides to clarify by decomposing the mathematical term input in English and focus on the prefix 'in' saying "I think I know the word 'in,' who doesn't know the word 'in'?" When the learners are still quiet Mr. Ndlela clarifies his question by code-switching to the learners' home language, describing the meaning, saying "in, in means kamohari ka Setswana akere" using informal mathematical language in Setswana. He switches again, asking a question using English language saying, "so it means when we say input, you are putting something…?."

He is expecting the learners to finish his sentence by saying 'inside'as he uses a gesture with his hand to show how to put something inside another. After describing the meaning of the individual word 'in,' Mr. Ndlela pulls the decomposed words together, connecting 'in' with the verb 'put' to focus on the word 'input' saying "so it means when we say input, you are putting something…," using his gestures to demonstrate inside. Thus, he is building conceptual mathematical knowledge by decomposing 'input,' focusing onthe prepositions 'in' and 'inside' and the verbs 'put' and 'putting' to describe the conceptual meaning of the mathematical term 'input.' He is using code-switching, decomposition, gestures, images, formal and informal mathematical language, different forms of questions, and English language as language practices. He further describes the relationship between 'input' and 'flow diagram' (as noted, by which he means a functional relationship) by indicating that input is the first part of the flow diagram, thus building conceptual mathematical knowledge. He is still using the representation flow diagram to develop the concepts of functional relationships.

In the next activity, Activity Four, Mr. Ndlela focuses on the conceptual meaning of the mathematical term 'output'. He follows the same pattern as he did for 'input,' pasting the flashcard written 'output' on the board (Figure 4.3).

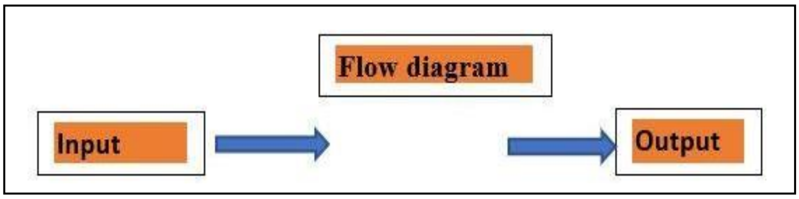

Figure: 4.3: Focus on the term 'output'

His usage of descriptions, open and closed questions, clarifications, and his language practices for 'output' are similar to what he did with the conceptual meaning of the concepts of the flow diagram and the input, using the flashcard written 'output' (Activity 3). He again still clarifies the question by decomposing the word 'output' and focusing on the meaning of the preposition "out" saying "what comes into your mind, when you say 'out'?" which is informal mathematical language in English. When the learners respond in Setswana by saying "kontle" which means 'out,' the teacher revoices "kontle," codeswitching by using informal mathematical language in Setswana. He further describes "out" by saying "it is out, out means you going, it means when I am opening the door here, I am going outside." He is describing the meaning of the preposition "out" walking towards the door and showing the outside of the classroom, using gestures and informal mathematical language in English language as language practices. To conclude his meaning of the concept of output, Mr. Ndlela connects the preposition "out" to the verb 'put,' thus building conceptual mathematical knowledge using formal mathematical language as a language practice.

To sum up, he describes the relationship between the concepts of input and output as represented in functional relationships by saying "Now when I look at the flow diagrams there is what we call 'input,' and there is what we call 'output'" referring to the images: flashcards and arrows in Figure 4.3.

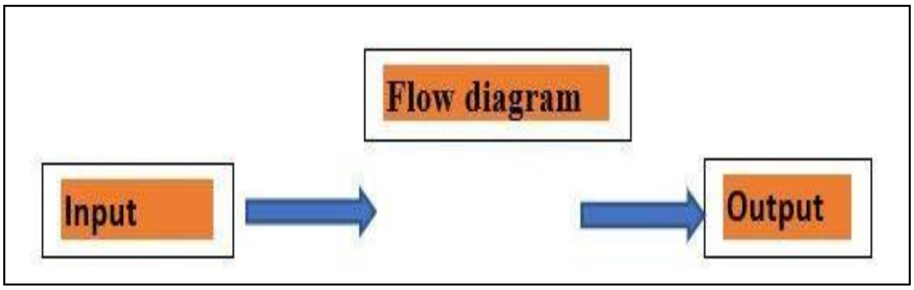

Figure 4.3: Focus on the term 'output'.

Here, he is aiming to build conceptual mathematical knowledge by describing the relationship between the input and output in functional relationships represented in the form of a flow diagram, using English language, decomposition, code-switching, gestures, formal and informal mathematical language in English and Setswana, revoicing and images as language practices. Up to this point, he has not yet referred to the concept in focus as 'functional relationship.'

4.5.3 Asking questions about the meaning of the concept 'rule' to relate the concepts input and output,using the learners' everyday context (Activity 6)

Next, Mr. Ndlela pastes a flashcard with the word 'rule' between the flashcards written 'input' and 'output' saying "what happens in-between?" (Figure 4.8). Here, he uses images to introduce the mathematical concept rule by describing the relations between the concepts input and output values. In what follows he seems to be using the word 'rule' for a function.

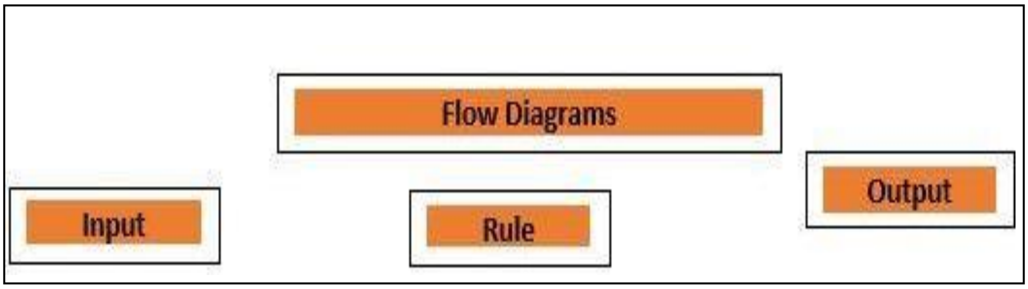

Figure 4.8: Introduction of the word 'rule'

When learners do not respond to his question, Mr. Ndlela asks again "what happens in between?" His question though does not seem to be clear. Before the learners respond to his question, he clarifies the question by asking closed questions and giving more descriptions saying: "Have you ever cooked pap…, When you are cooking pap, there are things that you put in the pot, okay… those are the things we call inputs.", "What do we put in a pot?" pointing to the pasted flashcard written 'input' in Figure 4.8, using learners' everyday context as a language practice.

After the learners have responded by mentioning the ingredients that must go into the pot, Mr. Ndlela asks another question saying, "and then once you have put water, salt, and mealie meal, will that thing become pap?" asking a closed question that requires a yes or no answer. When the learners say "no" he asks another open-ended question saying to them "what will you do with those things?", with "things" referring to the ingredients for cooking porridge. After the learners respond that they need to stir and they need heat from the stove to cook the porridge, Mr. Ndlela says “so that heat which you use becomes this thing that we call a rule…here is a rule that tells us how to mix those things.” Here, he is describing how the heat and the stirring relate to the mathematical term ‘rule’ as he points to a flashcard written ‘rule’ pasted on the chalkboard (Figure 4.8). Mr. Ndlela thereafter asks another closed question saying, “then what do you take out of that pot at the end of it all?” He is asking about the final product after the cooking process so that the learners may relate that to the concept of output value. When the learners are quiet, he clarifies his question, saying: “What do you put in your plate?” still referring to the concept of output value, using images and learners’ everyday context as language practices.

Here, Mr. Ndlela is working conceptually to describe that the rule shows a relationship between what is put in and what comes out of the function by using the learners’ everyday example of cooking porridge. He is attempting to help the learners gain access to mathematics by referring to the maize meal, salt, and water as “input,” boiling water, stirring, and fire as a “rule” and cooked porridge as “output.” He is giving these mathematical terms a meaning that relates to the learners’ everyday context. In this activity, Mr. Ndlela is aiming to build conceptual mathematical knowledge by showing the relationship between the concepts of input, rule, and output to develop the concept of functional relationship using the learners’ everyday context, images, English language, different forms of questions, and formal mathematical language as language practices.

4.5.4 Asking questions about the link between the action of finding the rule for a functional relationship and the action of completing number patterns (Activities 7 and 8)

Mr. Ndlela then shifts from the meaning of the concept rule to the description of the procedural action for finding the rule by asking different forms of questions, saying, “Is the same thing that we do in mathematics, last week we were talking about the number patterns if you are given a series of numbers or number sequence you have to establish a rule to find the number which is next.” Mr. Ndlela thereafter writes a number pattern on the board and asks for the action for identifying the next number in the pattern, asking a closed question, “let’s say I have got 3; 5; 7; 9; , what will be our next number?” He is reminding the learners about the procedural action of finding the next number in number patterns, using the image and the previously learned mathematical concept as language practices.

Mr. Ndlela’s question is attempting to encourage learners to think of the operational sign that has to be used to get to the next number. When the learner responds that the answer is “eleven,” Mr.

Ndlela asks an open-ended question saying "how did you find out it is eleven? Can someone tell me, how did you find out the next number is eleven?" He is asking for an explanation of the action for finding the next number in the number pattern. When one of the learners says he "checked the first two numbers," Mr. Ndlela continues to ask another open-ended question saying, "how did you check the first two numbers," still focusing on an explanation of an action.

When the learners seem not to be sure about their response, the teacher clarifies his question by asking a closed question in a different way saying, "What did you do to these first two numbers?" referring to three and five in the number pattern. His question requires learners to explain the action for getting to the next number in the pattern. So here he is signaling to them to observe the first two numbers to be able to find the rule in the pattern. When the learners say, "by adding or subtracting," he describes the procedure for finding the rule, saying, "you add or subtract," using revoicing as language practice.

Mr. Ndlela thereafter follows a pattern in his talk where he keeps on asking open-ended questions about the action for getting to the next number in the given pattern while the learners seem not to be able to respond, saying, "So, what did you do...I mean these numbers, the first two numbers …Yes, my dear, tell me?" Eventually, one learner responds by saying "add 3". However, the teacher does not notice that the answer "add 3" is incorrect, instead he continues by asking "between five and seven you did the same thing and what did you get?" The learners say "3" again. He continues to ask questions about the next number in the pattern and accepts three as the number that has been subtracted saying, "And then you said nine minus seven? …And then you told yourself that the next number here, if you subtract three you are going to get? … If you subtract three from that number that we don't know, if you subtract three, you going to get what?" After asking these questions he keeps quiet for some time and then says, "You see, that's not it my dear." His statement seems to make learners aware that subtracting 'three' is incorrect. Mr. Ndlela is asking for the answer to a calculation so that the learners may determine what the next number is.

Mr. Ndlela does not ask the learners or tell them why three is incorrect, missing an opportunity to ask an open-ended question. Instead, he continues with his questions saying, "Now what's our last number?" still asking a question that requires the learners to recall the procedural action for finding the next number in a number pattern. When the learners say "nine" he asks them another question saying, "if we go up and our answer is…?" He is asking a question that requires the learners to do the procedural action of finding the next number if the pattern is ascending, using informal mathematical language. When the learners say “eleven” the teacher writes eleven and asks more questions at the same time saying: “Now what is our rule?” “Can you see these numbers 3, 5, 7, 9, 11?”. He then asks them twice saying “Are they going up or down?” while they respond by saying “up.” He is using informal mathematical language, requiring the learners to recall the procedural action to be used when the number pattern is either ascending or descending. He thereafter asks another question saying, “If they are going up, what are we doing?” He is asking an open-ended question that requires the learners to associate the informal mathematical language ‘going up or down’ with an appropriate operational sign. When the learners say, “we add” Mr. Ndlela revoices their answer saying, “we add, …if they are going down, we subtract or divide” (1), using formal and informal mathematical language as language practices.

In activities seven and eight, Mr. Ndlela is building procedural mathematical knowledge by describing the action of finding the next number in a number pattern. Mr. Ndlela is attempting to show the learners that the procedural action for finding the output in ‘flow diagrams’ is the same as the procedural action for finding the next number in ‘number patterns,’ attempting to build conceptual mathematical knowledge. He is using previously learned mathematics concepts, different forms of questions, revoicing, images, and formal and informal mathematical language as language practices.

4.5.4.1 Describing the action of finding the output value using a rule with two operational signs in a table, also giving the tasks to the learners (Activities 9 and 10)

After describing the procedural action for finding the rule using a number pattern, Mr. Ndlela gets to another way of representing a functional relationship, which is a table (Figure 4.4). He draws a table with a rule with two operational signs and the given input value on the board and describes the initial part of the rule to the learners.

Input	Rule		Output
2	+3	x2	?

Figure 4.4: The input and the rule with two operational signs requiring output value.

He then writes ‘two’ which is the input value and ‘plus three multiplied by two’ from the column of the rule (Figure 4.4) and then asks close-ended questions referring to the task in Figure 4.4, saying: “Now if I write two here and then here, I say plus three…? What is our rule?” He is using images and formal mathematical language as language practices to ask how the rule works in functional relationships if the input value is given. When the learners say, “plus three times two,” Mr. Ndlela asks a closed question about the action, saying “Which means you add ……? Multiplied by …?” He is asking the learners to complete the calculation of the given rule, referring to operational signs which are previously learned mathematical concepts and also using formal mathematical language as language practices. After the learners respond to his question about what the rule is in Figure 4.4, he asks them a close-ended questionagain, saying, “what do we do?” (pointing at +3 and x2 in the table). His question is still focusing on the action for finding the rule.

Mr. Ndlela further describes that ‘adding three and multiplying by two’ as the rule means that “this is the heat that is in our pot.” He is attempting to give the meaning of the concept of rule by linking the procedural action for finding the rule with the process of cooking porridge, using learners’ everyday context as a language practice. He also points at the input value, which is two, saying “this is our mealie meal,” giving the meaning of the concept input, equating it with maize meal that must be poured into the boiling water. He thereafter asks them again saying “we add three multiplied by…. Two, what do we get?” He is attempting to describe to the learners that they can only get to the output value through the rule, using formal mathematical language as a language practice.

Next, Mr. Ndlela gives learners a task where he uses the table with the same rule but different input values (Figure 4.5), where the learners work in groups to find the output values.

INPUT	RULE		OUTPUT
3	+3	x2	?
5	+3	x2	?
6	+3	x2	?
7	+3	x2	?
9	+3	x2	?

Figure 4.5: Groupwork Task for finding the output values.

Though Figure 4.5 only requires the learners to write the output value, Mr. Ndlela repetitively mentions the rule to the learners saying, “plus three multiply by two” for them to get to the output value, using images. When he says “plus three…” he is using informal mathematical language as a language practice and when he says “…multiply by two” he is using formal mathematical language as a language practice. Here, he is focusing on the action of finding the output value using the given rule in functional relationships.

While the learners are writing, he asks them closed questions, one question after another while they are quiet, saying: “I want to see how you do your output values” “Who can come and show us on the board, who can come and write output values for us?” “As you write I want you to talk to the class.” He wants the learners to describe the procedural action they have used to get to the output value to their classmates when writing responses on the chalkboard. Here, Mr.Ndlela is building procedural mathematical knowledge by focusing on the action of using the given input value and the rule to find the output value. Mr. Ndlela is using procedures to build conceptual mathematical knowledge, giving meaning to the rule, input, and output value. He does this by using learners’ everyday context, formal and informal mathematical language, different forms of questions, and images as language practices.

4.5.4.2 Describing the action of finding the input value using a rule with two operational signs, focusing on the concept of inverse functions using ‘forward’ and ‘backward’ in a table (Activity 10)

Next, using the same function as in Figure 4.5, Mr. Ndlela describes the action for moving from the output value to the input value, using an image in the form of a table. This time he refers the learners to Figure 4.6 where the output values and a rule with two operational signs are given and two input values are missing.

INPUT	RULE		OUTPUT
3??	+3	x2	12
5	+3	x2	16
6	+3	x2	18
7??	+3	x2	20
9	+3	x2	24

Figure 4.6: Task for finding the input value when the rule and the output value are given

Mr. Ndlela covers the input values 'three' and 'seven' with his hand in the first and fourth rows of Figure 4.6. He thereafter asks and clarifies different forms of open-ended and closed questions while the learners are quiet saying:

> *"For interest's sake, let us say this three is not there…. And then let us also say this seven is not there…How are you going to find this [input]?...This missing value and that missing value?... It's like we are going backwards…Now if I am going forward, I will count one, two, three, four, okay…Now, if I am going backwards, I am going to…, let's count."*

He asks his questions moving forwards and backwards. His questions require the learners to explain the action for finding the input value if the rule and the output values are given. His clarification is attempting to make the learners aware that they are expected to think about the inverse operations that must be used in the given rule when moving from the output value to the input value.

He is using the word 'forward' as the opposite of 'backwards' by moving four steps forward and backward using his gestures and informal mathematical language as language practices. When the learners are not responding, Mr. Ndlela clarifies again saying: "now I am going back. Last time I talked to you about these operations, can you see these operations, '+' and 'x' …I said these operations go with another which are not there, they are opposites." He is attempting to describe how the operational signs change in inverse functions, using previously learned mathematical concepts. He then asks a closed question saying, "so which one is the opposite of this?" asking a question that requires the learners to recall the inverse operation for an addition sign. The learners respond by saying "minus." Mr. Ndlela revoices saying "it's minus" and continues to ask another question saying, "what is the opposite of this?" pointing at a multiplication sign. When the learners say "division" Mr. Ndlela revoices by saying "it's divided, okay." He is asking the learners to recall the inverse operation for multiplication, by using formal and informal mathematical language as language practices.

Thus, overall, in this activity, he is building procedural mathematical knowledge to give conceptual meaning for inverse operations using gestures, images, revoicing, different forms of questions, previously learned mathematical concepts as well as formal and informal language as language practices.

4.5.5 Describing inverse functions when asking the learners to find the input value, using a table (Activities 11 and 12)

Mr. Ndlela continues to describe how inverse operations work, saying, "now we were going forward". He then asks a closed question, saying "when we were going forward, what did we say? Let's go" pointing at a table (Figure 4.4). He is describing the action of moving from the input value to the output value and he is using an image in the form of a table, and informal mathematical language as language practices.

INPUT	RULE		OUTPUT
2	+3	x2	10

Figure 4.4: Task to find the output value.

When the learners say, 'two plus three' Mr. Ndlela asks another closed question saying, "what is two plus three?" When the learners say "five", Mr. Ndlela asks again saying "five times two?" requiring an answer to a calculation. He uses informal mathematical language and previously learned mathematical concepts as language practices. He thereafter refers the learners to the input of the first row in Figure 4.6 and describes "now we don't have anything…So, if we don't have anything it means we are going to start with the output going…backwards." He asks another closed question saying, "and when we are going backwards what happens to these signs, these operational signs?" getting to the concept of inverse function, using informal mathematical language and gestures as language practices. When the learners are quiet, he clarifies his question by asking it differently, saying, "We are now going backwards, what happens to them [operational signs]?" When the learners say, "they change" Mr. Ndlela asks another open-ended question saying, "how do they change?" He wants the learners to explain the procedural action on how operational signs change in inverse functions. When the learners say, "they become opposite" the teacher asks another question saying, "plus becomes…? And times will be?" He uses informal mathematical language when asking a question that requires learners to recall the procedural action of finding inverse functions.

He thereafter gives learners group work, which is the task in the fourth row in Figure 4.6, and says "now let's check with the other one. This is twenty, alright" pointing at the output value. When the learners are quiet when expected to give feedback from each group, Mr. Ndlela clarifies the question by giving clues, saying: "So, you don't need to crack your head, you must know that the opposite of plus is minus, and the opposite of times is…?" "Ok, so you don't need to guess, you must know the opposites….” He is attempting to build procedural mathematical knowledge by making the learners aware that they just have to recall the memorized procedure for finding inverse functions, using informal mathematical language as a language practice.

He is building procedural mathematical knowledge by describing how to find inverse operational signs in a given rule when moving from the output value to get to the input value. He is doing this by using images, gestures, previously learned mathematical concepts, different forms of questions as well as formal and informal mathematical language as language practices.

4.5.6 Asking and clarifying questions about the action of finding the rule when the input and output values are given(activities 13 and 14)

Mr. Ndlela continues to build procedural mathematical knowledge when describing how a rule works using a new table with given inputs and outputs, and only the arrows in the place of the rule. After giving the learners the first input value as one and the output value as seen in Figure 4.7, he asks the learners to complete the table by filling in the missing rule in the place of an arrow using images.

Input values	Rule	Output values
1	⟶	7
3	⟶	21
5	⟶	35
7	⟶	49
9	⟶	63
11	⟶	77

Figure 4.7: Finding the rule.

Mr. Ndlela, thereafter, asks, “are these arrows going backwards?” asking a closed question that requires a ‘yes’ and ‘no’ answer using images in the form of a table and arrows as well as informal mathematical language as language practices. When the learners say no’ he gets into a pattern of asking and clarifying different forms of questions using clues, saying, “all of them going forward, so what are you going to do?” “What are you going to do to get here?” “You ‘ve got one, you do something to one to get seven?” “And remember your rules must apply to all the levels, it must be one rule… Yes, what must we do?” He is asking them closed and open-ended questions that require learners to associate “going forward” with the appropriate operational sign, which is either addition or multiplication signs, using different forms of questions, informal mathematical language, and images as language practices.

The teacher is pointing at the arrow and the output value, asking for the operational sign to be used between the input value and the output value. When the learners say “times seven” Mr. Ndlela asks another closed question, saying “times seven, right. So, we have 1, 3, … So, three times seven?” referring the learners to the second row of Figure 4.7. When the learners say “21” he asks another closed question saying, “do we have 21 there?”. When the learners say “yes” the teacher asks about the third input value saying, “five times seven?” When the learners respond by saying ‘35’ he asks another closed question saying, “so what is our rule?” wanting to confirm again that the rule is “times seven” using informal mathematical language. When one boy gives the correct answer, Mr. Ndlela asks an open-ended question saying “…let him explain to us how he got it.” He is asking for the explanation and justification of the procedural action used to find the rule when moving from the input value to the output value.

Mr. Ndlela is building procedural mathematical knowledge to help the learners understand the action of finding the rule to determine how the domain corresponds with the range in functional relationships. He is using formal and informal mathematical language, previously learned mathematical concepts, different forms of questions, and images as language practices.

4.5.7. Clarifying questions about how to find the rule where input and output values are given and onlyone part of the rule is given (Activity 15)

Next, Mr. Ndlela introduces another representation of functional relationships in a table format, where only one part of the rule is given (Figure 4.8). Here, he describes the procedural action for finding the rule in functional relationships for the first row, saying “at times we find that we need to use two operations, okay… And then you have your output that is like this” pointing to an output value which is ‘6’. He thereafter asks different forms of closed and open-ended questions, pointing at the first row,saying, “Who can complete that? …Work with your friend, and complete that rule…Who can complete that?... You do something to one and then you add four and you are going to get what? …Six, so what is this?”

Figure 4. 8: Task with one missing rule

When one learner responds by saying “2” without explaining how he got the answer, the teacher spends a lot of time, using formal and informal mathematical language and learners’ everyday context as language practices. He gets into a pattern of describing procedures, asking different forms of open-ended and closed questions, and clarifying them, saying, “It goes with an operation, so when you say two, is it plus two or is it minus two, is it multiplied by two or divide two?... Subtract two, can you say one minus two?”

He describes by drawing a circle with an orange in it and asks, “say you have one orange in here, can you take two out of this?” “… so, what are we doing? Yes, what do you do?” When the learner responds by saying “we add one” Mr. Ndlela asks another closed question saying “…so say we add one, one plus one?” pointing at the first part of the rule. When the learners say, “plus two”’ the teacher says “two plus four we get six” pointing at the output value. He is testing if the action for finding the rule is working using different forms of questions and informal mathematical language as language practices.

He thereafter refers the learners to the second row in Figure 4.8, without indicating whether “add one” is correct or not. He gets into a pattern of asking and clarifying the following closed questions while the learners respond by completing his sentences with ‘yes’ and ‘no’ answers,saying: “Then we go to the next one, what does it say? The next input value is three, okay” “Our rule is plus one plus four… Three plus... one?” “Four plus four?” “Then our rule is?” He does not tell them that “add one” is incorrect, instead continues clarifying by giving some clues, saying “It must apply in all” “It must be the same rule, okay it must be a rule e tswanang” “Think about all the four operations” “Play around with them.” He is giving them the clue that the rule in functions must show correspondence between the domain and the range in the given table, using different forms of questions, code-switching, formal and informal mathematical language as language practices.

One learner responds by writing “x 2” on the chalkboard and Mr. Ndlela gets into a pattern of giving the clues by asking different forms of open-ended questions, saying: “Don’t give us the answer, tell us how you got it" "What do we do here?" … "What did you do?" "We don't know hore ke (that it is) times two, so explain to us how you got that answer" "How did you get, because akere rebatla (isn't it that we want) times two, fine, how did we get it?" "Anyone who can explain, come and help your friend." He is still asking for an explanation of a procedural action of finding the rule, where the function must show correspondence between the domain and the range using different forms of questions and learners' home language.

Another learner responds by saying, "I said six minus four is two". Mr. Ndlela clarifies by referring to the task in the second row of Figure 4. 8, saying "now if you say ten minus four, we don't get two, …. How did you do it?" His question requires a justification of the action used to get the rule in Figure 4.8, using images. The teacher decides to clarify the question again by saying, "Let me explain something, now let us use the second output, it's ten. So, it's ten because we are going backwards its ten minus…?" He is describing the action for using inverse operations, using informal mathematical language.

When the learner responds by saying "minus four" he asks another question, saying, "and we are going to get?" When the learners are quiet, he clarifies his question by giving a clue saying "but don't put six here. You will ask yourself what you did to three (the input) to get six." When the learners say, "we multiplied it by two" he asks a closed question saying, "which means our ruling will be a multiplication by….?" Expecting the learners to complete his sentence. When the learners respond by saying "by two" Mr. Ndlela revoices saying "multiply by two." He continues to clarify his question by giving another clue about the rule saying, "it must be the same for all these values" pointing at input values in Figure 4.8. He is describing how to perform a mathematical action in inverse functions, using formal mathematical language as language practice. Though his description introduces inverse functions, the teacher does not use the mathematical concept of inverse operations.

Mr. Ndlela is building procedural mathematical knowledge to give meaning to the concept of the rule when using inverse functions. He is describing how learners can come up with inverse operations in functional relationships with a rule with two operational signs. To do this, he is using images, formal and informal mathematical language, previously learned mathematical concepts, different forms of questions, revoicing, and code-switching as language practices.

4.5.8 Summary of how Mr. Ndlela builds procedural and conceptual mathematical knowledge

This section focuses on how Mr. Ndlela created opportunities for the enablement of mathematical knowledge (procedural and conceptual). Mr. Ndlela follows a particular pattern when building mathematical knowledge about functional relationships. At the beginning of the lesson, he builds mathematical knowledge by focusing on the conceptual meaning of the terms‘flow diagram,’ ‘input,’ ‘output’ and ‘rule.’

When describing the terms ‘flow diagram,’ ‘input,’ and ‘output’ he builds conceptual mathematical knowledge by using images in the form of flashcards and arrows, building a sign system. He also builds conceptual mathematical knowledge by decomposing these terms and focuses on their prefixes, thus using informal mathematical language in English and Setswana. He builds conceptual mathematical knowledge by using gestures, learners’ everyday context, images, and code-switching as language practices when using the prefixes, however not following a particular sequence. With regards to the conceptual meaning of the word ‘rule,’ be first uses learners’ everyday context, which is the cooking of porridge, thus building connections with the learners’ context.

In the second part of his lesson, he focuses on the building of procedural mathematical knowledge by using different functional representations to describe the procedural action for finding the rule. He does lots of procedural actions to develop the concept of functional relationships, for instance, the procedure for finding a rule in a number pattern, the procedure for finding the rule in a table, the procedure for finding the output and the input value, as well as the procedure for doing inverse operations.

He uses a number pattern to get to the next number. He then uses different forms of tables, ranging from a table with two rules where the learners have to find the output value, where they need to find the input value, where one operational sign of the rule is given. Here, he describes how the rule works in the action of finding either the input value or the output value. In all these tasks he also describes inverse functions by describing and asking questions about the action of moving from output value to input value or vice versa. At some point, he reverts to conceptual examples, using the example of maize, salt, and water as inputs, boiled water, and fire as a rule, and cooked porridge as output, using learners’ everyday context as a language practice, thus building connections with the learners' context.

Images seem to be the mostly used language practices to build conceptual mathematical knowledge in this class. When describing concepts and clarifying questions, he uses images in the form of flashcards and arrows. Also, when describing the procedural action for finding the rule and inverse functions he uses images in the form of a number pattern, tables, and arrows. His description of procedures builds conceptual meaning of the terms 'flow diagram,' 'input,' 'output' and 'rule.' Doing procedures using different language practices seems to be supporting the conceptual understanding of these different representations of functional relationships, namely, finding a rule in a flow diagram, in a number pattern, or in tables. For example, at times he uses gestures and images to support conceptual understanding of formal informal mathematical language in English and Setswana. He does all this, through the use of different forms of questions about the procedures that have been followed to find the rule, input value, output value, and inverse operations.

4.6 MR. NDLELA'S REASONS FOR USING THE LANGUAGE PRACTICES HECHOSE

In this section, I analyze why Mr. Ndlela said he chose to use the language practices he used when describing things and actions, asking informational questions, and clarifying questions. As described in Section 3.2, I conducted two interviews, which were a reflective interview (POI) and a focus group interview (FGI). Both interviews took place after the lesson observation. To understand Mr. Ndlela's reasons for using language practices, I use Gee's six of the seven building tasks to identify in his talk what meanings he aims to build using particular language practices (Gee, 2005). It should be noted that in the interviews Mr. Ndlela mentioned some of the language practices that he did not use in the classroom, and I included these in the analysis.

Mr. Ndlela drew on a wide range of language practices to build particular meanings. When attending to multiple language practices and multiple building tasks he managed some tensions. For example, code-switching to Setswana may build necessary conceptual knowledge, as well as learning identity, but he was also sensitive to the learners' needs to learn in English and his own inadequacies regarding the use of Setswana. As noted in the lesson analysis, Mr. Ndlela primarily used English, but there were a few instances of code-switching to Setswana. In Section 4.4, in the observed lesson Mr. Ndlela code-switched to Setswana when describing the meaning of the input value and the output value, thus aiming to build identity and relationships. He allowed the use of the words ‘kamohari’ and ‘kontle,’ which is an informal mathematical language in Setswana, even though he indicated in his reflective interview that “maths has to be taught in English because that’s our LoLT and their textbooks are written in English”.

At different times within and across the interviews, Mr. Ndlela gave arguments for and against both language practices. The issue of using English as a way of ‘avoiding Setswana’ came up a number of times in the interview. His first reason suggests that he is building politics by giving more status to English language than the learners’ home language. His preference is consistent with school policy. His reasons for using English were that he was following school policy and the learning materials.

Mr. Ndlela’s other reasons for not wanting to code-switch are not only for the learners, but they are also for himself as he said “…to be honest I wouldn’t have been able to ask in Tswana anyway like I said before we started… mh I am not good in Tswana, so using their context and my actions saved me.” (Ndlela, 10, POI). Though his second reason suggests that he is scared to build identity and relationships with learners as he tries to avoid Setswana, he still code-switched, but only minimally.

This suggests that there are some tensions in Mr. Ndlela’s interview responses because in the reflective interview, he indicated that he was “… not good in Tswana” (Ndlela, 8, POI), yet elsewhere in the same interview he justified his reasons for code-switching. Though he preferred English language, Mr. Ndlela sometimes used Setswana because he felt pity for learners, anticipating that they may not be understanding when he created opportunities for the development of procedural and conceptual mathematical Discourse. His reasons were about building identity and relations in the interest of building mathematical knowledge. For example, he stated that Setswana was productive in helping learners to “relax” and “feel confident”. His use of Setswana also demonstrated that he “cares” for learners, it shows that he and the learners are together” rather than “alone” (Ndlela, 26, 36, 38 POI). Thus, as much as he indicated that other language practices helped him avoid the use of the learners’ home language, he still saw it as a resource and also used it as such. Mr. Ndlela’s occasional use of code-switching was about building identity and relationships with the learners to build conceptual understanding. As much as he was suggesting that code-switching was good for the identity and relational aspects that underpin learning, he indicated that learners may miss the opportunity to access mathematical knowledge if their home language is not used cautiously. For instance, he indicated that if any teacher is "in a habit of code-switching…", learners may struggle when they are on their own (Ndlela,23, 25, FGI). He is building politics by giving less importance to Setswana, believing that learners should "learn exclusively in English."

Referring to his description of the functional representation 'flow diagram' in the observed lesson (Section 4.4.1), in the interview, Mr. Ndlela justified his use of the learners' everyday context in his lesson. His reasoning suggests that building a connection between the word 'flow' and the notion of a 'river' in the learners' everyday context is important for building mathematical knowledge for conceptual understanding. He argued:

> *"Well, I know my learners, when I realised that they could not give me the correct answer about flow diagrams, I had to give them a clue. Just by associating it with the river that they know it became easy for them to understand. I was avoiding telling them what it meant and I also did not want to tell them in their home language (Ndlela, 8, POI)."*

For Mr. Ndlela, using learners' everyday context provided two benefits. For the learners, it gave a 'clue' that helped him enable conceptual understanding for a 'flow diagram' because he was trying to ensure that "the content is not as much detached from their own experiences" (Ndlela,70, FGI). For himself, he managed to avoid using the learners' home language to describe the meaning of a 'flow diagram' (Ndlela, 8, POI). His interview talk suggests that he aimed to build connections with what the learners already know so that it may remind them of the information that can help them build the conceptual meaning of a 'flow diagram.' He is giving less importance to the learners' home language and giving more importance to English language, thus building politics.

Further evidence for building connections is provided in his talk about the 'pap' example. He told us here that this is a "straightforward" example, and in the interview he said:

> *"Everyone either eats pap or is able to cook it……I believe it's straightforward, when I said 'the things I put in the pot' it is clear that those are inputs. What I get after the pap is cooked is an output. Mixing everything together and stirring, that is a rule. A rule is the fact that there must be proper measurement of all the ingredients so that the pap may be tasty" (Ndlela, 12, 14, POI).*

According to Mr. Ndlela, he was helping the learners build conceptual mathematical knowledge because, in his view, the connection between cooking porridge and the concept of functional relationship is "straight forward" and "clear." His focus on the process of cooking porridge suggests that, as he argued in the interview, he wanted the learners to regard the ingredients, that is, "everything" that is put into the water for cooking porridge as 'input value', the cooking process "mixing" and "stirring" as the 'rule', and the cooked porridge as the 'output value' (Ndlela, 14

POI). His learners were from a context where they use the word “pap” instead of ‘porridge,’ at home.

Mr. Ndlela justified the use of gestures by indicating that through them he was able to build mathematical knowledge without using verbal language as well as the learners’ home language. He indicated that gestures enhanced conceptual understanding, as he says: “…and well they ended up understanding what flow diagram meant” (Ndlela, 10, POI). Overall, he was emphasizing the importance of building mathematical knowledge through sign systems by using gestures to enable understanding of the mathematical meaning of the concepts input, output, and flow diagram.

Mr. Ndlela justified the use of previously learned mathematical content as a language practice by saying “because the rules in flow diagrams and number patterns work the same way” (Ndlela, 16, POI). He further says: “…Like I said, in both, you have to get the clue from the given numbers and then you can be able to determine the rule.” (Ndlela, 16, POI). His explanation here suggests that in his role as a teacher, he needed to build connections with the learners’ prior knowledge if he was to build mathematical knowledge. There seemed to be a pattern in Mr. Ndlela’s reasons for choosing certain language practices, which was to enable conceptual understanding but also to avoid learners’ home language. While he used other language practices, especially non-verbal language practices like images and gestures to build conceptual mathematical knowledge, he admitted that he used these language practices to avoid Setswana. Mr. Ndlela justified his use of formal mathematical language throughout the lesson by indicating that:

> *“…whether English is my second language or not it doesn’t matter, when coming to mathematics you can teach and teach the mathematics concepts”* (Ndlela, 296, FGI).
>
> *“I … as long as you don’t understand the concept, the concept development, it’s a problem…because it’s not about knowing English …”* (Ndlela, 298, FGI).

Here, Mr. Ndlela highlighted the importance of knowing formal mathematical concepts rather than just knowing English language, though he did not name it a formal mathematical language.

4.7 CONCLUSION

Mr. Ndlela strategically employed verbal and non-verbal language practices when creating opportunities for the development of procedural and conceptual mathematical Discourse. His choices were influenced by several factors: the need for learners to grasp formal mathematical concepts and procedures, policy requirements that prioritize English language comprehension, and the teacher’s convenience. By predominantly using English, Mr. Ndlela emphasized its significance in understanding mathematics, especially considering that assessments are conducted in English from grade six onward.

Mr. Ndlela also explained the importance of code-switching to Setswana for supporting mathematical understanding because he assumed that rural learners had minimal exposure to English because of their context. His explanation was portraying the importance of English and Setswana at the same time, thus showing tension. In Gee's (2011) terms, the teacher was building politics by making the learners' home language important for building mathematical knowledge. He was also building identity and relationships by using the learners' home language because he empathized with them, so that they may easily understand the mathematical concepts. Mr. Ndlela explained that he recruited other language practices such as informal mathematical language in English, learners' everyday context, previously learned mathematical concepts, gestures, and images to support the understanding of formal mathematical language. For instance, he indicated that he encouraged the use of gestures and images to give learners opportunities to engage in mathematical Discourse if their home language or English language was not helping. In Gee's (2011) terms, there are multiple building tasks in how Mr. Ndlela said he was using language practices, which were sign systems (gestures and images), identity and relationships (informal mathematical language in Setswana), politics (informal mathematical language in English) as well as connections (learners' everyday context and previously learned mathematical concepts).

He argued that gestures and images helped to simplify informal and formal mathematical languages. He justified the use of learners' everyday context and previously learned mathematical concepts because learners understood better if they used what they already knew. Gestures and images also helped him to avoid Setswana, opting to use them in conjunction with informal mathematical language in English. The next chapter is the second of my analysis chapters and focuses on the second teacher, Mr. Dubazana.

CHAPTER 5: LANGUAGE PRACTICES OF MR. DUBAZANA

5.1 INTRODUCTION

This chapter focuses on the analysis of Mr. Dubazana's lesson on isometric transformations. I first focus on how the topic of isometric transformation geometry is described in the CAPS (Section 5.2). I thereafter briefly describe how Mr. Dubazana builds activities (Section 5.3), thus orienting the reader to the structure of the lesson. Next, focusing on each of the three language functions from Pozzi (2004) at a time, I describe how Mr. Dubazana uses language practices to describe what Gee's (2005) building tasks emerge when he uses these language practices. I further describe, in particular, how Mr. Dubazana creates opportunities for knowledge in relation to the development of procedural and conceptual mathematical Discourse for teachers (Section 5.5). Lastly, I present the reasons why he used those particular language practices (Section 5.6).

5.2 TRANSFORMATION GEOMETRY IN GRADE SIX ACCORDING TO THE CURRICULUM AND ASSESSMENT POLICY STATEMENT (CAPS)

Mr. Dubazana's lesson as a whole was on the description of the concept of isometric transformations. This lesson, as well as the preceding lesson on angles, can be located in the CAPS curriculum content section: Space and Shape (Geometry). His specific focus was on the properties of the three isometric transformations, namely, rotation, translation, and reflection, aiming to show the similarities and differences, as stipulated in the grade six curriculum.

The CAPS document indicates that when learning transformations at the grade six level, learners are required to identify and describe patterns of 2-D shapes and 3-D objects by using the concepts of rotation, reflection, and translation. Learners should "describe patterns by discussing the shapes they see in the pattern and how they would transform that shape if they wanted to extend the pattern" (p. 265). For instance, one can make a particular pattern by translating, rotating, or reflecting a 2-D shape. Learners are also required to draw transformations that can be made by rotating, reflecting, or translating different 2-D polygons. For example, the document states that learners can make a pattern like the one they see on a doily (small mat made with repeated patterns) by translating a parallelogram (Department of Basic Education, 2011). However, the analysis presented in Sections 5.4 and 5.5 suggests that Mr. Dubazana aimed to build knowledge that extended beyond the Grade Six requirements.

5.3 MR. DUBAZANA'S LESSON ON TRANSFORMATION GEOMETRY

This was a grade six lesson observed at a township school. Although the teacher-learner ratio is 1: 40 in Gauteng schools, there were 54 learners in Mr. Dubazana's class. All learners were learning Setswana as their home language, but the official language of teaching and learning at the school was English. The mathematics teacher was Mr. Dubazana, an immigrant teacherfrom Zimbabwe, whose home language was isiNdebele. This was a double period, each period being forty minutes long.

In this section, I give a brief description of Mr. Dubazana's lesson by describing how he builds activities, in Gee's (2005) terms. Mr. Dubazana's preceding lesson was on angles. Columns 1to 3 of Table 5.1 are a summary of the activities that Mr. Dubazana built in his lesson. The detailed analysis of the activities summarized in Columns 4 to 6 is presented in Sections 5.4 and 5.5 of this thesis. For most of these activities (Activities 1 to 14 and 17), Mr. Dubazana stood in front of the class while all the learners were seated to face the front. He only moved from this position to facilitate small group work in activities 15 and 16.

Table 5.1: Mathematics taught throughout Mr. Dubazana's lesson

MR. DUBAZANA: LESSON ON TRANSFORMATIONAL GEOMETRY					
Activity Number	**Utterances** (With Episodes used in Section 5.4)	**Language functions (Pozzi, 2004)**	**Language practices**	**Building tasks (Gee, 2011)**	**Procedural and conceptual Discourse**
1	1 to 10 (Episode 1, Utterance 5 to 10)	Describing the meaning of the concept of isometric transformation	English language Formal mathematical language Context Different forms of questions	• Politics • Knowledge • Connection	Conceptual
2	11 to 16 Figure 5.1 Figure 5.2 (Episode 1, Utterance 11 to 16)	Describing reflection, calling it a 'flip' using a grid and arrows. Describing rotation, calling it a 'turn' using a grid and triangles (Activities 1 and 2).	English language Formal math language Informal math language Images Context Different forms of questions	• Politics • Knowledge • Sign system • Connection	
3:	17 to 24 Figure 5.3 (Episode 1, Utterance 17 Episode 2, Utterance 21 to 24)	Describing the meaning of the concept of translation using triangles on grids on the board	English language Formal math language Informal math Images	• Politics • Knowledge • Sign system	Procedural Conceptual
4;	25 to 36 (Episode 2, Utterance 25 to 36)	Describing the meaning of the concept of translation using gestures	English language Formal math language Informal math Gesture Different forms of questions		
5:	37 to 42 Figure 5.3	Clarifying questions by describing the meaning of the concept of translation linking to the grids in learners' books	English language Formal math language Informal math		
	(Episode 2, Utterance 37 to 42)		Images Different forms of questions		

6	43 to 49 Figure 5.4	Describing the meaning of the concepts object and image using a grid on the board using the example of a translation.	English language Formal math language Informal math Images Gestures Context Different forms of questions	• Politics • Knowledge • Sign system • Connection	Procedural Conceptual
7	49 to 66 Figure 5.5	Describing the meaning of the concepts object and image using the action of vertical and horizontal translations on the board grid and floor tiles			
8	67 to 82	Describing the meaning of the concept of rotation focusing on the direction and size of the angle of rotation using gestures	English language Formal math language Gestures Different forms of questions	• Politics • Knowledge • Sign system	
9:	83 to 88 Figure 5.6 (Episode 3, Utterance 83 to 88)	Describing the meaning of rotation focusing on the direction of the angle of rotation, using gestures to show cardinal points.	English language Formal math language Informal math Images Gestures Context Different forms of questions	• Politics • Knowledge • Sign system • Connection	
10:	89 to 98 (Episode 3, Utterance 89 to 90) (Episode 4, Utterance 91 to 98)	Asking questions about the meaning of the concept of rotation focusing on thedirection the object and image are facing (using cardinal points), using gestures.	English language Formal math language Informal math Gestures Context Different forms of questions		

11:	99 to 123 (Episode 4, Utterance 99 to 105) (Episode 5, Utterance 123)	Asking questions about the meaning of rotationfocusing on the size and thedirection of the angle of rotation. Describing rotation using all threeproperties described in activities in8 to 10.	English language Formal math language Informal math Gestures Images Previously learned concepts. Context Different forms of questions		Procedural Conceptual
12:	124 to 126 Figure 5.7 (Episode 5, Utterance 124 to 126) (Episode 5, Utterance 123)	Asking questions about the action of translating and clarifying them by using the board grid and the concepts of object and an image, which are triangles with dots.	English language Formal math language Informal math Images Gestures Previously learned concepts. Different forms of questions		
13:	127 to 136 Figure 5.8 (Episode 5, Utterance 127 to 136)	Asking questions about the action of rotating and clarifying them by using the board grid and gestures, focusing on the direction and the angle of rotation	English language Formal math language Informal math Images Gestures Previously learned concepts. Revoicing Different forms of questions		
14:	137 to 180 Figure 5.9 (Episode 5, Utterance 137) (Episode 6, Utterance 138 to 144)	Asking questions about the action of reflecting and clarifying them by using the concepts of the line of symmetry, equidistant, and reflectional symmetry, using a grid and gestures	English language Formal math language Informal math Images Gestures Context Previously learned concepts.		

	(Episode7, Utterance 159 to 171)		Different forms of questions		
15:	Utterance 181 Figure 5.10 (Episode 8, Utterance 181)	Asking questions, using a task for learner pair/group work, focusing on identifying the properties of the three different types of transformations (reflection translation, and rotation), using the grid in their books.	English language Formal math Images Different forms of questions	• Politics • Knowledge • Sign system • Identity • Relationship	Procedural Conceptual
16:	182 to 208 Figure 5.10 (Episode 8, Utterance 182 to 184)	Asking questions from learners and they discuss in pairs/groups the properties of the three different types of transformations (reflection, translation, and rotation)	English language Formal math language Informal math Code-switching Images Different forms of questions	• Politics • Knowledge • Identity • Relationship • Sign system • Connection	
17	Utterance 209	Asking questions using a task in which learners must identify the properties of the three different types of transformations (reflection, translation, and rotation) through classwork and homework.	English language Formal math language Informal math Images Different forms of questions	• Politics • Knowledge • Sign system	

As shown in Table 5.1, Mr. Dubazana starts by describing reflection, calling it a ‘flip’ using a grid and arrows. He, thereafter, moves to rotation, calling it a ‘turn’ using similar language practices (Activities 1 and 2).

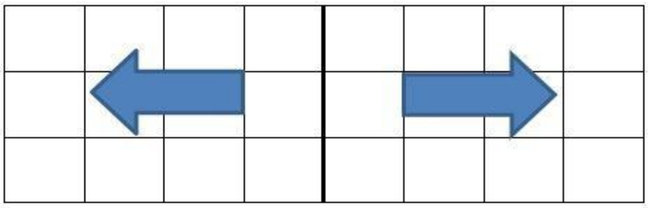

Figure 5.1: Reflection

Mr. Dubazana refers the learners to the concept of rotation, represented using triangles in Figure 5.2, calling it a “turn.” He points at the two triangles with dots on the grid on the chalkboard, labelling the first triangle A and the second triangle B.

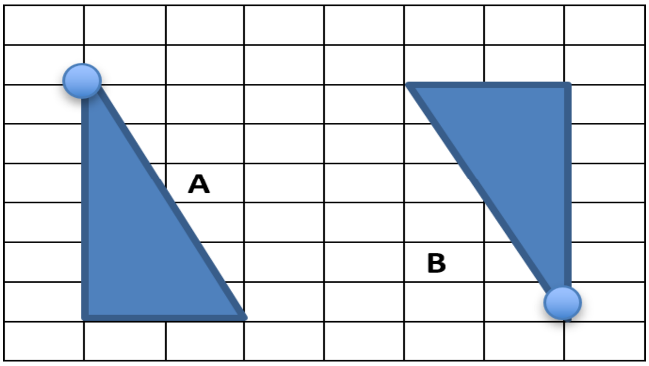

Figure 5.2: Translated rotation

Next, Mr. Dubazana describes the meaning of the concept of translation using triangles on grids on the board (Activity 3, Figure 5.3), using gestures (Activity 4), and linking to grids in learners’ books (Activity 5).

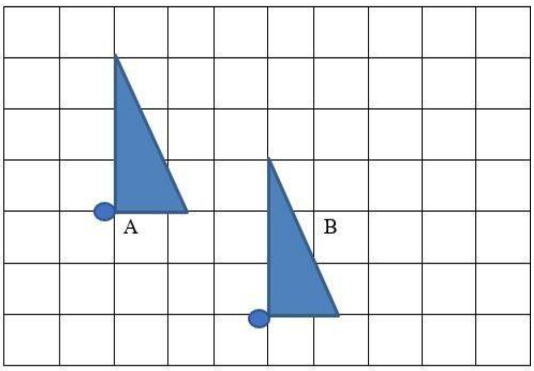

Figure 5.3: Double translation

In Activity Six, Mr. Dubazana describes the meaning of the concepts of object and image using a grid on the board, using the example of translations (Figure 5.4). He refers to triangle B as the image of triangle A in a 'mirror.'

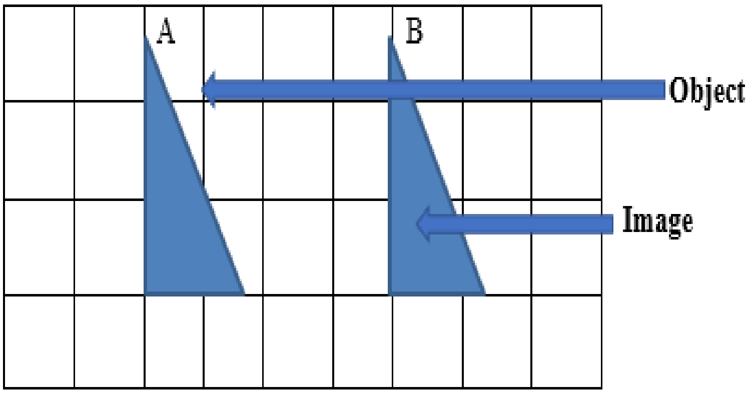

Figure 5.4: Difference between the object and image

In Activity Seven, Mr. Dubazana continues to describe 'translation', but explicitly introduces the object and the image. He does this by using the action of vertical and horizontal translations on the board grid and on the floor tiles (Activity 7, Figure 5.5).

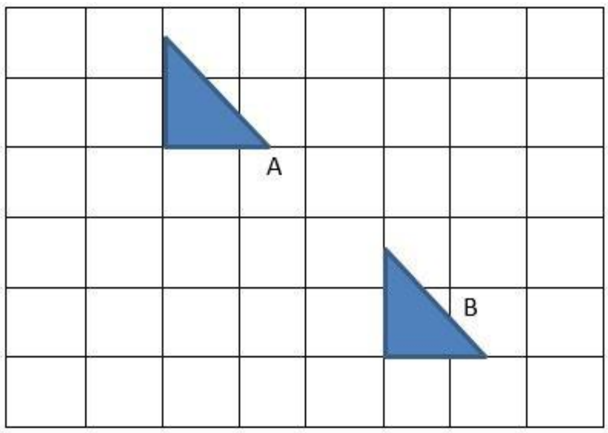

Figure 5.5: Horizontal and vertical translations

Next, Mr. Dubazana describes the meaning of the concept of rotation by focusing on the direction and size of the angle of rotation. Here he uses gestures and the grid, focusing on the conceptual meaning of the terms 'clockwise' or 'anticlockwise' (Activity 8 and 9, Figure 5.6).

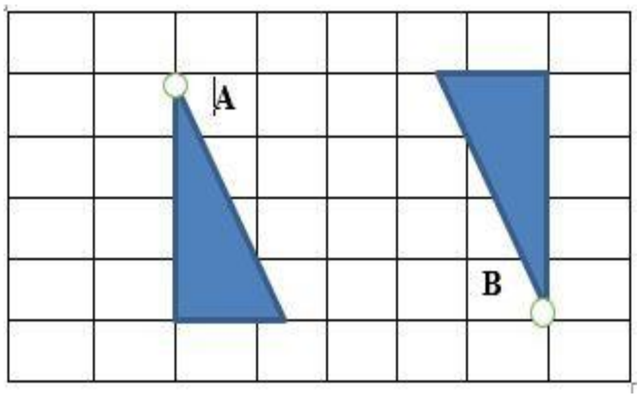

Figure 5.6: Translated rotation/rotated translation

In Activity Ten, Mr. Dubazana describes the meaning of the concept of rotation by focusing on the direction that the object and image are facing (using cardinal points), and also by using gestures. Thereafter, in Activity Eleven, he describes rotation by focusing on the size and the direction of the angle of rotation. He describes rotation using all three properties described in Activities Eight to Ten. In Activity Twelve, Mr. Dubazana describes the action of translating by using the board grid and the concepts of an object and an image, which are triangles with dots (Figure 5.7).

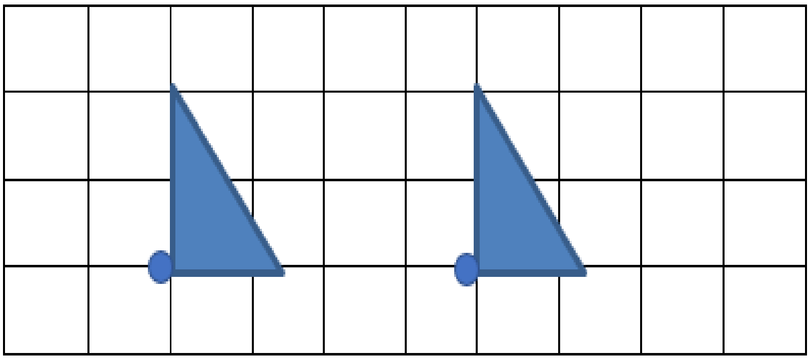

Figure 5.7: Horizontal translation with dots.

In Activity Thirteen, Mr. Dubazana goes back to the description of the action of rotating which he did in Activity Two. He is using the board grid and gestures, focusing on the direction and the size of the angle of rotation (Figure 5.8).

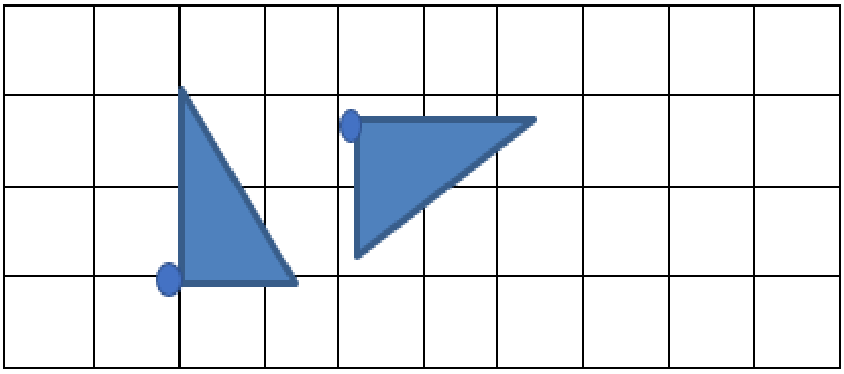

Figure 5.8: 90 degrees translated rotation with dots.

Next, Mr. Dubazana describes the action of reflecting by using the concepts of the line of symmetry, equidistance, and reflectional symmetry, using gestures (Activity 14, Figure 5.9).

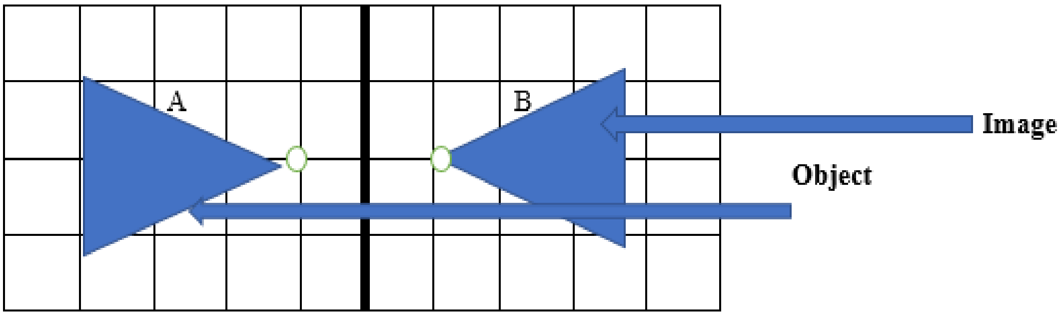

Figure 5.9: Reflection or a flip with dots

Mr. Dubazana thereafter gives a task (Figure 5.10) for learner pair/group work, focusing on identifying the properties of the three different types of transformations (reflection, translation,and rotation), using the grid in their books (Activity 15).

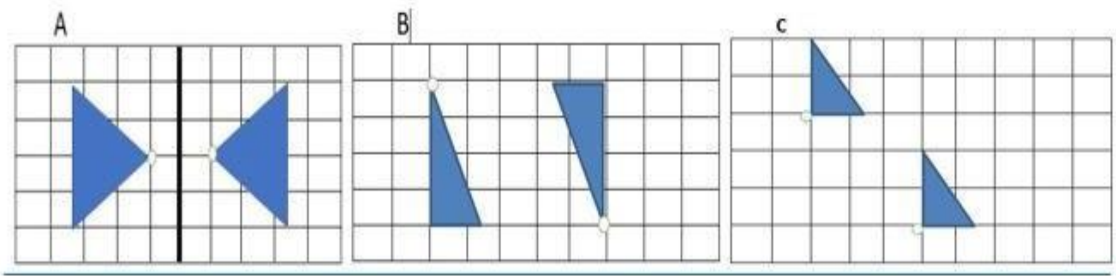

Figure 5.10: Task given to learners at the end of the lesson.

In Activity Sixteen, learners discuss in pairs/groups the properties of the three different types of transformations (reflection, translation, and rotation) focusing on Figure 5.10. At the end of the period, Mr. Dubazana gives learners homework on a task in which they have to identify the properties of the three different types of transformations (reflection, translation, and rotation) (Activity 17).

5.4 MR. DUBAZANA'S LANGUAGE PRACTICES

In this section, I look at the language practices that Mr. Dubazana used and how he applied them to the actions stated in Section 4.3. In the building task on 'building activities' in Table 5.1, I specifically focus on his use of these practices to perform each of the three language functions (Pozzi, 2004) when building the tasks named by Gee (2011) as activities, politics, identities, relationships, connections, sign systems and knowledge. I use evidence from the transcript of his lesson to validate my argument, referring to Activities Oneto Seventeen in Table 5.1 (Columns 4 and 5). In each subsection that follows, I first present the transcript extracts and thereafter follow with my analysis thereof. These episodes have been selected because they are rich in demonstrating how Mr. Dubazana used language for the three language functions across these activities. I give more details about building mathematical knowledge in Section 5.5 as shown in Table 5.1, Column Six.

Regarding the use of language practices, I note first that Mr. Dubazana predominantly uses English language in his whole-class discussions and for all three language functions in this lesson. He uses isiZulu very minimally and Setswana only once (Activities 2, 10, 12, 15, and 17) and I discuss these latter instances in detail in Sections 5.5 and 5.6. His predominant use of English language in all three language functions suggests that he is building politics as he makes Setswana less important.

5.4.1 Description of things and actions

With regards to 'things' in Pozzi's terms in this lesson, I refer to the mathematical concepts of transformation, translation, rotation, reflection, triangle, clockwise, anticlockwise, angle, 90 degrees turn, and 180 degrees turn. In Pozzi's (2004) terms, the actions I am referring to are, for instance, the action of rotating 90 degrees clockwise or anticlockwise or the action of reflecting when demonstrating the difference between the three isometric transformations. These 'things' and 'actions' are featured in Mr. Dubazana's descriptions (presented here), informational questions (Section 5.4.2), and clarification of questions (Section 5.4.3).

To support my argument about how Mr. Dubazana describes 'things' and 'actions,' I focus on three selected episodes, (Episodes 1, 2, and 3). I also draw from episodes in Section 5.4.2. I provide evidence that, when describing 'things' and 'actions' in these episodes, Mr. Dubazana uses images, learners' everyday context, English language, previously learned mathematical concepts, images, gestures, and formal and informal mathematical language to build the following meanings: identities, relationships, connections, sign systems and knowledge, as summarized in Table 4.1, Columns Four and Five.

Episode 1

Describing the meaning of the concept of isometric transformation and introducing the new mathematical terms for different types of isometric transformations, namely 'translation,' 'rotation' and 'reflection' (Activities 1, 2, 3)

11. Teacher: position right. For your sake grade six we will look at three transformations today alright. The types of transformations we have got what is known as translation right. I will explain what translation it is. The other name the simpler term for translation is slide. Right
12. Learners: yes sir
13. Teacher: we are also going to look at what is known as rotation. Simpler term it's a flip, it's a flip (showing them the image of a rotation on the grid that is on the chalkboard). And then the last one for today we are going to look at reflection. Right?

(Teacher draws the arrows with a line to show mirror image on the grid on the board showing reflection)

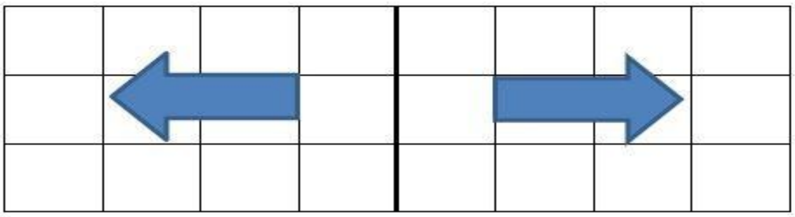

Figure 5.1: Reflection

14. Learners: yes sir
15. Teacher: aah oh sorry I made a mistake it's a flip, is a reflection, a mirror-image okay! See the arrows on the board (drawing arrows facing different opposite directions on the grid showing them a reflection instead ofa rotation on the grid that was on the chalkboard, correcting his mistake). This one is a flip (pointing at reflection on the grid that was on the chalkboard referring to the arrows on the grid). This one is a turn (pointing at a rotation of the two triangles on the grid that was on the chalkboard).
16. Learners; yes sir
17. Teacher: anyway, it's not only these; there are some transformations which you are going to meet. There isenlargement or reduction. There are others which you are going to meet maybe when you go to grade nine grade ten upwards. Things like those, you will meet them there.

But for your sake we will deal with this one (showing the learners the three different types of doing transformation on the grid), (changed the focus of the learners to the first shape on the chalkboard.) Alright,

18. let's start with the first one, Translation or slide. If something has been translated, it has just changed the position. It has just slided to a new position. (Demonstrating by moving a triangular shape to a new
   - position onthe grid that is on the chalkboard), it has slided to a new position. Right, I have this diagram or this triangle alright (at the same time pointing at the translation on the grid that is on the chalkboard).
   -

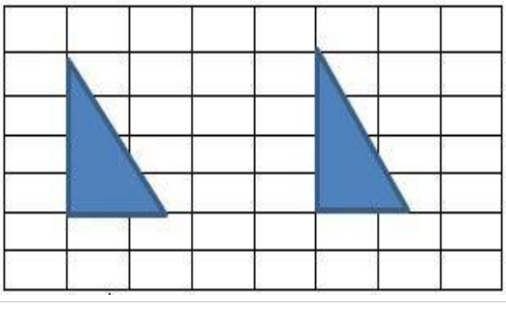

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Figure 5.1: Reflection

Episode 2

Describing the meaning of the concept of translation using triangles on grids on the board and in learners' books and gestures (Activity 3, 4, 5)

21. Teacher: when I just slide it there push it to a new position there, I have translated it to a new?
22. Learners: position
23. Teacher: you will see it when I stick the two of them. Or I can move it maybe from the (original position) downwards depending on what, I've never changed it I've never twisted it. Did I twist it?

24. Learners: no sir

25. Teacher: no, right it doesn't change the shape. When I'm here, is Mr. Dube he is standing there. When I slide to this position, have I turned around? (The teacher moves to a new position using gestures on the floor tiles)

26. Learners: no sir

27. Teacher: I'm still facing this direction, isn't it?

Episode 3

Describing the meaning of rotation focusing on the direction of rotation (clockwise or anticlockwise), using gestures, also focusing on the direction the object and image are facing using cardinal points (Activities 9 and 10)

83. Teacher: (the teacher demonstrating rotation using gestures) I'm still the same person, isn't it? Only that I've changed the direction I'm facing this way now, isn't it? Right?

84. Learners: yes sir

85. Teacher; I can even turn this way, so that's why we call it a turn alright because you will be turning facing the other direction alright, like east, south, west, north, okay! (Showing them rotation on the grid and also turning towards different directions)?

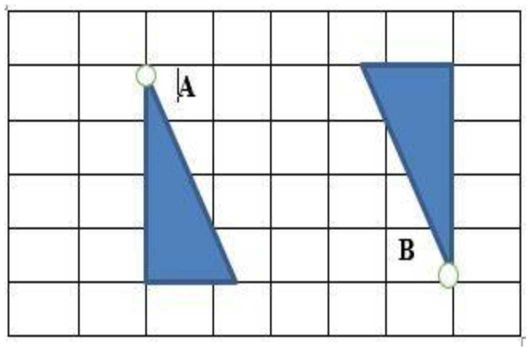


Figure 5.2: Translated rotation/rotated translation

86. Learners: yes sir

87. Teacher: class

88. Learners: yes sir

89. Teacher: when we are turning its we turn following how the clock turns. The clock turns to your right everytime. Everyone does this. (Teacher rotates his hand and arm clockwise and the Learners imitate him). To yourright. Someone is turning the opposite way. To your right. Right that turn is known as clockwise. Clock….?

90. Learners: wise

91. Teacher: why do we call it clockwise? Who can tell us why do we call it clockwise? Yes (after turning hisarm to the right)

92. Learner 1: because it turns like a clock

When describing the three different types of transformations throughout the lesson, Mr. Dubazana uses formal and informal mathematical language interchangeably as language practices. For example, he uses formal mathematical language when describing the concepts of isometric transformations, using the mathematical concepts “translation” (127, Episode 5), “rotation” (13, Episode 1), and “reflection”’ (13, 15, Episode 1). In Episodes One and Three, he also attempts to simplify the meanings of the three types of transformations by using informal mathematical language, describing the concept of reflection as a “flip” (15), translation as “slide” (17), and rotation as a “turn” (85). Here he is attempting to build mathematical knowledge about the meaning of transformations and how they are different from each other.

Mr. Dubazana also uses images as a language practice when describing the three isometric transformations. For example, in Figure 5.1 in Episode One, when describing the procedural action of reflecting, he uses images in the form of arrows to show the concept of the mirror image on the board, thus building sign systems (13) by making images relevant for building mathematical knowledge. He is building mathematical knowledge by using two arrows facing the opposite directions as the labels for the image and the object (Figure 5.1). In Episodes One to Three, he uses triangles on the board grid to represent objects and images when portraying translations and rotation. He is showing how the object is transformed to become an image (17, Figure 5.2; 39, Figure 5.7; 85, Figure 5.3. He mainly uses these images to describe formal and informal mathematical language, however, not following a particular order, to give meaning to different transformations.

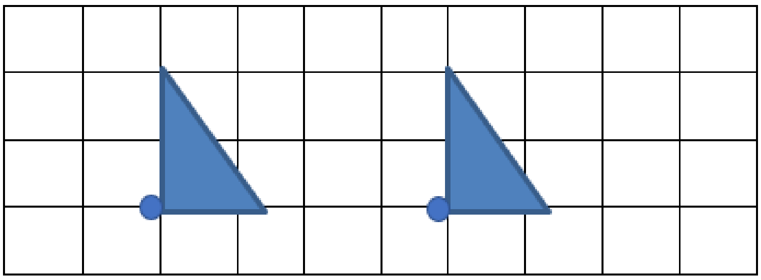


Figure 5.7: Horizontal translation with dots

Mr. Dubazana also uses gestures as a language practice. I also locate the gestures in Section 5.4.2 in Episodes Five, Six, and Seven. For example, in Episode Two, he moves his body, moving horizontally from one floor tile to the other in the classroom to demonstrate horizontal translation, (25, 27). He is using gestures in conjunction with informal mathematical language and images to give meaning to the concept of translation. By doing this, he is building sign systems by making body language relevant when he wants to describe mathematical knowledge about the action of translating.

In Episode Three, by turning his own body and his arm to describe the difference between clockwise and anticlockwise rotation, he is building mathematical knowledge by giving meaning to the direction of rotation (83 to 85). He is using gestures in conjunction with the learners' everyday context to give meaning to the direction ofrotation. In Episodes Five and Seven, he is also building sign systems when describing the action of reflecting, using an example of the flipped hands, facing each other, and seeing one'simage in the mirror (137, 159). Here, Mr. Dubazana uses gestures in conjunction with learners'everyday context to give meaning to the concept of transformation. His use of gestures in conjunction with different language practices helps him to differentiate between the three isometric transformations.

Mr. Dubazana uses the learners' everyday context as a language practice when describing the concepts of reflection and rotation (Episode 3). When describing rotation, he uses the example of a face clock to build mathematical knowledge about the direction of the angle of rotation (89). He is building mathematical knowledge by reminding the learners how the arm of the face clock turns, saying "The clock turns to your right every time" (89), describing the direction of clockwise and anticlockwise rotation. I noticed the use of the learners' everyday context in Episode Six, reflected in the next section. Mr. Dubazana also uses the example of a mirror to give meaning to the concept of equidistance in reflection (143, Episode 6). He is aiming to build connections as he associates the concept of reflection with the image they see whenever they look at themselves in the mirror at home. Mr. Dubazana uses the learners' everyday context and formal mathematical language to give meaning to the direction of rotation and the concept of reflection.

Mr. Dubazana uses previously learned mathematical concepts as a language practice when describing transformation geometry concepts, specifically the concept of angles and the line of symmetry. For example, he uses the example of 90 degrees angle when describing the angle of rotation to build mathematical knowledge about rotation (99 to 126, Episodes 4 and 5). In Episodes Five and Six, he also uses the line of symmetry to describe the concept of equidistance when building knowledge about reflection (137 to 171). In Episode Six he indicates that he taught the learners about the line of symmetry in the previous grade (141, 143). He does not, however, name the concepts by using formal mathematical language such as 'equidistant,' 'angle of rotation,' or the 'size of the angle of rotation,' instead, he just tells them which one is the image and which one is the object on the grids. Here, he is building connections by using previously learned mathematical concepts and formal mathematical language as language practices to give meaning to 'equidistant,' 'angle of rotation,' and the 'size of the angle of rotation.'

5.4.2 Asking informational questions

In this section I show how Mr. Dubazana uses images, learners' everyday context, gestures, formal and informal mathematical language, and the different forms of questions to build the following meanings: connections, sign systems, and knowledge (summarized in Columns 4 and5, Table 5.1) when asking informational questions. For evidence of my argument about how Mr. Dubazana asks informational questions, I focus on eight selected episodes (Episodes 1 to 8) because questions are spread across the lesson. The teacher poses the questions before or after he has described things and actions.

Episode 4

Describing the meaning of rotation focusing on the direction the object and image are facing (using cardinal points), using the grid, describing the clockwise and anticlockwise rotation focusing on the size of an angle and the direction of rotation (Activities 10, 11)
93. Teacher: it turns like a clock good. You will never see a clock turning this way, isn't it? (Showing anticlockwise and also turning anticlockwise) 94. Learners: yes 95. Teacher: you will never. It will always turn clockwise like this (turning clockwise). So that direction is known as the direction. So, if I am turning this way, I am turning clockwise this way clockwise. I am turning clockwise. But if I go the other way around, opposite the clock face I will be turning anticlockwise. Anti….? 96. Learners: clockwise 97. Teacher: anticlockwise. That is the direction alright? 98. Learners: yes 99 Teacher: it's either I'm turning in right angles, how many degrees is right angle? 100. Learners: 90 degrees 101. Teacher: good right, just for the moment stand up. Be free, be free alright. Which direction are we facing? 102. Learners: south

Episode 5

Describing the clockwise and anticlockwise rotation focusing on the angle and the direction of rotation; describing the action of translating, rotating, and reflecting using the grid focusing on the concepts of object and an image (Activities 11, 12,13, 14, 15)

123. Teacher ....Let me show you on a paper here (flashcards). Here is my triangle. Alright. Let me find out from you. Here is another triangle. Let me just put it like this. Can you tell us what kind of a transformation is it? This shape, here is the dot here is the dot (pointing at the dots in the first and the second triangles). This shape has moved from there to there. What kind of a transformation is it?

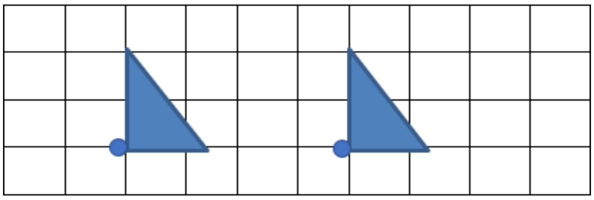


Figure 5.7: Translation with dots

124. Learners: it's a slide.
125. Teacher: it's a slide, what do we call a slide?
126. Learners: translation
127 Teacher: translation. Right. There is another one. I don't know whether it's still a slide. There is the dot and then I put it like this (doing 90 degrees rotation clockwise to the given triangle with a dot). Yes, what is it?

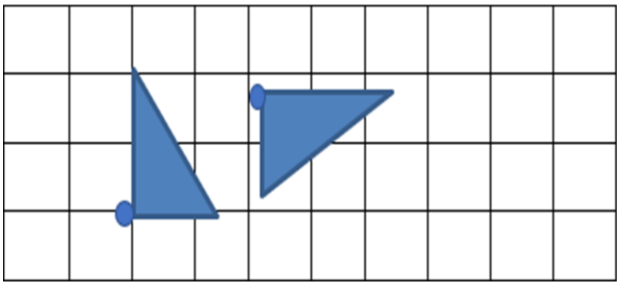


Figure 5.8: 90 degrees translated rotation with dots.

128. Learner 2: rotation
129. Teacher: it's a rotation. It has turned, can you see that this shape has turned. How many degrees do you think it has turned? How many degrees?
130. Learner 3: 90 degrees
131. Teacher: if you look carefully, you will see a, if I can draw you will see some 90 90 degrees being formed there alright?
132. Learners: yes
133. Teacher: how did it turn? Did it turn clockwise or anticlockwise? one person not chorus
134. Learner 4: clockwise
135. Teacher: clockwise. It has turned like this isn't it? (Turning 90 degrees clockwise)
136. Learners: yes sir
137. Teacher: let's look at the last transformation. Okay. This one is known as a reflection or a flip alright (pointing at the images showing reflection on the grid), why do they call it a flip? When something flips, it turns over like this isn't it? (Flipping his hands and putting them on top of each other) Right let me use my hands. Can you see that these hands are fitting one on top of the other?

Episode 6

Describing the action of reflecting using the line of symmetry; gestures and equidistant and reflectional symmetry (Activity 15)

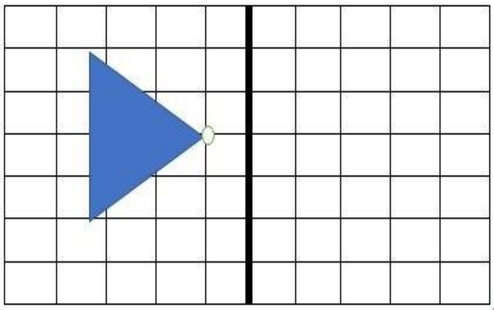
Teacher: alright, if I turn this one like this (putting a triangularshape along the line so that there could be a reflection of an object), there's a line which is formed there. What do you think in mathematics what do we call that line which makes a half and another half which is equal to this one? I remember teaching you this last year, yes?

140. Learner: line of symmetry
141. Teacher: it is a line of symmetry isn't it and there is a line of symmetry which is formed there. So, which means if this was an object this will be an image when we put a mirror in between isn't it (Showing the learners where the line of symmetry should be)?
142. Learners: yes
143. Teacher: like yourself when you stand up in front of a mirror, here is Tshegofatso standing in front of the

Episode 7

Describing the action of reflecting using the line of symmetry; gestures and equidistant and reflectional symmetry (Activity 15)

159. Teacher: right, this goes on to say when we are reflecting you will see the image of yourself and the front, if you stand your back towards the mirror, you will see the back will be towards your mirror isn't it?
160. Learners: yes
161. Teacher: in that person so this is what is happening, here is the line of symmetry or a mirror line, wecall it a mirror line. Here is a mirror I put a mirror there. There is my shape. Okay this is a mirror line alright. Or let's say this is yourself standing in front of the mirror. Who can come and put the image of that? yes come?



162. Learner 5: (comes and places the shape on the board).
163. Teacher: do you think Andile is correct?
164. Learners: no sir
165. Teacher: why do you think so?
166. Learner: because he makes the rotation
167. Teacher: now it's like Andile is standing up in front of the mirror and now the image of Andile is upside down the head is….
168. Learners: down
169. Teacher: the feet up. Alright who can correct it? Koketso, Keletso sorry
170. Learner: (comes and changes the position of the shape)
171. Teacher: check carefully, check the dots carefully, good boy. correct isn't it.

172. Learners: clap hands
173. Teacher: good, thank you right, what happened to this? (Pointing at the line of symmetry) What happened there? Let's say it's Keletso moving away about 1cm, (The teacher decides to point the learners to the grid with the mirror line and the triangles on the chalkboard) let's say 5centimeters away from the mirror line. Right, what will happen to the image? Show us how many cm. Show us; put it in the correct order. Don't worry just put it, estimate the distance, put it the other side (giving the learners the flashcard triangle to be used as an image).

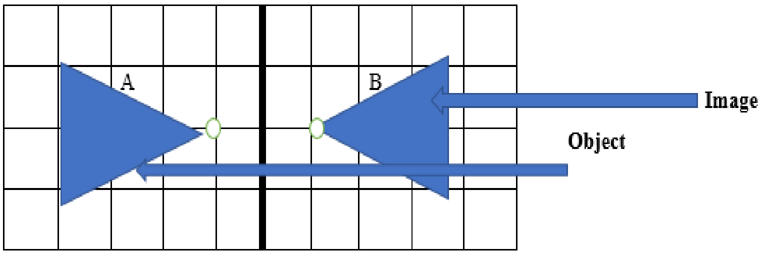


Figure 5.9. Reflection or a flip with dots

Episode 8

asking informational questions Giving a task for learner pair work, focusing on identifying the properties of the three different types oftransformations which are reflection, translation, and rotation, using the grid in the learners' books, working in pairs (Activities 16, 17)

181. Teacher: for now, in pairs, I will not say in groups in pairs I want you to have a piece of paper there with your friend. Just write down quickly what do you think these transformations are.

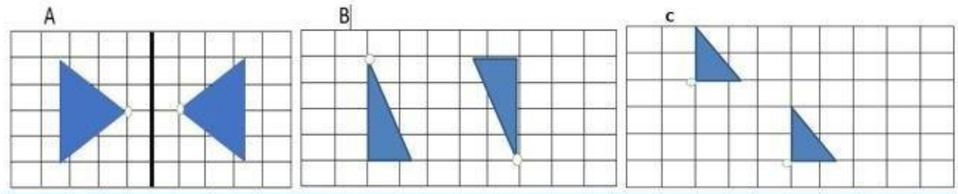


Figure 5.10: Task given to learners at the end of the lesson.

Is it a rotation? Is it a reflection? Is it a translation? What are they? There is the first one there is the first one I will call it A. Right down what A is. What is it? Is it reflection, is it a rotation or is it a translation? Here is B. what is it? Don't do alone talk to your friend, you can be threes assisting each other. Write it down, don't draw just write the names. Don't draw. Talk freely. Here is C. what is C (pointing at the grid under C.)

182 Group 1: nthoena e ke reflection kahore diatshwana eh diatshwana (this thing is reflection because they are the same, yes, they are the same). …B ke rotation because ke turn around (B is rotation because it's a turnaround). Translation e slidile. e ke subject A subject B le subject C (its translation, it has slided, it's subject A, Subject B and Subject C)

183. Group 2: e slidile, rotation, ke rotation kwala, rotatione, ya rotate-ah. (It slided, rotation its rotation, write rotation, it's rotation)

184. Group 3: re ibitsa rotation because e goile because e goile, go tena (we call it rotation because it has turned, it has turned). ena ke reflection kagore akere neyintsi just like yamathomong hafetsa ebe e changer (this one is reflection because it was just like the first one after that it changed)

When asking informational questions, Mr. Dubazana uses different forms of questions as a language practice. Some of the questions he asks are closed questions requiring "yes" or "no,"such as: "Did I twist it?" (23, Episode 2). He also asks closed questions that require short answers, like naming a concept or an action, for instance, "What kind of a transformation is it?" (123, Episode 5), also using formal mathematical language, wanting the learners to recall the name of the displayed transformation on the grid. These two questions are attempting to build mathematical knowledge about the concepts of horizontal and vertical translation. In Episode Seven (161), Mr. Dubazana uses open-ended questions that require learners to focus on the action of reflecting, saying "Okay this is a mirror line alright. Or let's say this is yourself standing in front of the mirror. Who can come and put the image of that? yes, come." When the learner responds by placing the second triangle as rotation, instead of placing it as a reflection of the object, the teacher asks the class, saying, "Do You think Andile (pseudonym) is correct? Why do you think so?" (163, 165). In this final example, he is building mathematical knowledge by asking different forms of questions, requiring justification to give meaning to the concept of reflection.

Mr. Dubazana uses images as language practices (Episodes 2, 4, 5, 6, 7, and 8) when asking informational questions. For example, in Episode Five he asks two closed questions saying, "What kind of a transformation is it?" referring to the action of translating in Figure 5.7 (123), also using formal mathematical language and different forms of questions as language practices.

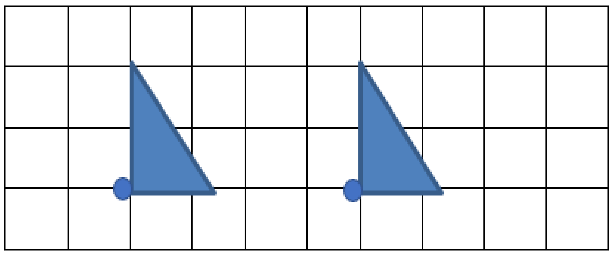


Figure 5.7: Translation or a slide with dots

Then, in Line 127 he asks "there is the dot and then I put it like this…. Yes, what is it?" referring to the action of rotating in Figure 5.8.

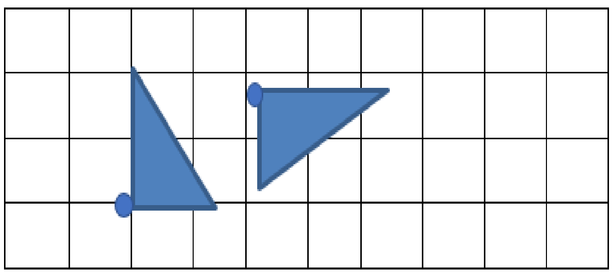


Figure 5.8: 90 degrees translated rotation with dots

In Episode Eight Mr. Dubazana refers learners to question A in the task given to learners in Figure 5.10 and asks open-ended questions, saying "Why do we say this is a reflection?" requiring the learner to justify why he says what is on the grid is the action of reflecting (202).

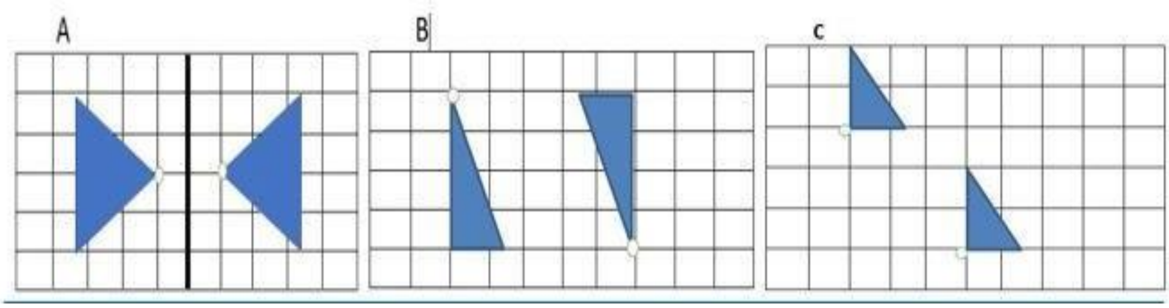


Figure 5.10: Task given to learners at the end of the lesson

Here, Mr. Dubazana is building mathematical knowledge through a sign system by using images in the form of a grid to require justification for the procedural action of reflecting to give meaning to the concept of reflection. He asks about the procedure for translating in Figure5.7, rotating in Figure 5.8, and reflecting in Figure 5.10, question A. Here, Mr. Dubazana is building mathematical knowledge through sign systems about distinguishing between the three isometric transformations.

When asking informational questions, Mr. Dubazana uses gestures. For example, in Episode Four, while turning together with the learners, he asks closed questions saying, "Which direction are we facing?" (101) "I want you to turn 90 degrees clockwise" (103) "Did you turn clockwise if you are facing east now?" (105), also using formal mathematical language and different forms of questions as language practice. After rotating his arm to the right, he asks an open-ended question that requires justification from the learners, saying "Who can tell us why we call it clockwise?" (91, Episode 4). He is building mathematical knowledge through sign systems by using gestures in conjunction with formal mathematical language and different forms of questions to give meaning to the concept of the direction and the size of the angle of rotation (89).

The teacher also uses informal and formal mathematical language as language practices when asking informational questions. For example, in Episode Nine he uses the word "slide" in the question "what is a slide by the way? another name for slide? ..." (39), using informal mathematical language. Here, he is building mathematical knowledge by asking closed questions that require learners to recall formal mathematical language for the word "slide" to give meaning to the mathematical concept of translation. In Episode Five he asks a closed question saying, "How many degrees do you think it has turned?" (129) "how did it turn?" (133), using the word "turn" instead of 'rotate'. Mr. Dubazana is building mathematical knowledge by using informal mathematical language in English to give meaning to the concept of rotation. In Episode Five he asks an open-ended question saying, “why do they call it a flip?”(137). He is building mathematical knowledge by using the word ‘flip’ for the procedural actionof reflecting to give meaning to the concept of reflection. Mr. Dubazana is using informal mathematical language and gestures to support the understanding of formal mathematical language when giving meaning to the isometric transformations.

Mr. Dubazana is also using learners’ everyday context as a language practice when asking informational questions. In Episode Four, he refers learners to the clock, which is also from their everyday context. He asks an open-ended question that requires justification by saying, “Who can tell us why we call it clockwise?” (91). He is attempting to build mathematical knowledge by associating the hands of a clock with clockwise rotation to give meaning to thedirection of rotation. He is also building connections with the learners’ everyday experiences, attempting to see if they can link the hands of the face clock to the direction of rotation. In Episode Six, he also asks a closed question saying, “what happens to that person who is that side when she moves away” (143), referring to a mirror. By using the example of a mirror thatis used in their everyday context, he is attempting to build mathematical knowledge by giving meaning to the line of symmetry and equidistance. He is building connections with the learners’everyday experiences, giving meaning to the line of symmetry and the line of reflection.

Mr. Dubazana is asking informational questions using previously learned mathematical concepts as a language practice, specifically focusing on the line of symmetry and measurement in centimeters. In Episode Six, he asks closed questions that require learners to recall the concepts that were previously taught in the previous lesson, saying: “… what do we call that line which makes a half and another half which is equal to this one? I remember teaching you this last year, yes?” (139) referring to the ‘line of symmetry.’ He is building mathematical knowledge, attempting to connect the understanding of the concept of the line of symmetry with the concept of reflection. In Episode Seven he asks an open-ended question, saying “What happened there? Let’s say it’s Keletso moving away about one centimeter, I..?” (173), also using formal mathematical language.

Mr. Dubazana is building mathematical knowledge by requiring the learners to remember the conceptual meaning of measuring distance in centimeters, learned from previous grades. With the first and the second questions in this example, he is building connections with the previously learned mathematical concepts which are the line of symmetry and measurement in centimeters. He is doing this, attempting to give the conceptual meaning of the concept of equidistance and reflectional symmetry. Mr. Dubazana is asking different forms of questions using different language practices to support the understanding of formal mathematical language to give conceptual meaning to the isometric transformations.

5.4.2 Clarification of questions

In this section, I show how when clarifying questions, Mr. Dubazana uses images, learners' everyday context, different forms of questions, and gestures, to build the following meanings: connections, sign systems, and knowledge (summarized Table 5.1). The analysis in this section explores how the teacher makes the questions clearer to the learners whenever he realizes that they do not understand the informational questions. Mr. Dubazana clarifies questions indifferent ways and at different times. For example, after asking a question sometimes he describes a particular concept or action. Sometimes he asks a closed or open-ended question and clarifies it by repeating it slowly, rephrasing it, or asking it in a different way. Here, I present the findings with evidence from some of the utterances selected in Episodes Four to Nine and also from Episodes One to Three.

Episode 9

Clarifying questions by describing the meaning of the concept of translation linking tothe grids in learners' books (Activity 5)

37. Teacher: good boy, the position. You have change to a new position alright. When you are translating, we have to describe it how you have translated? How do you describe? In your books, you have the squares, isn't it?
38. Learners: yes sir
39. Teacher: All those squares or when you are using a grid paper you will have the squares like that. Your books have got squares. Nice like that. Right. Suppose this here is your triangle. (Teacher draws triangle on the board). Let me make it bolder. There is your triangle I will call it triangle A alright. I slide triangle A, what is a slide by the way? Another name another name for slide? another name for slide.
40. Learners: translation
41.

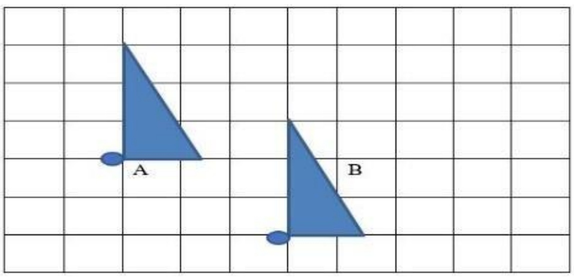


Figure 5.3: Horizontal and vertical translations

Mr. Dubazana uses images as a language practice to clarify his questions. In Episode Five, he asks a closed question, "Can you tell us what kind of a transformation it is?" (123) using formal mathematical language. Before the learners respond, he clarifies it by saying, “This shape, here is the dot…This shape has moved from there to there” (123, Figure 5.3), “… there is the dot and then I put it like this. Yes, what is it?” (127, Figure 5.4). Here he is using the action of horizontal and vertical translations on the grid to clarify his questions. He is pointing at the dots in the first and the second triangles, drawing the learners' attention to how the objectis translated to be the image on the grid. He, however, does not give details on how the dots can assist in differentiating between the object and the image. He aims to build procedural mathematical knowledge by using sign systems to show the learners the difference between the concept of horizontal and vertical translations (Figure 5.3) and the concept of rotation (Figure 5.4).

In Episode Nine, still using images as a language practice, Mr. Dubazana asks the learners an open-ended question to describe a translation. He asks, “When you are translating, we have to describe it how you have translated, how do you describe?” (37), also using formal mathematical language. When the learners are quiet, he clarifies the question by referring them to the squares in their books saying, “In your books, you have the squares…” (37) …. “All those squares or when you are using a grid paper you will have the squares like that… There is your triangle I will call it triangle A alright. I slide triangle A.” (39) referring to Figure 5.3. Here, Mr. Dubazana clarifies his question by describing the procedure, demonstrating the action of translating a horizontal translation of three squares to the right and two squares vertically downwards. He is attempting to build mathematical knowledge by using the related sign systems which are images and formal mathematical language to build conceptual meaning for translation.

Mr. Dubazana uses learners’ everyday context as a language practice to clarify questions about the concept of rotation. In Episode Four, after asking an open-ended question saying, “Who can tell us why we call it clockwise?” (92) requiring justification from the learners. He thereafter clarifies the question by referring to the hands of the face clock they use at home, saying “You will never see a clock turning this way, isn’t it?” (93), while rotating anticlockwise, using gestures as a language practice. He is building mathematical knowledge by using the hands of the clock that is used at home to describe a procedure for rotation to give meaning to the concept of clockwise and anticlockwise rotation. He is also building connections with the learners’ everyday context by linking the hands of a clock to build the conceptual meaning of the direction of rotation.

When clarifying questions, Mr. Dubazana uses gestures as language practices. For example, in Episode Five he asks an open-ended question about reflection, saying, “This one is known as a reflection or a flip alright, why do they call it a flip?" (137) also using informal mathematical language in English. When the learners are quiet, he clarifies his question by flipping his hands and putting them on top of each other, saying "Right let me use my hands. Can you see that these hands are fitting one on top of the other?" (137). In this clarification, he is building sign systems for mathematical knowledge by showing the learners the procedural action for reflecting. He does this by showing the learners how the image faces the opposite of the object, thus enabling the mathematical meaning of the concept of reflection.

5.4.4 Summary of the language practices used

Mr. Dubazana is building activities on transformational geometry in this lesson using various language practices to give conceptual meaning to the three isometric transformations: rotation, translation, and reflection when using language functions. When he describes mathematical procedures and concepts and when he asks and clarifies his questions, he uses language practices individually but sometimes as a collective. His language practices support each other while he uses English language in his entire lesson, thus building politics.

In his lesson, Mr. Dubazana employs both formal and informal mathematical language to elucidate the concepts of isometric transformations, which are translation, rotation, and reflection. He initially uses informal language paired with gestures and images to create a foundational understanding. Later, he shifts to a more non-verbal approach, using gestures andimages to deepen the understanding of these transformations. By integrating informal languagewith previously learned concepts and the learners' own experiences, he bridges their prior knowledge with new information, facilitating a comprehensive grasp of the procedures involved in the three transformations.

Mr. Dubazana avoids code-switching to Setswana. However, he does allow learners to use their home language when doing group work or pair work, thereby building identity and relationships. When asking informational questions about the procedures for rotating, translating, and reflecting, he uses different forms of questions and revoicing to give conceptual meaning to the formal mathematical language. He supports the use of different forms of questions by using informal mathematical language, gestures, and images, (building sign systems) as well as previously learned mathematical concepts, and learners' everyday context, thus building connections.

At some point, Mr. Dubazana predominantly uses gestures, different forms of questions, formal and informal mathematical language to clarify questions when the learners keep on responding incorrectly. The incorrect response regarding the action of rotating up to the end of the session may have been caused by various reasons. Here, the teacher may have missed opportunities for the development of procedural and conceptual mathematical knowledge.

5.5. HOW MR. DUBAZANA CREATES OPPORTUNITIES FOR THE LEARNERS TO ENGAGE IN PROCEDURAL AND CONCEPTUAL MATHEMATICAL DISCOURSE.

In this section, I look in depth at the building task mathematical knowledge in the analysis, as identified in Section 5.4. This involves exploring how Mr. Dubazana creates opportunities for the development of procedural and conceptual mathematical Discourse when he describes things and actions, asks informational questions, and clarifies his questions as set out in the Analytical Framework (Table 2.1, Column 3).

Regarding the procedural mathematical Discourse, as presented in Table 2.1 and in the conceptual and procedural analytical tool (Appendix M), I focus on what and how the teacher describes how to perform a mathematical action, how he requires the learners to complete an action and how he requires that the learners memorize some of the rules. Regarding conceptual knowledge, as noted in Table 2.1, I look at how the teacher describes the meaning of mathematical concepts for understanding and communicating mathematical ideas, how he asks the learners to explain and justify why they used a particular action, and also how he encourages learners to compare, contrast and integrate related concepts.

While Section 5.4 is structured using Pozzi's functions, looking at the language practices the teacher uses and the meanings of Gee's (2011) building tasks, this section is structured according to the flow of the lesson. This structure brings into view how Mr. Dubazana, in the lesson as a whole, attempts to build procedural and conceptual Discourse. Mr. Dubazana uses English language to build procedural and conceptual Discourse, thus building politics. Also, while building mathematical knowledge, and using different language practices, he is building different meanings. I use the activities in Table 5.1 to structure the analysis in this section. Forease of reading, I repeat the key figures already analyzed in Section 5.3.

5.5.1 Describing the meaning of the concept of isometric transformation (Activity 1)

After writing the mathematical term 'transformation' on the board, Mr. Dubazana asks the question: "Right, first of all, what does the word transformation mean?" Before the learners respond, he describes the meaning to them, using three descriptions, one after the other. In his first two descriptions he says, "It means changing right…You change the area, you change the position, or you change the size or the shape, alright?" This description is about the action of changing, referring it to as "a change of position or change of size or area or shape." Though he is teaching about isometric transformations, this definition is not specific to isometric transformations. While the learners are quiet, the teacher continues to describe the word "transformation" saying, "Otherwise basically transformation is something you change, something you have changed to this to be this thing to another thing, alright." This description refers to something one changes, using English language as a language practice.

Mr. Dubazana then moves one step to a new position in front of the learners, and asks another closed question, this time requiring them to complete the sentence, saying "Or the same thing you have just moved to a new…….?" In doing so, he is using a gesture to give the meaning of transformation as a change of position, however, his description is no longer referring to the shape and size that change. Thus, in Activity One, he is aiming to build conceptual mathematical knowledge for the mathematical concept transformation by defining it as a change of position, using gestures, formal mathematical language, and English language as language practices.

5.5.2 Describing different types of isometric transformations, namely 'translation,''rotation' and 'reflection' (Activity 2)

Mr. Dubazana tells learners that the focus of the lesson will be on three types of transformations, using the grid (Figures 5.1 to 5.3). Learners respond with "yes sir," when the teacher says: "For your sake grade six we will look at three transformations today … The types of transformations we have got what is known as translation … the other name, the simpler term for translation is a slide." Here he uses informal mathematical language to give the conceptual meaning of the mathematical concept translation.

He then attempts to describe rotation by saying: "We are also going to look at what is known as rotation, In simpler terms it's a flip, it's a flip." He is attempting to help learners understand the conceptual meaning of the mathematical concept rotation, again by using informal mathematical language. However, he does this without noticing that he is actually describing the concept of reflection. He does not correct his mistake immediately but continues to describe the third transformation, saying "And then the last one for today we are going to look at reflection. Right?" He only realizes when describing the meaning of the mathematical concept of reflection that he made a mistake by naming a rotation as a flip, saying "… sorry I made a mistake, it's a flip, is a reflection, a mirror-image okay!" He, thus, corrects himself immediately when looking at the image of the grid used for reflection on the chalkboard in Figure 5.1. He further describes the conceptual meaning of reflection as a "flip" and "mirror-image," referring the learners to images using informal mathematical language (building sign systems), and also drawing on an everyday context (building connections).

He continues to use images as a language practice by directing the learners' attention to two arrows facing in opposite directions, showing a reflection on the grid saying: "See the arrows on the board" (Figure 5.1).

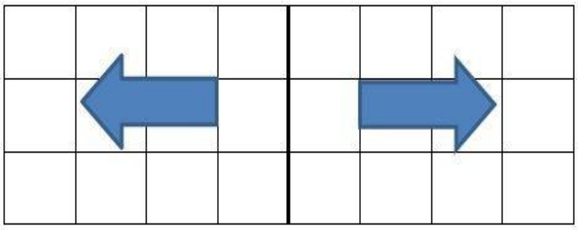


Figure 5.1: Reflection

He thereafter draws a line of symmetry between the two arrows on the grid, showing learners the line of reflection, thus building a sign system by using images as language practice. His action is attempting to give meaning to the concept of reflection. He further corrects himself by describing the third isometric transformation saying, "This one is a turn," pasting two triangles with dots on the grid, one representing the object and the other representing the image in Figure 5.2, still using images as a language practice thus building sign systems to enable mathematical Discourse. He however does not explicitly name the two diagrams as an object and an image.

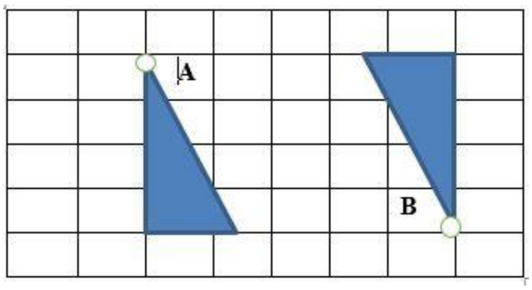


Figure 5.2: Translated rotation/rotated translation

In these activities, Mr. Dubazana is building conceptual mathematical knowledge about the three isometric transformations, using images in the form of shapes on the grid, learners' everyday context, as well as formal and informal mathematical language.

5.5.3 Describing the meaning of the concept of translation using grids on the board, in learners' books, and the floor tiles (Activities 3, 4, 5, 6, and 7)

After the brief introduction of the three types of transformations, Mr. Dubazana describes the meaning of the concept of translation using grids in different ways in Activities Three, Five, Six, and Seven. He uses a grid that is on the board (Activities 3 and 6), a grid in the learners' books (Activity 5), a grid on the board and in the floor tiles (Activity 7). His main focus in all these activities is 'moving to a new position.'

For example, in Activity Three, he starts by saying to the whole class "Alright, let's start with the first one, translation or slide". He gives its meaning in both formal 'translation' and informal 'slide' mathematical languages. He then describes the procedure for translating "If something has been translated it has just changed the position. It has just slided to a new position." He moves a triangular labeled A three blocks to the right and pastes it to a new position (Triangle B) on a grid (Figure 5.3). He continues to describe the procedure for translating by saying, "when I just slide it there, push it to a new position there."

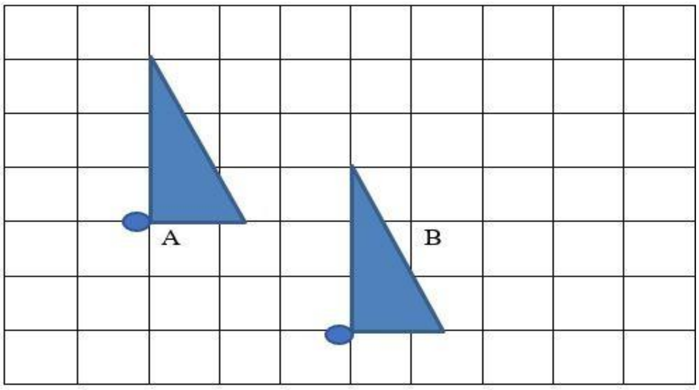


Figure 5.3: Double translation

He then moves triangle B vertically two blocks downwards. He thereafter points at Triangles A and B in Figure 5.3 showing how Triangle A moved horizontally, three squares to the right to be Triangle B, saying, "this triangle is there." He also points at Triangle B and traces around it with chalk saying, "Is there alright, can you see?" He then asks a closed question: "I have translated it to a new…….?."

He is using images, informal and formal mathematical languageas language practices to describe the procedure for translating. He is expecting the learners to observe the action on the grid and complete his sentence by indicating how the transformation happened, thus building sign systems to build mathematical knowledge**.** At this stage, his emphasis is on the change of position when doing the action of translating.

Mr. Dubazana then refers the learners back to Figure 5.3, saying “Did I twist it?” asking for a “yes” or “no” response. He is using images as language practices to clarify his question, referring to the direction faced by the image, expecting the learners to observe how the triangle moved to the position of triangle B, thus building sign systems when describing the procedure for translating. When learners say “no” he further describes, “so when you are translating the shape does not change… and the size does not change as well.” He is using formal mathematical language to describe the mathematical meaning that applies to all three isometric transformations since these properties do not apply to translations only.

After describing translation using the grid in Activity Four, Mr. Dubazana moves his body to a new position in front of the class. He uses gestures and different forms of questions as language practices, following a pattern of describing and asking various closed questions about his actions, saying:

> *“When I slide to this position have, I turned around?…I’m still facing this, isn’t it?… Have I become bigger or smaller?…I’m still facing this direction, isn’t it?…And the size does not change as well. What changes, is what?... Does it change?”*

When learners respond by saying that “the position” changes, he asks a closed question again: “Does it change? Has the shape changed?” He wants the learners to observe and see that when doing the action of translating, he did not change the direction the object faced and also did not change his body size, thus building sign systems. He is expecting the learners to observe the difference between what he will later name as the ’object’ and the ‘image’ when doing the procedure for translating.

Mr. Dubazana is attempting to build mathematical knowledge by showing the learners what changes and what does not when doing the procedure for translating. He is using procedures by describing the action to be taken when translating, thus giving meaning to vertical and horizontal translations. By doing this, he is building conceptual mathematical knowledge, using images, gestures, different forms of questions, formal and informal mathematical language as language practices. In his description, Mr. Dubazana focuses on the key concepts overall but does not bring in the formal mathematical language, in this case, vertical and horizontal translations. He also does not mention that when translating, an object and its translated imageface the same direction.

In Activity Five, Mr. Dubazana continues to describe the concept of translation, saying “When you are translating, we have to describe it how you have translated”. While the learners are quiet, he asks an open-ended question: “How do you describe?” Before the learners respond he clarifies his question by saying: “in your books you have squares, isn’t it? All those squares orwhen you are using a grid paper you will have the squares like that,” describing the procedure for translating. He is using images as language practices, referring learners to the squares in their exercise books, and likening them to a grid such as that on the chalkboard (Figure 5.3). He further clarifies his question by saying: “I slide triangle A”, demonstrating the procedural action for translating by first moving the triangle labeled A three blocks to the right. He then moves it again two blocks downward on the grid. He then pastes Triangle A and Triangle B onthe grid. By doing this, Mr. Dubazana is using procedures to give conceptual meaning to horizontal and vertical translation.

He continues to clarify his questions by describing a ‘slide’ while the learners are quiet, saying, “Your books have got squares, right,” “Suppose this here is your triangle, there is your triangle, I will call it Triangle A, alright. I slide Triangle A,” “I slide it maybe to a new position here,” “And then I call it B although it is the same triangle….” He is building procedural mathematical knowledge by using squares in the learners’ exercise books to direct learners to the object and image. Here he is building sign systems by using images to clarify questions by describing ‘vertical’ and ‘horizontal’ translations, however, still does not call them that. He also does not use the terms ‘object’ and ‘image.’ In Activity Six, Mr. Dubazana attempts to describe the conceptual meaning of the object and the image saying, “Like when you are standing in front of a mirror isn’t it?” He is using learners’ everyday context as a language practice to give meaning to the concept of an image, thus building connections with the learners’ context. He then asks a question “…what do you see?” referring to an image they would see in the mirror. His question requires the learners to remind themselves about what they usually see when they stand in front of the mirror so that they may associate the image they see in the mirror with the image of the object on the grid. When learners say “yourself” he refers them back to the grid on the board (Figure 5.4) saying, “The object is you, and what you see on that side is the image. B is the image of A.” He is attempting to give meaning to the difference between the object and the image in Figure 5.4.

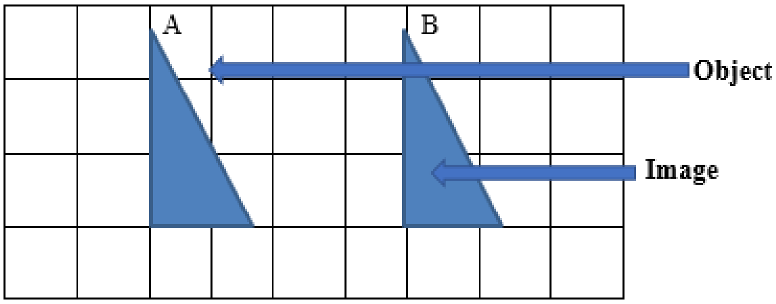


Figure 5.4: Difference between the object and image

Mr. Dubazana thereafter refers the learners to Figure 5.5 and says "let's describe this transformation. You describe by counting how many boxes have you moved to the right or the left or down isn't it or upwards" describing the procedure for translating horizontally and vertically. To do this, he uses 'right' 'left' 'down', and 'upwards' which is informal mathematical language in English.

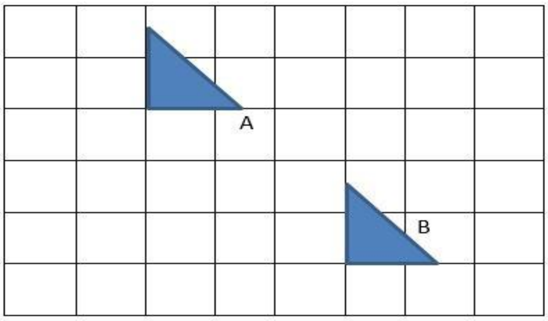


Figure 5.5: Horizontal and vertical translations

He is using images as language practices by making learners aware that an object can be translated horizontally or vertically by counting units on the grid, thus building sign systems. His description introduces the distance translated and the direction of the movement as vertical and horizontal. At this stage, he still does not use formal mathematical language 'horizontal or vertical translation.' He is building procedural mathematical knowledge to give meaning to the concept of translation by using images, formal and informal mathematical languages, different forms of questions, and learners' everyday context as language practices.

In Activity Seven, after his description, Mr. Dubazana asks a closed question: "How many boxes? We pick a point; how many did you move downwards?" using informal mathematical language and images as language practices to ask about the procedure for translating. He is expecting learners to indicate the translated distance by counting the number of squares from the original 'point' as he uses the words “pick a point.” However, when using the words “pick a point,” Mr. Dubazana does not mention the dots as the point of departure in the triangles in Figure 5.3. He also does not relate the “pick a point” to equidistance which indicates that everypoint of the triangle on the grid has to move the same distance towards the same direction.

When learners respond by saying “two,” Mr. Dubazana asks another closed question saying, “How many boxes this direction?” pointing to the right of the grid in Figure 5.3. Before the learners respond, Mr. Dubazana further clarifies his question about the procedure for translating, saying “So, we describe by saying we have translated, or we have moved two squares down and….?.” He is expecting the learners to count the number of squares again to Triangle B and see that this is a horizontal translation towards the right-hand side, using images, formal and informal mathematical language as language practices. While the learners are still listening, he asks and describes at the same time: “… Has the shape changed? If you haven’t changed it, it just moved, it just slided…you know that this transformation is a….?” He is building procedural mathematical knowledge by giving meaning to the concept of equidistance as well as vertical and horizontal translations, using formal and informal mathematical language as language practices.

This analysis suggests that Mr. Dubazana’s focus on Activities Three, Five, Six, and Seven is to describe the procedural action for translating. He is using images, showing learners that translating means a movement of a certain number of units on the grid and in a particular direction from the original position to a new position, with no change in shape or size. When describing the procedure for translating, his main focus is on ‘moving to a new position’, showing horizontal and vertical translation. It is also about the change of direction faced as well as differentiating between object and image. The images he uses to build mathematical knowledge are the following: the grid that is on the board (Activities 3 and 6), the grid in learners’ books (Activity 5), as well as the object and image using a grid on the board and floor tiles (Activity 7). In his description, he is using procedures to give meaning to vertical and horizontal translations. Here, he is building conceptual mathematical knowledge by using images, different forms of questions, formal and informal mathematical language, English language as well as learners’ everyday context as language practices.

5.5.4 Describing the meaning of rotation, focusing on the direction of the rotation andthe angle of rotation, using gestures and images (Activities 8 to 13)

In Activities Eight to Thirteen, Mr. Dubazana describes the meaning of rotation, focusing on the direction of rotation using grids, cardinal points as well as clockwise and anticlockwise rotation. He also focuses on the angle of rotation using grids, gestures, and images. In these activities he is going back and forth, attempting to give meaning to the concept of rotation.

In Activity Eight, Mr. Dubazana refers learners to Figure 5.6 and says: "let's look at another one, a rotation. Right same applies to rotation, the shape does not change alright, or the size of the shape does not change, it remains the same." Here, he describes the mathematical concept of rotation, which he introduced at the beginning of the lesson. He is using formal mathematical language and images as language practices to remind the learners about the properties of isometric transformations. He then asks a closed question "… but what changes, is this thing you have turned it, what changes is, is where is it facing now alright, …here is Mr. Dubazana,alright facing you" describing the procedure for rotating. He is using gestures to distinguish rotation from translation concerning the change of direction faced by the object, thus building sign systems.

Mr. Dubazana further describes the action of rotating, saying "If I say Mr. Dubazana turn 90 degrees to your right, Mr. Dubazana will turn this way, isn't it?" He is turning to the right, using gestures and formal mathematical language to describe the angle of rotation and the direction faced, thus building sign systems. He turns 90 degrees to the right again. He thereafter asks a series of closed questions like: "North, I'm turning (turning)….? ... Have I changed my size? … Am I small? I was big facing this way, now am I small facing this way?" using gestures, different forms of questions, and informal mathematical language as language practices to describe procedures for rotating. Here, he is attempting to remind learners that even in 'rotation' the size does not change.

After a series of closed questions, Mr. Dubazana continues to describe the angle of rotation by saying: "If I say Mr. Dubazana turn 90 degrees to your right, Mr. Dubazana will turn this way, isn't it?" He thereafter makes another 90-degree rotation to the right which makes his turns a total of 180 degrees and asks, "he is facing now….?", using his gestures, and formal and informal mathematical language, describing the procedure for finding the size of rotation. When some of the learners respond incorrectly by saying "west" the teacher does not correct them, instead, he rotates 90 degrees anticlockwise facing the north and then asks saying "he isturning…?". It seems he uses the words "turning" (for the angle through which his body rotates) and "facing" (for the direction his body is facing) interchangeably but does not describe the difference in their meanings, building sign systems.

Mr. Dubazana continues to ask a series of closed questions while learners respond by a "yes" or "no," saying:

> *"Have I changed my size? ...Am I now big or small…I'm still the same person, isn't it?… Only that I've changed the direction I'm facing this way now, isn't it? Right…I can even turn this way, so that's why we call it a 'turn' alright".*

Here, the teacher is asking different forms of questions about the procedure for rotating when he uses gestures and informal mathematical language, turning and facing different directions. While asking these questions, he is facing the learners and thereafter turns 90 degrees clockwise, using gestures, different forms of questions, and formal and informal mathematical language as language practices. He is still attempting to show learners that there is no change of size or shape when doing the procedural action of rotating.

In Activity Nine, Mr. Dubazana refers the learners to Figure 5.6 and describes the direction of rotation saying, "you will be turning facing the other direction alright, like east, south, west, north, okay?" He is using gestures and informal mathematical language as language practices to describe the action of rotating, making learners aware of the change of the direction faced when using cardinal points, using sign systems.

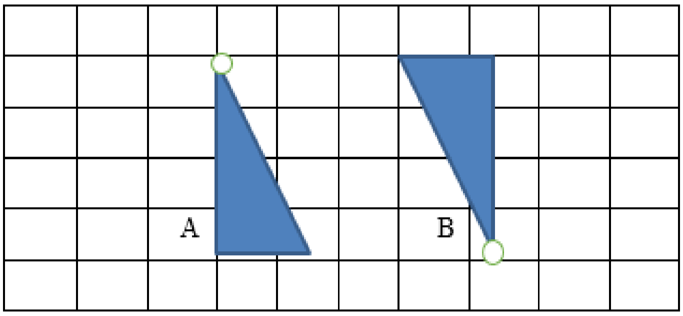


Figure 5.6: Rotation

When demonstrating using gestures, it appears that he is attempting to make the learners aware that in rotation, a figure (his body) turns around a fixed point of rotation and may be turned clockwise or anticlockwise. However, the grid (Figure 5.6) shows a composition of two isometric transformations, where there is a procedure for rotating and a procedure for translating displayed on the same grid. On the grid, the object is translated three squares horizontally and then rotated 180 degrees clockwise. Therefore, while attempting to build conceptual mathematical knowledge by doing the action of rotating through his gestures, formal and formal mathematical language, and images (building sign systems), he ends up sending different messages about the procedure for rotating to the learners.

In Activity Ten, Mr. Dubazana continues to describe the action of rotating, saying "when we are turning it, we turn following how the clock turns. The clock turns to your right every time". He turns his body clockwise, using gestures and learners' everyday context as language practices to give meaning to clockwise rotation, building sign systems and connections. He then asks learners to turn their bodies saying "everyone do this? To your right." He thereafter describes the meaning of the action of rotating saying "Right, that turn is known as clockwise. He is using gestures and formal and informal mathematical language as language practices,using the term 'clockwise' for the first time.

He thereafter continues his pattern of describing and asking closed and open-ended questions saying:

> *"Why do we call it clockwise…Who can tell us why do we call it clockwise? Yes?…You will never see a clock turning this way, isn't it?… It will always turn clockwise like this…So, if I am turning this way, I am turning clockwise this way…But if I go the other way around, opposite the clock face I will be turning anticlockwise. Anti….?"*

He is asking about the procedure for rotating clockwise and anticlockwise, using gestures, formal and informal mathematical language (building sign systems), and learners' everyday context (building connections) as language practices. While turning with the learners, some of them seem not to follow the instructions for the most part of the lesson.

Mr. Dubazana continues to ask learners open-ended questions by saying: "Why do we call it clockwise?" His question requires an explanation for giving a particular name for an action. He is using procedures, attempting to build conceptual mathematical knowledge for clockwise and anticlockwise rotation using formal and informal mathematical language, gestures, different forms of questions, and learners' everyday context.

In Activity Eleven, Mr. Dubazana describes the angle of rotation again saying, "it's either I'm turning in right angles" He then asks a closed question about the angle of rotation saying, "how many degrees is a right angle?" using gestures, formal mathematical language and previously learned mathematical concepts as language practices. When the learners don't respond he continues with a pattern of asking them closed questions while they turn in different directions,saying:

> *"Which direction are we facing?…I want you to turn 90 degrees clockwise…did you turn clockwise if you are facing east now?…face this side again, 90 degrees clockwise, turn into your right, towards your right hand as you are following the clock…Hee! some of you are copying from others and you are copying the wrong thing", "you are copying alright, thank you sit down class"*

Mr. Dubazana is continuously using formal mathematical language, gestures, and previously learned concepts to give meaning to the direction of rotation which are clockwise and anticlockwise directions.

This discussion of clockwise and anticlockwise took most of the lesson time (Activities 9 to 11). Throughout the entire process of describing, asking, and clarifying questions most of the learners are still quiet, some are turning in the wrong directions, while others are just copying from their classmates. After a series of descriptions, and open and closed-ended questions about 'clockwise' or 'anticlockwise' rotation, learners continue to give the teacher mixed responses. After raising a concern that they are copying from each other, Mr. Dubazana concludes by saying "And then when you are describing it you have to state the angle whether it's 90 degrees and tell us the direction whether it's 180 degrees alright". By direction here, he might mean 180 degrees 'clockwise' or 'anticlockwise'. He is using formal mathematical language and previously learned mathematical concepts as language practices and building sign systems. It should be noted that up to so far, Mr. Dubazana has not described the role of the dots that are in Figure 5.6 to the learners, though he has mentioned them. He does not tell learners which triangle represents the object, and which one represents the image on the grid though they are labelled in Figure 5.4. It is also not clear if his use of translation in Figure 5.7 is helping the learners understand the concept of the object and image in the concept of rotation or not.

When the learners seem to be struggling to follow the instructions of rotating clockwise and anticlockwise in Activity Twelve, Mr. Dubazana decides to clarify his question by using translation as an example. He refers learners to Figure 5.7, pasting two flashcard triangles with dots, using images as language practices but never explains why the dots are there.

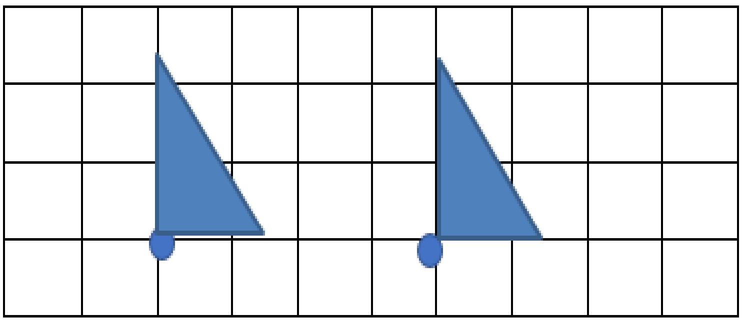


Figure 5.7: Horizontal translation with dots

He then gets into a pattern of describing while learners just respond with "yes" and "no sir," saying:

> *"Let me show you on a paper here…Here is my triangle. …Let me find out from you. Here is another triangle. Let me just put it like this…This shape, here is the dot…. This shape has moved from there to there."*

Mr. Dubazana thereafter asks a closed question saying, “What kind of a transformation is it?” When one learner responds, “it’s a slide” the teacher revoices and asks another open-ended question saying, “it’s a slide, what do we call a slide?” He is using images, formal and informal mathematical language, and previously learned concepts as language practices referring the learners to the dots in Figure 5.7, thus building sign systems. Without describing how he links the concept of translation and the questions about clockwise and anticlockwise rotation at this stage, Mr. Dubazana goes back to the concept of rotation in Activity Thirteen.

He refers the learners to Figure 5.8 and describes “There is another one. I don’t know whether it’s still a slide. There is the dot and then I put it like this,” He then asks a closed question, saying “Yes, what is it?” pasting the flashcard of the first triangle with a dot on the grid. Two blocks to the right he pastes another triangle that is rotated 90 degrees clockwise, using images as language practice.

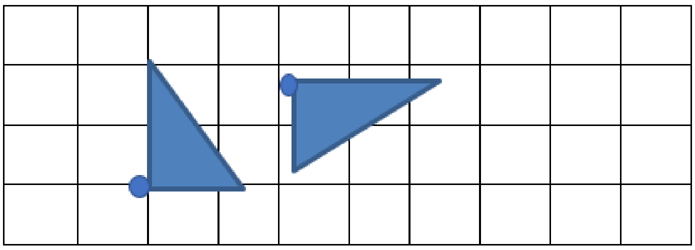


Figure 5.8: 90 Degrees translated rotation with dots

When learners say “rotation,” the teacher revoices saying “it’s a rotation. It has turned. Can you see that this shape has turned?” In this case, Mr. Dubazana is using images, revoicing, and formal and informal mathematical language as language practices, thus building sign systems. He further asks another closed question that relates to the angle of rotation saying, “How many degrees do you think it has turned?” After learners say, “90 degrees” the teacher further describes rotation saying, “if you look carefully, you will see a, if I can draw you will see some 90, 90 degrees being formed there alright?” He turns the triangle 90 degrees clockwise in Figure 5.8 on the grid, using images and formal mathematical language as language practices to give meaning to the direction and the angle of rotation, thus building sign systems. At this moment he does not mention ‘clockwise’ or ‘anticlockwise’ rotation.

When learners respond by saying “yes” he asks another closed question: “how did it turn? Did it turn clockwise or anticlockwise?” He is asking about the procedural action for rotating, using images and formal and informal mathematical language as language practices. This question requires learners to look at the dots in the object and the image so that they can determine the direction of rotation in

Figure 5.8. When learners say ‘clockwise’, the teacher revoices the answer “clockwise” and then describes the action again saying, “It has turned like this, isn’t it?”, using his gestures, rotating his body 90 degrees clockwise. It should be noted that when Mr. Dubazana uses his gestures to describe the action of rotating, he does not translate first ashe did on the grid in Figure 5.8. He also does not, as before, describe to learners that where heis standing is the ‘point of rotation.’

In Activities Eight, Nine, Ten, Eleven, and Thirteen (five activities), Mr. Dubazana is attempting to build procedural mathematical knowledge by describing the action of rotating. He is showing the angle of rotation and the direction of rotation to build the conceptual mathematical meaning of the mathematical concept of rotation. His use of language practices seems unhelpful to some learners as they are not able to respond correctly to his questions. His descriptions, while using language practices are incomplete because he still does not mention the fixed point of rotation to the learners. When using gestures, he rotates from a fixed point but when using images on the grid he shows composite transformation. He does not make learners aware that there is a composition of two isometric transformations in Figure 5.8. Figure 5.8 actually portrays a 90-degree clockwise rotation, and two units translations to the right and one unit upwards (in any order). Using a face-clock assumes that all learners have seen a face-clock before, whereas some learners may be using digital watches. He is using gestures, images, learners’ context, previously learned concepts, different forms of questions, revoicing, formal and informal mathematical language to give meaning to the concept of clockwise and anticlockwise rotation. When using these language practices to build mathematical knowledge, the other meanings that are being built are sign systems, connections, and politics.

5.5.5 Describing the action of reflecting, and the mirror image in the line of symmetry, equidistance, and reflectional symmetry (Activity 14)

Without establishing why learners are struggling to respond to clockwise and anticlockwise rotation questions, Mr. Dubazana moves to the description of the mathematical concept reflection. I have divided Activity Fourteen into different subsections (which are Activities 14.1 to 14.5) because of the different concepts the teacher focuses on when building mathematical knowledge on the concept of reflection. He describes the action of reflecting using images and gestures, focusing on concepts of symmetry (Activity 14.1 and Activity 14.4), flip (Activity 14.2), and equidistance (Activity 14.3 and Activity 14.5), thus building sign systems.

In Activity 14.1, Mr. Dubazana describes the concept of reflection by using the grid image in Figure

5.9, and says, “if I turn this one like this…there’s a line which is formed there” (14). He draws a vertical line one block away from the object and then pastes a reflected triangular shapeon the other side one block away from the line of symmetry so that there could be an image that reflects the object over a line of symmetry.

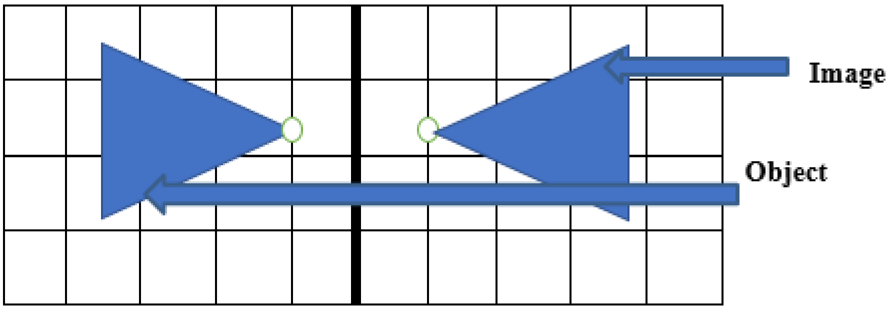


Figure 5.9: Reflection showing object and image.

He pastes the image in such a way that the dot of the image over the line of symmetry faces the dot of the object (Figure 5.9). In Figure 5.9, Mr. Dubazana draws an arrow pointing at the first triangle which is an object, and writes the word ‘object’ next to it. He then draws another arrow next to the second triangle which is an image and writes the word ‘image’ next to it without saying anything. His use of the informal word ‘turn’ suggests that he wants learners to see that an image has to change the direction faced when doing the action of reflecting.

After drawing the line of symmetry, he asks a closed question: “What do you think in mathematics, what do we call that line which makes a half and another half which is equal to this one?” Before learners say anything, he clarifies his question by reminding them that he once taught them about it. He says: “I remember teaching you this last year, yes?” pointing at the line of symmetry, the object, and the image on the grid in Figure 5.9, using previously learned mathematical concepts as language practices, thus building connections. As much as he is asking a question that requires the learners to recall the formal mathematical name for theline of reflection, his question seems not to be clear. Saying “a half and another half which is equal to….” may be literally interpreted by the learners as one half plus one half in fraction concepts.

After the learners have responded by saying “line of symmetry” the teacher revoices saying, “it is a line of symmetry, isn’t it and there is a line of symmetry which is formed there” pointing at Figure 5.9. Here, he is using formal mathematical language and previously learned mathematical concepts as language practices. The teacher further describes reflection by using an example of a mirror from learners' everyday context, saying, "So which means if this was an object, this will be an image when we put a mirror in between, isn't it", using learners' everyday context, thus building connections. He shows learners where the line of symmetry should be in Figure 5.9. He is using procedural mathematical knowledge to give the conceptual meaning of 'reflection' by differentiating between an object and an image. He does this by using images, learners' everyday concepts, formal mathematical language, and previously learned mathematical concepts as language practices.

In Activity 14.2, Mr. Dubazana refers the learners to Figure 5.9 and says: "Okay. This one is known as a reflection or a flip alright". He uses images and informal mathematical language 'flip' to give meaning to the mathematical concept of reflection. Thereafter, Mr. Dubazana gets into a pattern of describing, asking closed and open-ended questions, and also clarifying them, pasting a flashcard of a triangle on the reflected side of the line of symmetry in Figure 5.9 while learners are quiet, saying, "Why do they call it a flip? … When something flips it turns over like this isn't it? … Right, let me use my hands. Can you see that these hands are fitting one ontop of the other?" Through these questions, he is using informal mathematical language and gestures as language practices to give meaning to the mathematical concept reflection, thus building sign systems.

In Activity 14.3, Mr. Dubazana describes 'reflection' in Figure 5.9, saying: "like yourself when you stand up in front of a mirror, here is Mpho standing in front of the mirror in the morning and then she sees herself there". He is attempting to describe the conceptual meaning of reflection in relation to the object and the image using learners' everyday context and gestures as language practices. He thereafter uses images and gestures, asking a series of closed questions and giving descriptions before the learners even respond, saying: "What happens to her when she moves, what happens to that person who is that side when she moves away…That image will do exactly as she does, isn't it?…When she moves closer to the mirror?…It will move, isn't?" Here, Mr. Dubazana is using procedures, attempting to give conceptual meaning to equidistance, using images, learners' everyday context, and gestures as language practices. He is making learners aware that every point of the given object and the corresponding point of its image are equidistant from the line of symmetry whenever the action of reflecting takes place.

In Section 14.4 Mr. Dubazana continues with his pattern of asking and clarifying closed questions about reflection symmetry, while the learners are quiet, saying:

> *"Have you ever seen yourself in front of the mirror?… You are standing in front of the mirror and then you see your back?… You will never see your back, isn't it?… When we are reflecting you will see the image of yourself and the front, if you stand with your back towards the mirror, you will see the back will be towards your mirror isn't it?"*

Mr. Dubazana is attempting to build the conceptual meaning of 'reflection' by using learners' everyday context as a language practice. He is making learners aware that in the action of reflecting there is always a reversed image where the object has reflection symmetry. Mr. Dubazana thereafter goes back to the description of the line of symmetry by referring learners to the object in Figure 5.10 and says:

> *"here is the line of symmetry or a mirror line, we call it a mirror line. Here is a mirror, I put a mirror there. There is my shape. Okay this is a mirror line alright. Or let's say this is yourself standing in front of the mirror".*

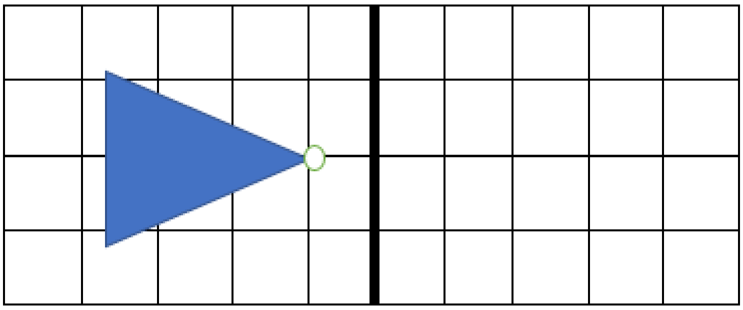


Figure 5.10: Line of symmetry with an object

Here, he is using images, formal mathematical language, learners' everyday context, and gestures to give meaning to the line of symmetry. He thereafter asks a closed question: "Who can come and put the image of that? Yes, come." He is attempting to help the learners see that the image faces the opposite side of the object over a mirror line when doing the action of reflecting, using images. When one learner shows the class where the image should be, showing 90 degrees rotation, the teacher asks another closed question saying, "do you think Baningi is correct?" When the learners say "no", he asks an open-ended question saying, "why do you think so so?". He is asking the learners to explain why they think Baningi's response is not the action of reflecting, using gestures and images as language practices, thus building sign systems.

One learner responds by saying "because he make the rotation". Mr. Dubazana decides to describe Baningi's response to the learners by saying: "now it's like Baningi is standing up infront of the mirror and now the image of Baningi is upside down, the head is down and...and the feet up." After his description he asks another closed question, saying, "Alright who can correct it?" One learner pastes the triangle with the dot on the other side of the line of symmetry facing the opposite side of the object in Figure 5.10. Mr. Dubazana describes further by saying:"Check carefully, check the dots carefully, good boy, correct isn't it, good thank you" referring them back to Figure 5.9.

In his description, Mr. Dubazana is using dots on the triangles to attempt to give meaning to the mathematical concept of reflection, looking at the relationship between the object and the image. However, he does not elaborate on why he says learners should check the dots. His description of using dots could have shown learners that the dots ended up facing each other after the change in the direction faced by an object. He also does not make learners aware that in both rotation and reflection, there must be a change in the direction faced by the object, and in reflection the image faces the opposite side of the object, hence the dots are facing each other in Figure 5.9. At this stage, he does not indicate the concept of equidistance though he demonstrates it on the grid. Mr. Dubazana also does not at this stage indicate that the line of symmetry or the mirror line can be in any direction.

In Section 14.5, Mr. Dubazana asks closed questions and clarifies them, pointing at the line of symmetry in Figure 5.10 while the learners are quiet, and says: "Right, what happened to this?...What happened there?...Let's say it's Keletso moving away about 1cm, let's say 5 centimeters away from the mirror line. Right, what will happen to the image?...Show us how many cm. Show us…" The teacher is directing the learners to the distance between the triangle that represents the object and the line of symmetry on the grid. While learners are quiet, he clarifies his question again by giving them a clue saying, "don't worry, just put it, estimate the distance, put it the other side", pointing at the other side of the line of symmetry, using images, previously learned mathematical concepts, gestures and formal mathematical language as language practices. He is attempting to describe the concept of equidistance by making learners aware that when doing the action of reflecting, the distance between the object and line of symmetry must be equal to the distance between the image and the line of symmetry.

After the teacher's clarification, one learner responds by saying: "changes the position of the shape." Without asking how the change of position happens, Mr. Dubazana adds to the learner's response saying: "somewhere there, isn't it? When you go closer it will come closer alright". He says this while pointing at the place where the image should be in Figure 5.10, using images as a language practice. His description is attempting to give meaning to the concept of equidistance. He thereafter continues with his description while learners respond with a "yes sir," saying: "Always it maintains the distance between the mirror and the image and the distance between the mirror and the object. Alright?", "Okay when you are describing this reflection you have to tell us the mirror line. You have to tell us what the mirror line is alright" using images as language practices.

Mr. Dubazana's emphasis on asking about measuring the distance suggests that he wants learners to use the distance between the object and the line of symmetry to determine the distance between the image and the line of symmetry. He is using procedural mathematical knowledge to give meaning to the concept of equidistance in reflection. At this stage in his description, he however does not use the mathematical concept line of reflection and equidistance. He also does not indicate that the mirror line can either be vertical or horizontal.Mr. Dubazana is using procedures to describe the action of reflecting, reflectional symmetry, and equidistance to give meaning to the concept of reflection. He is using images, gestures, formal and informal mathematical language (building sign systems) different forms of questions, previously learned mathematical concepts, and learners' everyday context (building connections) as language practices to give meaning to the mathematical concept reflection.

Mr. Dubazana is using procedural mathematical knowledge when attempting to give meaning to the concept of reflectional symmetry, using the object and the image. He is doing this by using images, gestures, previously learned mathematical concepts, different forms of questions, formal and informal mathematical language, and learners' everyday context as language practices.

5.5.6 Asking questions, using a task for learner pair work, focusing on identifying the properties of the isometric transformations (reflection, translation, and rotation) (Activity 15)

After describing the concept of reflection, Mr. Dubazana gives a task to learners that focuses on all three transformations and says: "for now in pairs, … Just write down quickly what do you think these transformations are," using images and formal mathematical language, thus building sign systems. He is asking closed questions that require learners to observe the action on the grid and recall the name of the isometric transformation represented in Figure 5.11 below.

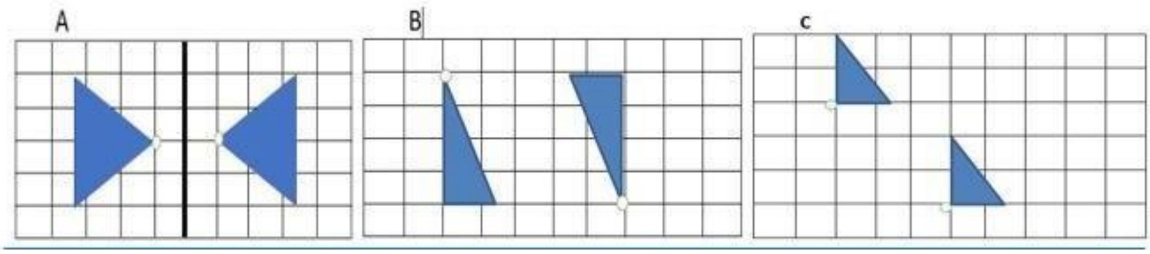


Figure 5.11: Task given to learners at the end of the lesson.

After the teacher has put the triangles on the grids on the chalkboard, he asks and clarifies closed questions while walking around in the class saying:

> *"Is it a rotation, is it a reflection, is it a translation, what are they?... There is the first one, there is the first one, I will call it A…Write down what A is. What is it? Is it reflection, is it a*

rotation or is it a translation?... Here is B. what is it?...don't draw just write the names…Here is C. What is C?"

Mr. Dubazana is building mathematical knowledge by asking questions that require learners to recall the procedures for reflecting, rotating, and translating and be able to justify their answers. He is using images, formal mathematical language, and different forms of questions as he asks questions that require learners to observe the action on the grid and recall the name of the isometric transformation represented in Figure 5.11, thus building sign systems.

5.5.7 Asking questions from the learners about the properties of the three different types of transformations (reflection, translation, and rotation), and they discuss while working in pairs/ groups (Activity 16 and 17)

When learners had finished writing, Mr. Dubazana then asks open-ended questions from the first group saying: "let's find out from few groups what do they, how do they do their work? What did you do? Speak up which one?" in his questions, it is not clear what he requires from the learners. Before learners respond, he asks: "speak up, which one?" It is still not clear how this question is connected to the first one. When learners say, "its reflection" he asks a closed question: "you say it is reflection and then B?" When one learner says "rotation" the teacher asks another closed question: "rotation uhuh?" He asks as if he is not sure about their answer.When another learner from the same group responds by saying: "translation," Mr. Dubazana decides to refer the learners back to Grid A in Figure 5.11, using images and formal mathematical language as language practices, thus building sign systems. He asks an open-ended question saying: "eheh, can you explain to us why did you say reflection, just explain A only. Why did you say it's a reflection?" referring to Figure 5.11, A. Here, he is using different forms of questions, formal mathematical language, and images as language practices to distinguish between the three isometric transformations.

When one learner says, "we made a mistake" referring to the answer 'reflection' for Grid A, Mr. Dubazana asks another closed question, basically leading the learner: "you made a mistake, but you said it's a reflection? Which is which, is, is this not correct?" using formal mathematical language and images as language practices. The teacher's question is attempting to remind the learners about the properties of reflection in Grid A, using images. When another learner says,"it's correct" the teacher revoices by saying "it's correct," affirming the learner's response by revoicing. He immediately goes back to his initial open-ended question saying: "Who can explain on her behalf? Why do we say this is a reflection?" still using formal mathematical language and images, referring to Grid A. His questions require learners to identify and explain the properties of reflection in Grid A.

One learner responds: “sir I say it is a reflection because it’s the same, it hasn’t changed the shape,” the teacher accepts the response saying “alright?” He then points at Grid B without indicating to the learners that all three isometric transformations are shape-preserving. When another learner says: “B is reflection”, he does not make the learner aware that the answer is incorrect, instead he probes for justification by asking an open-ended question: “why is it reflection?” using formal mathematical language. His question still requires the learners to distinguish between the three different isometric transformations on the given grids and building sign systems. When one learner says: “because it is like symmetry,” the bell rings. Mr. Dubazana does not ask any further questions instead he says: “ok our period is over, thank you very much, class. You will write that in your exercise books at home, not in groups.” Through the task in Figure 5.11, Mr. Dubazana is building conceptual mathematical knowledge of the three isometric transformations by focusing on the actions of reflecting, rotating, and translating, using images and formal mathematical language as language practices.

5.5.8 Summary of how Mr. Dubazana builds procedural and conceptual mathematical knowledge

This section focuses on how Mr. Dubazana created opportunities for the enablement of mathematical knowledge (procedural and conceptual). Mr. Dubazana follows a particular pattern when building mathematical knowledge about the three isometric transformations. His language practices work together, supporting each other to give procedural and conceptual meanings of the isometric transformations.

The first part of his lesson focuses on the meaning of the concept of transformation as well as the three types of transformations, using formal mathematical language. He first describes the meaning of the word ‘transformation’ by using decomposition, informal mathematical language in English language, and gestures as language practices, thus building sign systems. He also describes the conceptual meaning of the three isometric transformations ‘slide,’ ‘turn’and ‘flip’ but he does not call them such. Firstly, he uses informal mathematical language in English language and thereafter moves between formal and informal mathematical language, gestures, and images when describing the three isometric transformations, thus building politics and building sign systems.

The second part of his lesson focuses on describing the procedural action of these three isometric transformations. He starts with the procedural mathematical knowledge for ‘translations’ to give conceptual meaning to the concept translation. He describes the procedure for finding horizontal and vertical translations using images in the form of grids on the board, in the learners' books, and on the floor tiles, thus building sign systems. He uses triangles, sometimes with dots to describe the procedure for translating to describe the concept of translation. He also uses gestures as well as informal mathematical language in English language, which is 'up, down, left or right,' thus building sign systems and politics to describe procedures for finding horizontal and vertical translations, however, he does not name them assuch. At this point, he also does not make learners aware that every point of his body moves the same distance towards the same direction when translating. Here he is building sign systems and politics as he builds procedural mathematical knowledge to give meaning to mathematical concepts.

Mr. Dubazana uses formal mathematical language, clockwise and anticlockwise rotation, gestures, cardinal points, left-hand and right-hand sides, and images (grids with triangles) to give meaning to the direction of rotation, thus building sign systems. When introducing the angle of rotation, he describes the procedural action of rotating 90^0 and 180^0 towards different directions, linking gestures with cardinal points, as well as the right and left-hand directions. When he clarifies questions about the procedure for the action of clockwise and anticlockwise rotation, he supports its conceptual meaning by using gestures and the face clock from the learners' context. Here, he is building sign systems and connections to build conceptual meaning for rotation. There is however some slippage in his description of rotation when using images because his procedural actions show composite translations but when he uses gestures his actions show rotation from a fixed point. The learners sometimes respond incorrectly to his closed questions and clarifications about clockwise and anticlockwise rotation regardless of the time he spends clarifying.

Regarding the description of the concept of reflection, Mr. Dubazana focuses on the procedure for representing the line of symmetry, reflectional symmetry, and equidistance, but he does not name them as such. The procedures he describes, using different language practices show the actions for reflectional symmetry and equidistance. He supports the use of procedures by describing a mirror image, focusing on the line of symmetry and reflectional symmetry, using learners' everyday context, thus building connections. When describing equidistance, he describes the procedure for reflecting over a line of symmetry by using a mirror, referring the learners to the position of the object and the image using a grid with arrows and triangles and the mirror thus building sign systems and connections. He is building connections by using learners' everyday context and previously learned mathematical concepts to give conceptual meaning to reflectional symmetry.

Sometimes Mr. Dubazana facilitates the discussion of classwork by asking the learners to explain how they got their answers and to write their responses on the chalkboard. Though he uses various language practices, where he has an opportunity to get more explanation from the learners, he sometimes misses the opportunity by accepting 'yes sir' or 'no sir' or one-word answers. Sometimes he gives answers before the learners respond or he moves on without correcting learners when they have responded incorrectly. He describes, asks, and clarifies questions using English language, images, different forms of questions, formal and informal mathematical language, gestures, previously learned mathematical concepts, learners' everyday context, and revoicing as language practices.

5.6 MR. DUBAZANA'S REASONS FOR USING THE LANGUAGE PRACTICES HE CHOSE

In this section, I analyze why Mr. Dubazana said he chose to use the language practices he used when describing things and actions, asking informational questions, and clarifying questions based on Pozzi's (2004) language practices. As described in Section 3.2, I conducted two interviews, a reflective interview (POI) and a focus group interview (FGI) that took place after the lesson observation. The POI was an individual interview which was done immediately after the lesson, and the FGI was a focus group interview with all three teachers,which was done after I did an initial analysis of the lessons. To understand Mr. Dubazana's reasons for using language practices, I use Gee's (2005) seven building tasks to identify what meanings he is building in his talk about his language practices. It should be noted that in the interviews, Mr. Dubazana mentioned some of the language practices that he did not use in the classroom.

As presented in Sections 5.4 and 5.5, Mr. Dubazana used English language throughout the lesson, thus building politics. He only allowed learners to code-switch to Setswana during group work, building identity and relationships. Mr. Dubazana justified the use of English language, citing the following reasons: "… because mathematics assessment is in English" and that "…English will help them even in future" (Dubazana, POI, 12, 24). His first reason is related to the academic benefits of knowing English as well as social goods, which is English language as he indicates that it will help the learners in the future. He is building politics by giving more status to English language when building mathematical knowledge. He also indicated that he would rather speak simplified English, which may be informal mathematical language than use learners' home language as he says, "Sometimes you just have to find simple English language and use it……I use easy English, you see most of these children I believe they watch TV at home and they know some English, then I can use that" (Dubazana, POI, 18,20).

Though he allowed the learners to code-switch to Setswana when they were doing group work when differentiating between the three transformations, in the interview he justified why he preferred not to code-switch to the learners' home language. His justification was that "…why use the language that will not help the learners…. I could have easily responded in Zulu if I wanted to. But I want to communicate with them in English so that they get used to it" (Dubazana, FGI 6, 8). Here, he was building politics by giving less importance to the learners' home language, Setswana. He also adds another reason that is not related to the learners, saying "Anyway I am not that good in Setswana" (POI, 8). This reason suggests that English works as his comfort zone because he is not fluent in Setswana. Here he is also building politics by regarding English language as an easy language to communicate with.

Mr. Dubazana's reasons showed some tensions because, at some point, he justified the importance of the learners' home language when doing group work, saying "English can sometimes be difficult…it's not their language and they may not be able to say what they want to say and that may affect the group discussion in a negative way…their home languages are helpful…" (Dubazana, POI, 56). Here Mr. Dubazana is building politics by making the learners'home language more important than English language, citing that it makes mathematical knowledge easily accessible.

The tension in his reasons is evident when he cautions by saying: "but children are very clever if you always use their home language, they will get used to it …I cannot compromise… because they will easily get used to code-switching" (POI, 14). Here, the teacher is building politics by making Setswana not an important language for accessing mathematics even though at some point he was building politics by making Setswana important for accessing mathematics because English language can be difficult. Here, there is evidence of a dilemma of code-switching in Mr. Dubazana's use of language practices. His dilemma of code-switching suggests that he adopted a different language practice for the purpose of enabling effective mathematical Discourse within the groups to ensure mathematical understanding. This suggests that there are circumstances that make him build politics by giving more importance to the learners' home language.

Mr. Dubazana used other language practices to support the use of English language as a language practice, citing that the added language practices helped the learners understand mathematical concepts without resorting to their home language. For him, gestures helped as a non-verbal language practice as he says: "…that's why I was using my hand to show a flip…"(Dubazana, POI, 22). He further justified by saying:

> *"I don't have to speak Tswana for them to understand. I just used what they already know…I use body language…You saw how I explained rotation. I was rotating with them…Even if you can't speak English if I demonstrate or use my body language, you just get it, mh, no talk, no voice, just the doing…With that I believe no one can ever say sir I don't understand." (Dubazana, POI, 30, 44)".*

Mr. Dubazana is building sign systems by using images to enhance the understanding of the mathematical concept of reflection. He is also building politics by giving less status to the learners' home language. His reasons suggest that while other language practices are used to avoid speaking learners' home language and to encourage the use of English language, they also help with the building of mathematical knowledge.

The teacher justified his use of learners' everyday context by indicating that all learners knowit, saying: "…in fact, I even used the story of a mirror. They all know a mirror, I suppose. I go to their context." This suggests he aims to build connections by linking the mathematics in the classroom with what the learners already use at home. Mr. Dubazana enabled the understandingof the direction and the size of rotation by using the example of the face-clock, which he assumed they already knew, as he says "…..I reminded them of the clock and how its arms rotate clockwise. … it was easy to explain the difference between clockwise and anticlockwise…" (Dubazana, POI, 46). With the use of the face clock, he was still attempting to build connections with the learners' context.

The teacher believed in the use of formal and informal mathematical language as he says: "…I believe that if I teach them correct mathematics using the correct mathematical language, theywill understand mathematics…. I explain the concept correctly and they understand, and this will help them even in future" (Dubazana, POI, 24). Formal mathematical language, therefore, became one of his key language practices in his entire lesson because he believed that for learners to do well in mathematics, they need to know formal mathematical language.

5.7 CONCLUSION

When building mathematical knowledge, Mr. Dubazana used language functions in conjunction with language practices in English language to build conceptual and procedural mathematical knowledge. He used different language practices in an intertwined and interchangeable manner to describe mathematical action to build conceptual mathematical meanings. At some point, hemissed some opportunities to enable mathematical Discourse because of the choice of language practices or because of the mathematical description he gave or displayed when using a particular language practice.

Mr. Dubazana chose specific language practices in his teaching to ensure learners' comprehension of formal mathematical concepts and procedures. He emphasized the necessity of English proficiency, as textbooks and assessments are in English, and aimed at learners to grasp mathematics in the LoLT independently. To prevent code-switching to Setswana, he used'simple' English, supplemented by gestures and images. His decision was based on the assumption that learners, living in townships with access to television, were familiar with basic English. His method, similar to Mr. Ndlela's, prioritized English to foster the development of mathematical discourse, using terms like 'slide,' 'turn,' and 'flip' to describe translation, rotation, and reflection, respectively.

Mr. Dubazana justified the use of gestures and images as aids in explaining both informal and formal mathematical language in English, building conceptual understanding. Through these methods, he built sign systems, particularly in elucidating the procedural mathematical knowledge related to isometric transformations. By using learners' everyday contexts and previously learned mathematical concepts, Mr. Dubazana aimed to build connections between new and existing knowledge, thereby fostering procedural and conceptual understanding. Notably, he avoided code-switching to Setswana, considering it a compromise, and instead prioritized English language. However, he permitted the use of Setswana during group work to promote fruitful discussions and understanding of mathematical concepts, thus building identity and relationships. Mr. Dubazana explained his use of formal mathematical language by indicating that it gives learners a good mathematical background that helps them cope with mathematics even in the future. In Gee's (2011) terms, the teacher was building sign systems by making formal mathematical language important in the development of mathematical Discourse.

CHAPTER 6: LANGUAGE PRACTICES OF MR. ZIKODE

6.1 INTRODUCTION

In this chapter, I focus on the analysis of Mr. Zikode's lesson on the concept of proper fractions, represented using decimal notation. I first focus on how this topic is described in the CAPS (Section 6.2). I then briefly describe how Mr. Zikode builds activities, in Gee's (2005) terms (Section 6.3), thus orienting the reader to the lesson's structure. I further look at the language functions from Pozzi (2004) and how Mr. Zikode uses language practices to perform these language functions (Section 6.4). In this section, I also describe Gee's (2005) building tasks that emerge when Mr. Zikode uses these language practices. I then describe, in particular, how Mr. Zikode creates opportunities for knowledge in relation to the development of procedural and conceptual mathematical Discourse (Section 6.5). Lastly, I present the reasons why he usedthose particular language practices (Section 6.6).

6.2 PROPER FRACTIONS IN GRADE SIX IN CURRICULUM AND ASSESSMENT POLICY STATEMENT (CAPS)

Mr. Zikode's lesson as a whole was on the description of proper fractions using different representations, moving from diagrammatic representation to common fraction notation, and decimal notation. The focus was specifically on the concept of positive fractions smaller than one, focusing particularly on the part-whole concept of proper fractions. Thereafter the focus moved to the addition and subtraction of these proper fractions in decimal notation, up to two decimal places.

This topic can be located in the curriculum content section: Numbers, Operations, and Relationships. The CAPS document stipulates that the range of numbers developed by the end of the Intermediate Phase (Grade 6) should be at least 9-digit whole numbers (DBE, 2011). Proper fractions should be represented to at least two decimal places as common fraction notation and as percentages. The document also indicates that when working with proper fractions in this grade, learners should convert between the tenths and hundredths, represented in common fraction notation, and decimal notation, to two decimal places. Learners are expected to do addition and subtraction calculations with proper fractions in decimal notation, to at least two decimal places. It requires learners to recognize the equivalence between proper fractions represented in common fraction notation and decimal notation. Learners must be able to order decimal fractions and proper fractions by counting forwards and backward, using decimal notation to at least two decimal places. The document highlights that attention needs to be focused on “understanding the concept of place value so that the learners may develop a sense of large numbers and decimal fractions” (DBE, 2011, p. 9). This requires understanding the concept of place value in decimals, Learners can use the place value notation column method in a table for these calculations (as they do with whole numbers).

6.3 MR ZIKODE’S LESSON ON ADDITION AND SUBTRACTION OF DECIMAL FRACTIONS

This was a grade six lesson observed at an informal settlement school. Although the teacher-learner ratio is 1: 40 in Gauteng schools, many informal settlement schools are overcrowded because of the high level of influx from other provinces and countries, and in this class, there were 50 learners. All learners were learning Setswana as their home language,but the official language of teaching and learning at the school was English. They were taught mathematics by Mr. Zikode, an immigrant teacher from Zimbabwe, whose home language was isiNdebele. This was a double period, each period being forty minutes long.

The previous lesson was on the concept of common fractions. Also, the concept of place value for whole numbers had already been taught. Columns One to Three of Table 6.1 is a summary of the activities that Mr. Zikode built in his lesson. The detailed analysis of the activities summarized in Columns Four to Six is presented in Sections 6.4 and 6.5. Similarly, to Mr. Dubazana, for most of these activities (Activities 1 to 19), Mr. Zikode stood in front of the class while all the learners were seated to face the front. He only moved from this position to facilitate small group work in Activity One.

Table 6.1: Mathematics taught throughout Mr. Zikode's lesson.

MR. ZIKODE: LESSON ON THE CONCEPT OF PROPER FRACTIONS, REPRESENTED USING DECIMAL FRACTIONS.					
Activities	**Utterances** (With Episodes used in Section 6.4)	**Language functions (Pozzi, 2004)**	**Language practices**	**Building tasks (Gee, 2005)**	**Mathematical Discourse**
1	1	Describing the topic of addition andsubtraction of proper fractions in decimal notation as an introduction of his lesson.	English language	Politics	
2	2 to 53	Asking questions using mental mathematics, focusing on two-digit and three-digit open-number sentences.	English language	Politics	Procedural
3	54 to 70 Figure 6.1 (Episode 1: Utterances 54 to 69)	Describing the concept of hundredths in a proper fraction, using 100-square diagram notation.	English language Formal mathematical language Images Revoicing Different forms of questions	Politics Knowledge	
4	71 to 78 Figure 6.2 (Episode 1: Utterance70 to78)	Describing the concept of tenths in a proper fraction, using 10-square diagram notation.	English language Formal mathematical language Images Revoicing	Politics Knowledge Sign system	Procedural Conceptual
5	79 to 89 Figure 6.3	Describing the concept of tenths in a proper fraction is represented using 10-square diagram notation, common fraction notation, and decimal notation, while learners work in pairs.			
6	90 to 95 Figure 6.3 (Episode 2: Utterances 90 to 95)	Describing the concept of proper fractions,using formal mathematical language for decimal and common fraction notations.			Procedural Conceptual

7	96 to 115 Figure 6. 3 (Episode 2: Utterances 96 to 98)	Describing a proper fraction represented using a 10-square diagram and common fraction notation.			
8	116 to 157 Figure 6. 4 (Episode 3: utterances 116 to 133) (Episode 4: utterances 156 to 157)	Describing a proper fraction represented using a 100-square diagram and common fraction notation.		Politics Knowledge Sign system	
9	158 to 199 Figures 6.1, 6.2, 6.4 (Episode 4: utterances 158 to 166) (Episode 5: utterances 194 to 199).	Describing the equivalence in the concepts of tenths and hundredths in a proper fraction, moving from common fraction notation to decimal notation, using formal mathematical language for proper fractions.	English language Formal mathematical language Images Revoicing Different forms of questions		
10	200 to 210 Figure 6.4 (Episode 5: utterances 200 to 210)	Describing the concept of place value using the place value headings: 'units', 'tenths', and 'hundredths' on top of the digits of the decimal notation.			Procedural Conceptual
11	211 to 216 Figure 6.5 (Episode 5: utterances 211 to 216)	Describing the concept of place value using the place value notation columns in a table to describe the concepts of units, tenths, and 'hundredths' with headings named units, tenths, hundredths, and thousandths.		Politics Knowledge Sign system	
12	217 to 263 Figure 6.1	Describing the equivalence of the concept of hundredths, moving from a 100-square			

	Figure 6.6 (Episode 5: utterance 217 to 228)	diagram to common fractions and decimal notations.	English language Formal mathematical language Images Revoicing Different forms of questions		
13	264 to 289 Figure 6.5 (Episode 6 (Episode 6: utterances 264 to 266) (Episode 7: utterances 282 to 289)	Describing the concept of expanded decimal notation of proper fractions focusing on place value			Procedural Conceptual
14	290 to 299 Figure 6.5 (Episode 7: utterances 290 to 299)	Describing the action of expanding decimal fractions using the place value notation columns to describe the concepts of tenths and hundredths		Politics Knowledge Sign system	
15	300 to 310 Figure 6.5 (Episode 7: utterances 300	Asking questions through group work, focusing on the description of the action of horizontal and vertical addition of proper fractions in decimal notation, to two decimal places.	English language Formal mathematical language Images Revoicing		
16	311 to 328 Figure 6.5	Asking questions using tasks on the action of horizontal and vertical addition of proper fractions in decimal notation as feedback from the groups.		Politics Knowledge Sign system	Procedural Conceptual
17	329 to 349 Episode 9	Asking questions focusing on the action of adding and subtracting proper fractions in decimal notation, to two decimal places using individual work tasks.			
18	350 to 353	Clarifying questions while moving around the class and marking the learners' individual			

		work on the action of adding and subtracting of proper fractions indecimal notation, with two decimal places.			
19	354 to 359	Asking questions focusing on the action of adding and subtracting proper fractions in decimal notation, to two decimal places through the homework from the textbook.	English language Formal mathematical language	Politics Knowledge Sign system	

As shown in Table 6.1, at the beginning of the lesson, Mr. Zikode introduces the topic of addition and subtraction of proper fractions in decimal notation (Activity 1). In Activity Two, he gives mental mathematics to the learners. Learners are writing and marking mental mathematics, focusing on two-digit and three-digit open-number sentences.

Mr. Zikode then returns to the focus of the lesson in Activity Three, where he describes the concept of hundredths in a proper fraction, using 100-square diagram notation. Here he describes the part-whole concept of proper fractions focusing on the concepts of tenths and hundredths.

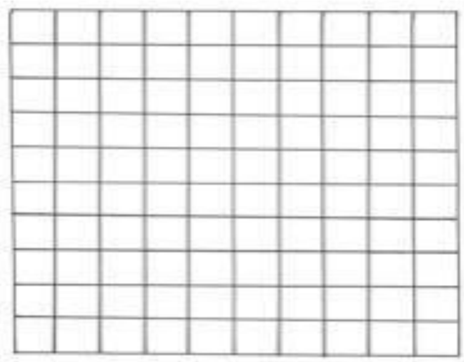


Figure 6.1: 100-square diagram

In Activity Four, Mr. Zikode describes the concept of tenths in a proper fraction, using 10-square diagram notation. Here he describes the part-whole concept of proper fractions, focusing on the concepts of tenths.

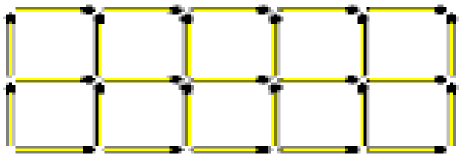


Figure 6.2: 10-square diagram

Mr. Zikode thereafter uses a 10-square diagram, common fraction notation, and decimal notation in Activity Five, to describe the concept of tenths in a proper fraction, organized in table form for comparison, while learners work in pairs (Figure 6.3).

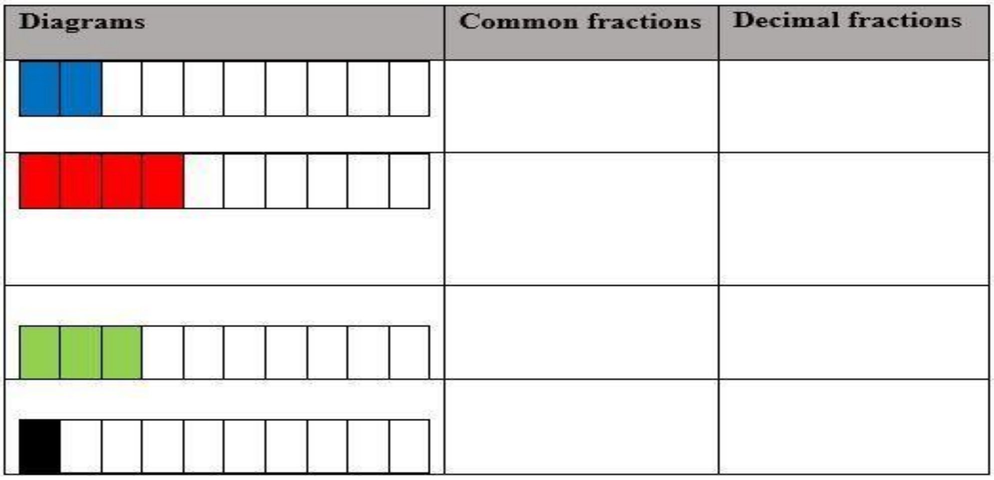


Figure 6.3: First pair task (Activity 7)

In Activities Six and Seven, he describes the concept of a proper fraction using Figure 6.3. He does this by moving between three representations: 10-square diagrams, common fraction notation, and decimal notation to one decimal place. He also describes the equivalence of the concept of tenths in a proper fraction represented using a 10-square diagram and common fraction notation. Next, in Activity Eight he describes the concept of hundredths in a proper fraction represented by using a 100-square diagram. Though there is a column for decimal fractions, here, the teacher only focuses on the equivalence between the diagram format and the common fraction notations (Figure 6.4).

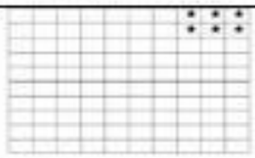
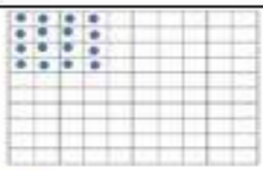
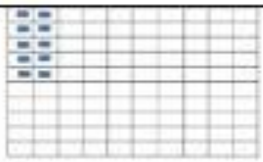
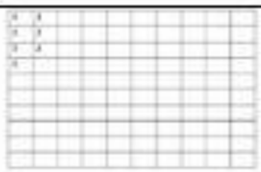
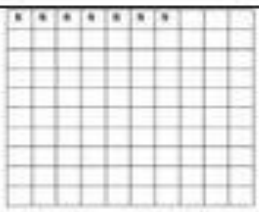
	Diagrams	Common fractions	Decimal fractions
a)			
b)			
c)			
d)			
e)			
f)			

Figure 6.4: Task on hundredths

In Activity Nine, Mr. Zikode describes the equivalence in the concepts of tenths and hundredths in a proper fraction, moving from common fraction notation to decimal notation. He presents a common fraction and expects the learners to write that fraction in decimal notation. For the tenths, he refers learners to Figure 6.2, and for the hundredths, he refers learners to Figures 6.1 and 6.4.

He then moves to the description of a place value in Activity Ten. Here, he describes the concept of place value using the place value headings: ‘units’, ‘tenths’, and ‘hundredths’ on top of the digits of the decimal notation. He refers the learners to Figure 6.4 when describing the concept of hundredths.

In Activity Eleven, the teacher describes the place value of digits by drawing the place value notation columns to describe the concepts of units, tenths, and 'hundredths' with headings named units, tenths, hundredths, and thousandths. Here he refers the learners to Figure 6.5.

Units	Tenths	Hundredths	Thousandths

Figure 6.5: Place value notation column for decimal fractions

He continues to describe the equivalence of the concept of hundredths, moving from fractions in diagram format to common fraction and decimal notations in Activity Twelve, referring the learners to Figures 6.1 and 6.6.

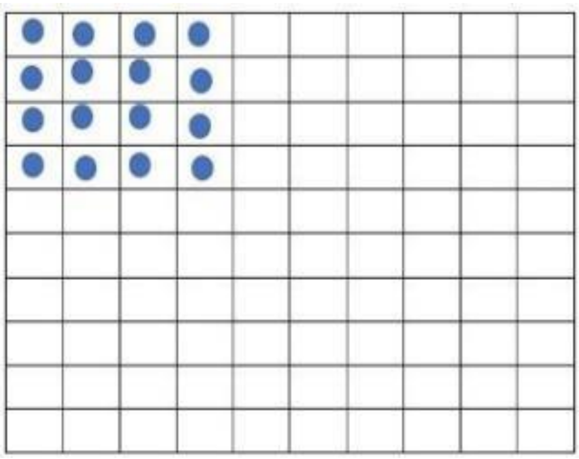


Figure 6.6: Sixteen hundredths

Then in Activity Thirteen, after focusing on the equivalence of the three representations for representing proper fractions, he decides to focus on the description of the representation of decimal expanded notation (for example 0,16 = 0,1 + 0,06) of proper fractions, referring to Figure 6.5). He describes the concept of place value using the place value notation column with units, tenths, and hundredths with headings named units, tenths, hundredths, and thousandths.

Next, in Activity Fourteen, Mr. Zikode continues to describe the action of expanding decimal fractions using the place value notation columns to describe the concepts of tenths and hundredths, referring learners to Figure 6.5. He thereafter moves to the action of adding and subtracting decimal fractions. He does this using a whole class input, but also small group work towards the end of the lesson. He describes the action of adding proper fractions using decimalexpanded notation and a place value notation column in a table in Figure 6.5.

In Activity Fifteen, the teacher gives group work, focusing on the description of the action of horizontal and vertical addition of proper fractions in decimal notation, to two decimal places,which requires a calculation of 0.53 + 0.43 and 0.15 + 0.04 (Activity 15).

Mr. Zikode asks for feedback on the group work task on the action of horizontal and vertical addition of proper fractions in decimal notation. He has a whole class discussion to give feedback after the group task while circulating among different groups (Activity 16). Here he is still referring learners to Figure 6.5.

He thereafter gives individual task which requires a calculation, (a) 1.06 + 0.4 and (b) 0.91– 0.1. The tasks focus on the action of horizontal and vertical addition and subtraction of proper fractions in decimal notation, to two decimal places from the textbook (Activity 17).

While the learners are writing, he moves around the class, marking the learners' individual work (Activity 18). Finally, he sets a similar task for homework (Activity 19).

6.4 MR. ZIKODE'S LANGUAGE PRACTICE

In this section, I look at Mr. Zikode's use of language practices and how he applied them in the activities listed in Section 4.3. Within the built activities in Table 6.1, I specifically focus on his use of these practices to perform each of the three language functions (Pozzi, 2004) when building the tasks named by Gee (2005) identities, relationships, connections, sign systems, and knowledge. I use evidence from the transcript of his lesson, to validate my argument, referring to Activities One to Nineteen in Table 6.1 (Columns 4 and 5). In each subsection that follows, I first present the transcript extracts and thereafter follow with my analysis thereof. These episodes have been selected because they are rich in demonstrating how Mr. Zikode used language for the three language functions across these activities. I give more details about building mathematical knowledge in Section 6.5 (Table 6.1, Column 6).

Regarding the use of language practices, I note first that Mr. Zikode predominantly uses English language in his whole class discussions. He uses isiZulu very minimally and Setswana only once (Activities 2, 10, 12, 15, and 17) and I discuss these latter instances in detail in Sections. 6.5 and 6.6. His predominant use of English language in these three language functions suggests that he is building politics, by giving less value to isiZulu and Setswana.

6.4.1 Description of things and actions

In this lesson, the 'things' I refer to, in Pozzi's (2004) terms, are the concepts of proper fractions, and the related concepts such as place value, tenths, hundredths, and thousandths. These are represented using a 10-square diagram or 100-square diagram, decimal notation, and common fraction notation. With regards to actions, in Pozzi's (2004) terms, I am referring to what Mr. Zikode did with the proper fractions, for instance adding or subtracting proper fractions in decimal notation. These 'things' and 'actions' featured in Mr. Zikode's descriptions (presented here), informational questions (Section 6.4.2), and clarification of questions (Section 6.4.3).

To support my argument about how Mr. Zikode describes things and actions in this section I focus on two selected episodes (Episodes 1 and 2). I provide evidence that, when describing things and actions in these episodes, Mr. Zikode uses English language, images, formal mathematical language, previously learned mathematical concepts, and revoicing to build the following meanings, which in Gee's (2011) terms are connections, sign systems and knowledge (Table 6.1, Columns 4 and 5). He also uses the language practice of formal mathematical language from the start and consistently.

Episode 1

Mr. Zikode describes decimal fractions using a 10-square and a 100-square diagram. He introduces the word 'part' e.g., 'out of 10 parts' (Activities 3 & 4)

54. Okay we want to talk about decimals, okay, we want to talk about this square first, you look at this big square first (pointing at a 100-square diagram: Figure 6.1 on the chalkboard) how many small squares do you see? How many? How many small squares are there? How many? Yes?

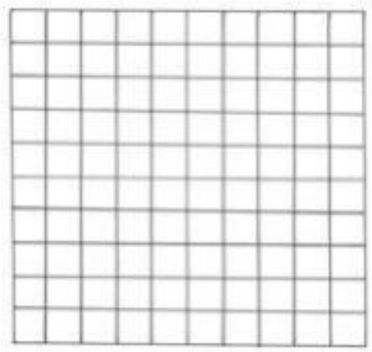


Figure 6.1: 100-square diagram

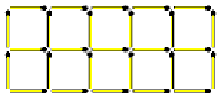


Figure 6.2: 10-square diagram

55. Learner: ten
56. Teachers: She says there are ten small squares that make up this big one, is it true?
57. Learners: Yes Sir.
58. Teacher: Are they ten?
59. Learners: Yes sir
60. Teacher: Thank you, lets count
61. Learners: 1…10….
62. Teacher: Why you stopping? I'm looking at this black square (pointing at Figure 6.1 with hundred squares). Okay how many squares are there? You said it's ten. Yebo (yes)?
63. Learner: A 100 squares
64. Teacher: How many are there?
65. Learners: A 100 squares
66. Teacher: How many?
67. Learners: A 100 squares
68. Teacher: Yes, there are 100 small squares. There are 100, one of these squares, hello? One of these squares represents that fraction, are we together?
69. Learner: Yes Sir.
70. Teacher: It represents one hundredth here. Let's look at this square, this one, with blocks, how many blocks are there? (Pointing at Figure 6.2). How many blocks are making up this square? How many?
71. Learner: ten
72. Teacher: There are?
73. Learners: ten
74. Teacher: ten, there are?
75. Learners: ten
76. Teacher: One of the blocks represents that fraction, are we together?
77. Learners: Yes sir.
78. Teacher: It represents one part out of ten parts, one part out of how many parts (also pointing at a 100-square diagram in Figure 6.1)?

Episode 2

Mr. Zikode describes formal mathematical language for proper fractions (Activity 9)

(When the learner responds by saying there are two shaded squares in the first task in Figure 6.3., the teacher further asks another question).

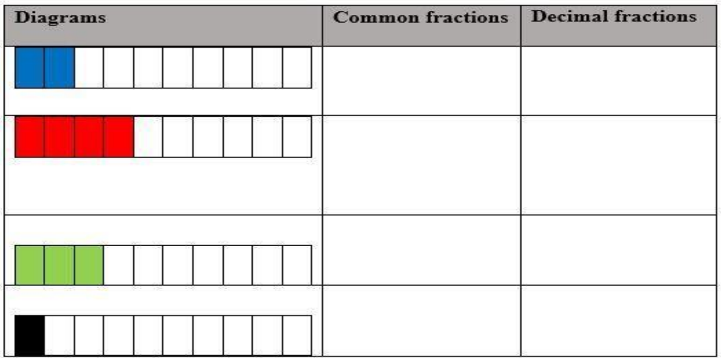


Figure 6.3: First pair task

90. Teacher: So, okay can we call that (referring to the first diagram in Figure 6.3) can we call that as a fraction, don’t say two only. We say….? Remember what we were doing last week?
91. Learner: zero comma two
92. Teacher: Okay, as fraction? Yes?
93. Learner: Two tenths
94. Teacher: Yes, is two….?
95. Learners: Tenths
96. Teacher: Yes, that is two-tenths. Okay. How many blocks are coloured red? (Referring to the second row in Figure 6.3) How many blocks are coloured red? How many? Yes?
97. Learner: Four
98. Teacher: Are they four? Let’s count…

Mr. Zikode uses formal mathematical language when he introduces his lesson as “decimal fractions.” He also describes the difference between the concepts of tenths and hundredths (Figures 6.1. and 6.2, Episodes 1 and 2) referring to them in formal mathematical language as“hundredths” (70, Episode1) and “tenths” (93, 95, 96, Episode 2). He also writes formal mathematical language “common fractions” and “decimal fractions” (Figures 6.3 and 6.4) in the tables used for the representation of proper fractions in different notations. By showing the action of converting the diagram format of fractions to common fraction notation, Mr. Zikode is building procedural mathematical knowledge by attempting to describe the equivalence of the concept of tenths and hundredths in the form of a proper fraction. The two examples of the concepts of tenths and hundredths of Mr. Zikode’s use of formal mathematical language shown here are typical of how he uses this language practice throughout the lesson.

In Episode One, Mr. Zikode uses the language practice of images to introduce the part-whole concept of proper fractions. Specifically, the images he uses for his description are in the form of a 10-square diagram and a 100-square diagram (54, Figures 6.4) to represent the concepts of tenths and hundredths respectively (62, Figure 6.3). When the learners are not sure about the total number of squares in the 100-square diagram (Figure 6.1, 56), he says "thank you, let's count" (60) referring them to Figure 6.1, using the action for finding a fraction in a diagram. He is building mathematical knowledge through sign systems by using 10-square and 100-square diagrams to describe the part-whole fraction concept. With his use of images in Figures 6.1, 6.2, and 6.3, he is building mathematical knowledge through sign systems to describe the procedure for differentiating between the tenths and hundredths in common fraction notations and to describe the equivalence of the three different representations as representing the same proper fraction.

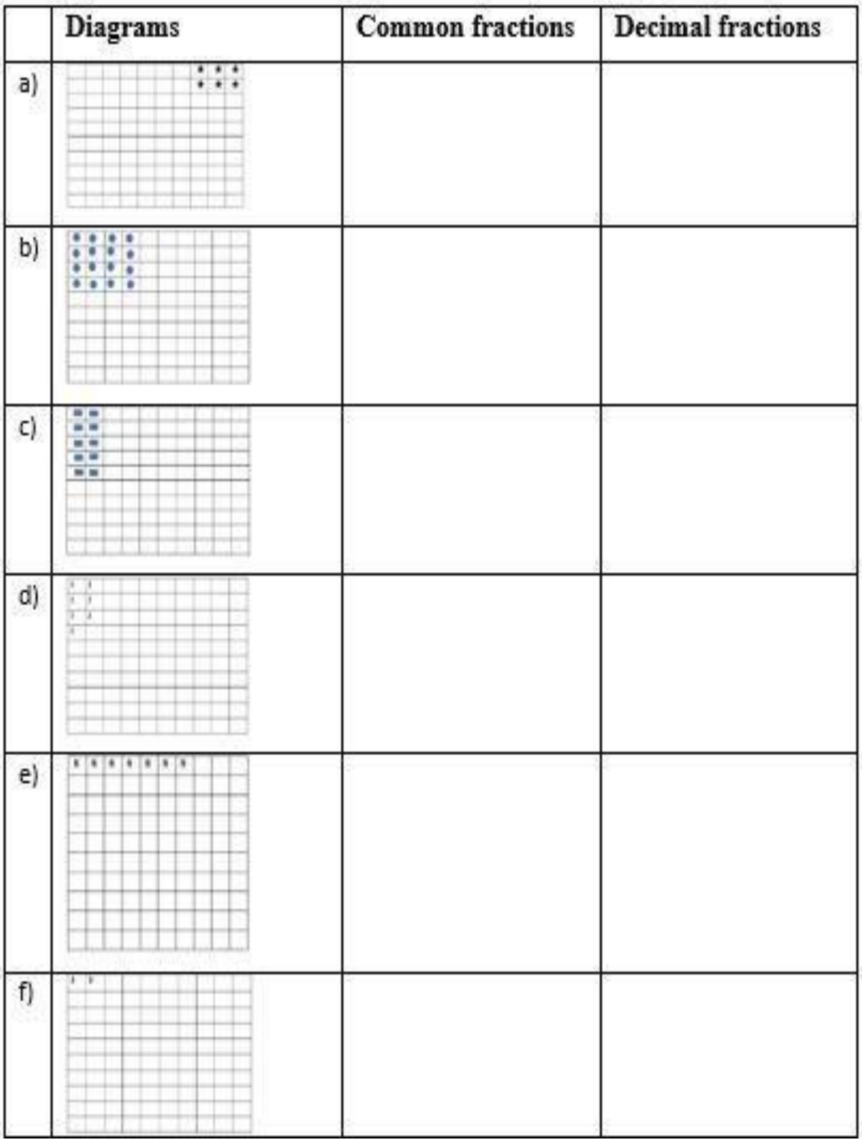
Mr. Zikode also uses previously learned mathematical concepts, specifically the concept of a part-whole fraction in diagram format and common fractions notation as language practices. Here he reminds learners about the action of representing proper fractions using diagram fraction format and common fraction notation, as he described in the previous lesson (90). In Activity Three, when referring to the diagrams in Figures 6.1 and 6.2, he says, "One of the blocks represents that fraction… one part out of 10 parts …and one part out of ….100 parts" (78 Episode 1). He is building mathematical knowledge by describing the concepts of tenths and hundredths, to give meaning to the concept of a part-whole fraction. He is also building connections with proper fractions represented using common fraction notation that was taught in the previous lesson.

6.4.2 Asking informational questions

In this section, I show how, when asking informational questions, Mr. Zikode uses English language, images, previously learned mathematical concepts**,** formal mathematical language, revoicing, code-switching, and different forms of questions to build the following meanings: politics, connections, sign systems, and knowledge (summarized in Columns 4 and 5, Table 6.1). For evidence of my argument, I focus on the five selected episodes, which are three, four, five, six, and nine, looking at how the teacher asks questions before or after he has described things and actions. I also draw on Episodes One and Two for additional evidence for my argument.

Episode 3

Describing the equivalence of the concept of hundredths in a proper fraction is represented using the 100-square diagram and common fraction notation (Activity 8).



	Diagrams	Common fractions	Decimal fractions
a)			
b)			
c)			
d)			
e)			
f)			

Figure 6.4: task on hundredths

116. Teacher: One tenth. Right, let’s move on to our big square now, how many, how many squares have black stars in them? How many? How many squares have black stars? Have stars…Relebogile?
117. Relebogile: Six.
118. Teacher: Six? As a fraction? Yes?
119. Relebogile: Six tenths
120. Teacher: Six tenth? she says… Six?
121. Learners: Six tenths.
122. Teacher: yeIshe says...... ? (Pointing at other learners)
123. Learner: six hundredths
124. Teacher: Yes, because there are a hundred parts altogether (pointing at the hundred-square diagram), so we say six …? (Writes $^{6}/_{100}$ on the board)
125. Learners: Six hundredths.
126. Teacher: Six Hundredths? How many squares have circles in them? Circles? (Pointing at the hundred-square diagram) How many? Quickly please. Circles? Yes?
127. Learner: Sixteen hundredths.

128. Teacher: Six…?
129. Learner: Sixteen
130. Teacher: Sixteen. Can we count?
131. Learner: 1…16
132. Teacher: Okay, so it's sixteen hundredths
133. Learners: Sixteen Hundredths

Episode 4

Describing the equivalence in the concept of tenths and hundredths in a proper fraction, moving from common fractions to notation for decimal fractions (Activity 9)

(The teacher is focusing on Figure 6.4 asking about the shaded squares in the sixth task)
156. Teacher: How many? (Referring to the sixth task in Figure 6.4)
157. Learners: Two Hundredths
158. Teacher: Two…hundredths, okay. We can write these fractions as decimals.
159. Learner: Yes, sir
160. Teacher: We can write these fractions, as what?
161. Learners: Decimals.
162. Teacher: No.1, who can write that as a decimal, someone to write that as a decimal? Yebo? Quickly… fast…fast…fast. Uzokhona ukh'bhala lapha ya? (*Will you be able to write here*, *yes*?) (Referring to the third column in Figure 6.3,

The teacher gives each learner who responds a chance to write an answer on the column of decimal fractions on the chalkboard)

163. Learner: Yes, sir. (Writes 0,2 on the board).
164. Teacher: Okay, is that correct?
165. Learners: Yes, sir.
166. Teacher: The next one?

Episode 5

Describing the equivalence in proper fractions using the headings named 'units', 'tenths' and 'hundredths' on top of the digits of the decimal notation (activities 9 to 12)

194. Teacher: Which one is correct then? (Looking at 0.16 and 0.06)
195. Learners: This one (pointing at 0.06)
196. Teacher: This one is correct? (Pointing at 0.06)
197. Learners: Yes, Sir (some learners are quiet).
198. Teacher: This one? (Pointing at 0.16)
199. Learners: Yes, sir (some learners are quiet).
200. Teacher: Okay, let me remind you, can someone write the heading here? The headings…? (Asks the learners to write headings on top of the digits in decimal fractions)
201. Learner: Yes, sir…
202. Teacher: Can you go and write the headings for that one, zero comma one?
203. Learner: Yiphi (*which one*), Sir
204. Teacher: Write the headings only. Units, Tens…
205. Learner: For yiphi, sir?
206. Ieacher: bhala i answer yakho ngale *(write your answer that side*) (pointing at zero comma one)
207. Learner: La? (*here*)
208. Teacher: yes, write the headings on top of the digits… (the learner writes tens instead of tenths) ses' bhala kanjalo manje (*is that how we write*)?
209. Learners: No, sir
210. Next Learner: (writes "tenth" on top of 0,1 on the board)
211. Teacher: okay these are just the tenth columns ne?
(The teacher shows them because they seem to be struggling, draws a table, and writes)

Tenths	Hundredths	Thousandths

212. Learner: yes (looking at the tenths column)
213. Teacher: and that's the hundredths, this one should be? (Pointing at the middle column)
214. Learner: hundredths…
215. Teacher: Thousandth's column…
216. Learner: Thousandth's column…
217. Teacher: okay? If this is our answer, if we, you are saying this is our answer and if you are saying that is the correct answer, it means you have that situation. Which one is the correct answer? How many parts are we having here, we said we have how many parts? (Pointing at the diagram with hundred squares, where sixteen parts are shaded)
218. Learners: Hundred
219. Teacher: How many?
220. Learners: Hundred.
221. Teacher: we said hundred?
222. Learners: … sixteen…
223. Teacher: out of how many?
224. Learners: hundred
225. Teacher: do we have thousandths? (Pointing at the diagram with hundred blocks, where sixteen parts are shaded)
226. Learners: No…
227. Teacher: do we have a thousandths column? Do we have that?
228. Learners: No, sir

When asking informational questions, Mr. Zikode uses different forms of questions as a language practice. In the lesson as a whole, all his questions are close-ended and most of themare about procedures. These close-ended questions come in different forms, where some are 'yes' or 'no' such as "do we have a thousandths column?" pointing at Figures 6.5 and 6.6 (227, Episode 5). This question requires the action of counting the number of squares so that the learners may decide what denominator is required for the decimal fraction 0.16. They also need to determine the number of decimal places for the decimal fraction 0.16 and decide if it requires a column for thousandths in a notation column table or not. Sometimes his closed questions require learners to complete his sentences. For instance, he asks, "Because there are a hundred parts altogether, " "o we say six …?" pointing at the 100-square diagram (124, Episode 3). He is building mathematical knowledge by asking a question that requires the action of counting the shaded squares and the total number of squares so that learners may determine the name of the represented proper fraction in a common fraction notation.

However, in Episode Six, when he gets to the addition, subtraction, and expanded notation of decimal fractions with two decimal places, he uses closed-ended questions that mainly focus on ’yes’ or ‘no’ answers. He mostly asks, “is that correct?” Sometimes he tells them that “it’s correct” and misses the opportunity to ask for justification from the learners (238 to 258).

Some of Mr. Zikode’s closed questions require an answer to the action of counting, for instance, when he asks, “how many blocks are coloured in black?” (114, Episode 3). His question requires an action of counting the squares in the 10-square diagram so that they may determine the name of the represented proper fraction in common fraction notation. Some of his questions require learners to do an action of representing proper fractions in an expanded decimal notation. For instance, he asks, “can someone expand this one? zero comma one…?” referring to the decimal fraction 0.16 (282, Episode 8). He is attempting to build mathematical knowledge by focusing on the action of counting the squares to determine the names of the represented decimal fractions.

In Episode Four, when asking informational questions, Mr. Zikode code-switches to IsiZulu. For example, he refers the learners to the first task in the third column of Figure 6.3 and asks a closed-ended question: “Number one, who can write that as a decimal, someone to write that as a decimal? Yebo? Quickly… fast…fast…fast. Uzokhona ukh’bhala lapha ya? (*Will you beable to write here, yes?*), pointing at the third column of Figure 6.3, showing the learners where to write the digits. His question requires the learner to represent the common fraction in decimal notation. He is attempting to build mathematical knowledge, aiming to represent the equivalence of the common fraction and decimal notation.

In Section 6.4,1 I have provided evidence that Mr. Zikode uses images in the form of 10-square (Figure 6.2) and 100-square diagram notation (Figure 6.2) to describe the concepts of tenths and hundredths. He also uses these images in his informational questions. For example, in Episode Three, he directs the learners to Figure 6.4, where each column is used for different representations, namely, 100-square diagram, common fraction notation, and decimal notation.Mr. Zikode thereafter asks a closed-ended question saying, “How many squares have circles in them?” (126), referring to a 100-square diagram where sixteen squares have circles in them. He is building mathematical knowledge, using the sign system as his question requires an action of counting the shaded squares in Figure 6.4. He is aiming to determine the common fraction notation that is equivalent to the given fraction in diagram format represented by the second task.

In Episode Four, Mr. Zikode refers the learners back to the 10-square diagrams in Figure 6.3, which is the first task where two squares are shaded blue. He asks a closed question saying, "Number one, …someone to write that as a decimal?" (162). The teacher is asking the learners to fill in the third column of the first task in Figure 6.3 by using diagrams in the first column as a point of departure. His question requires the action of counting the number of squares in a10-square diagram to determine the number of decimal places when representing the decimal notation in the third column. These two examples from Episodes Three and Four are evidence that he is using images in his informational questions, aiming to build mathematical knowledge through sign systems about the concept of hundredths in proper fractions. The images are representing the equivalence of the proper fractions represented using common fraction notation and decimal notation.

Mr. Zikode uses previously learned mathematical concepts, specifically, the concept of common fractions as a language practice when asking informational questions. In Episode Two he asks a closed-ended question requiring an answer to an action, saying "How many blocks are coloured blue?" referring to the first task in Figure 6.3. When the learner responds by saying "two" the teacher asks a closed question "can we call that as a fraction, don't say two only. We say….? Remember what we were doing last week" (90). His question requires the learners to represent proper fractions in common fractions notation, which was the focus of the previous lesson. It also requires an action of counting the shaded squares from a whole as he attempts to describe the difference between the whole number and a proper fraction (90 to 95, Figure 6.3). He is building connections with previously learned mathematical concepts. Heis attempting to build mathematical knowledge by using the part-whole fraction concept, giving meaning to the concept of equivalence in representations for proper fractions and diagram notation.

In line with his consistent use of formal mathematical language to describe the concepts and actions in this lesson as noted in Sections 6.3 and 6.4.1, Mr. Zikode uses this language practice consistently when asking informational questions, attempting to build mathematical knowledge. For example, in Episode Three when the learners respond to the first task in Figure 6.4 by saying "six" instead of 'six hundredths' in the second column, the teacher asks a closed-ended question by referring to the 100-square diagram with six stars in six squares. He revoices by saying "Six? As a fraction? Yes?" (118). He is building mathematical knowledge as his question requires the learners to use formal mathematical language for the proper fractions represented in common fractions notation. Through this question, he is building the conceptual mathematical knowledge of a denominator in common fraction notation.

In Episode Five Mr. Zikode uses formal mathematical language when introducing a place value notation column in a table for decimal notation. He refers the learners to a 100-square diagram with sixteen shaded squares (Figure 6.6) and asks a close-ended question “do we have thousandths? ….do we have a thousandths column?” (217). By using this formal mathematical language “thousandths,” Mr. Zikode is building mathematical knowledge, aiming to give meaning to the concept of the place value in decimal fractions. His questions attempt to show the difference between the concepts of tenths, hundredths, and thousandths in decimal notation.Towards the end of the lesson in Episode Nine, after giving learners a task about addition and subtraction of decimal fractions he asks a closed question saying, “what are we doing here… are we adding or subtracting?” (339 to 347). He is building mathematical knowledge, wanting the learners to differentiate between the addition sign and the subtraction sign.

Mr. Zikode also uses revoicing as a language practice when asking informational questions. He is either using this language practice to affirm the learners’ responses or as a point of departure to ask another question. In Episode One, he asks a question, saying, “we want to talk about this square first, you look at this big square first? How many small squares do you see? How many small squares are there?” showing them Figure 6.1 (54). After several attempts by the learners, one learner responds, “A 100 squares” (67), and Mr. Zikode revoices by saying “Yes,there are a 100 small squares”. He is affirming that Figure 6.1 is a 100-square diagram. In Episode Three, Mr. Zikode asks a close-ended question about the name of the represented fraction by task (a) in Figure 6.4. When the learner responds by saying “Six tenths” (119) instead of six hundredths, Mr. Zikode revoices the incorrect answer as a closed-ended question saying, “Six tenth? she says… Six?” (120). His revoicing is used to show the learners that the answer is incorrect, they still need to come up with the correct answer. In both examples, his revoicing is attempting to build the mathematical meaning of the concept of “hundredths.”

6.4.3 Clarification of questions

In this section, I show how, when clarifying questions, Mr. Zikode uses English language, previously learned mathematical concepts, images, code-switching, and formal mathematical language to build the following meanings: connections, identities, relationships, sign systems, and knowledge (summarized in Columns 4 and 5 in Table 6.1). The analysis in this section explores how the teacher attempts to make the questions clearer to the learners whenever he realizes that they do not understand the informational questions.

Mr. Zikode's clarification of questions happens in different ways and at different times. After asking a question, he clarifies it by describing a particular concept or action, by asking another closed question, by repeating it slowly, or by rephrasing it. Here I present the findings with evidence from some of the utterances selected in Episodes Two, Three, Five, Six, Seven, and Eight.

Episode 6

Describing the equivalence of the concept of hundredths, moving from a 100-square diagramto common fractions and decimal notations (Activity 12)

235.Teacher: can we move on now?
236.Learners: Yes
237.Teacher: this one as a decimal? (*Pointing at the diagram form representing ten hundredths*) Yes?
*238.*Learner: (*writes 10/100 = 0,10*)
239. Teacher: bhala bhala bhala (*write write write)*
240. Learner: writes on the board
241.Teacher: is that correct?
242.Learners: Yes, sir
243.Teacher: next one
244.Learners: SIR!! SIR!!
245.Teacher: the next one
246.Learners: SIR!!! SIR!!!
247. Learner: writes on the board (*writes 7/100 = 0,70)*
248. Learners: no sir, no sir 249.Teacher: it's wrong? 250.Learners: Yes, sir…. SIR!!! SIR!!!
251.Teacher: Come and correct, can you correct that?
252.Learner: (erases 0,70 and writes 0,7 on the board).
253.Learners: haaaaaa!!! ….. SIR!!! SIR!!!
254.Next Learner: (erases 0, 7 and writes 0,07 on the board)
255.Learners: YESS!!!!!
256.Teachers: Is that correct?
257.Learners: YES SIR!!
258.Teacher: right, next one?

Episode 7

Describing the concept of expanded decimal notation of proper fractions focusing on place value (Activity 13)

264. Teacher: now we want to move a step further, we want to expand. (Moving from focusing on converting from common fraction notation to decimal notation) When you're expanding, we want to show the value of each digit in a number, okay? What are we saying here? We are saying here we have zero comma.
265. Learners: two
266. Teacher: zero comma two, Okay? We can't expand that further, its fine as it is. This one as well is zero comma…?

Episode 8

Describing the concept of expanded notation (0,16 = 0,1 + 0,06) of proper decimal fractions focusing on place value (Activity 13 to 15)

282. Teacher: can someone expand this one? zero comma one…?
283. Learner: yes sir
284. Teacher: yes?
285. Learner: (tries to write 1 + …. on the board but gets stuck, other learners quickly raise their hands in order to help).
286. Teacher: is it correct?
287. Learners: no
288. Teacher: quickly please
289. Learner: (writes 0, and erases, she seems unsure as she keeps on writing and erasing, other learners raise their hands to help, others are laughing
290. Teacher: boys and girls we have zero comma, zero comma what? (Pointing at 0,16)
291. Learners: zero comma ten
292. Learner: sixteen?
293. Teacher: plus, zero comma zero six
294. Learners: yes
295. Teacher: plus, zero comma one?
296. Teacher: can we try to add that and check, zero comma one plus zero comma zero six, what is the answer? What is the answer? What is the answer?
297. Learner: zero comma sixteen
298. Teacher: 0 comma?
299. Learners: sixteen
300. Teacher: okay… I want us to do, in our books; I want us to do this. Can we quickly add this one in our books?

0,53 + 0,43

Episode 9

Asking questions using tasks onthe action of horizontal and vertical addition ofproper fractions in decimal notation as feedback from the groups (Activity 16)

(After the learners have written solutions for the *0,15 + 0,04; 0,53 + 0,43 and for* 1.–6 + 0.4) and 0.91 - 0.1,the teacher asks a series of questions).

339. Teacher: if you are through… if you are done with number one please I want to mark…
340. Teacher: Underline…
341. Learner: yes sir…
342. Teacher: what are we doing here… are we adding or subtracting?
343. Learner: we are adding…
344. Teacher: show that…
345. Learner: (corrects mistake by putting the addition sign with the notation column…)
346. Teacher: underline, underline, underline.
347. Learner: yes sir

Mr. Zikode uses previously learned mathematical concepts, specifically, the concept of place value from the previous lessons when clarifying questions. In Episode Five, when the learners are not able to respond to the teacher's closed question "which one is correct then?" between '0.16' and '0.06' for the common fraction notation $^{06}/_{100}$ in Figure 6.4, Mr. Zikode decides to clarify his question (194 to 199). He says "Okay, let me remind you, can someone write the heading here?" (200) referring to the headings for place value on top of the digits 0,16. When the learners struggle to put the place value headings on top of the digits in the decimal fraction, 0.16, he clarifies by asking the question differently, saying "Write the headings only units, tens…" (204). He mentions "units, tens," although he is referring to proper fractions in decimal notation (and not whole numbers). The words "let me remind you" suggest that they are reminded about the things they already know which are "Units, Tens" for whole numbers. Hisquestion is attempting to make the link to the previously learned concept which was the place value for whole numbers (204, Episode 5). He is building connections by using the place value notation column used for whole numbers to extend it for the representation of decimal notation.

I have already provided extensive evidence of how Mr. Zikode uses images in the form of a 10-square and a 100-square diagram (Figures 6.1 and 6.2) to ask informational questions as a language practice. He also uses these in his clarification of those informational questions. In this section I provide some evidence of this, but this time from Episode Five. Here, the teacher asks a closed question about the place value headings on top of the digits in 0.16 for the fifth time saying "yes, write the headings on top of the digits" (208). He asks a question in the form of an instruction, asking the learners to indicate the place values of the given digits. When the learners continue to struggle, Mr. Zikode decides to clarify his question by drawing a table of the place value notation column with place value headings showing the columns of units, tenths, hundredths, and thousandths (211, Figure 6.5).

Units	Tenths	Hundredths	Thousandths

Figure 6.5: Place value notation column for decimal fractions

He then decides to clarify his question again by referring to the diagram format in the second task in Figure 6.4. He points at the diagram with a hundred squares, where sixteen squares are shaded (Figure 6.6), and asks, "okay? If this is our answer, if we, you are saying this is our answer" pointing at $^{16}/100$, "how many parts are we having here, we said we have how many parts?" referring to the shaded squares (217). His closed question is focusing on the part-whole concept of proper fractions represented in diagram format. After the learners have responded by saying "sixteen" he asks another closed question requiring the action of counting the total number of squares in the 100-square diagram saying, "out of how many?" (223). When the learners say "hundred" he clarifies his question by asking another closed question saying, "do we have a thousandths column?" pointing at the 100-

square diagram (225, 227, Figure 6.6). His clarification is attempting to show that there is no digit under the column of 'thousandths' in Figure 6.5 for the common fraction "16/100" because the whole is not a 1000-square diagram. He is attempting to build mathematical knowledge for sign systems, using images to show the equivalence of the concept of hundredths, moving from a fraction in diagram notation to common fractions and decimal notations.

Mr. Zikode continues to use formal mathematical language as a language practice even when clarifying questions to the learners about expanded decimal notation, writing each digit according to its place value. He combines expanded notation with addition and subtraction. In Episode Eight he first asks a closed question: "can someone expand this one? zero comma one…?" (282) referring to 0.1. When the first learner responds by writing an incorrect answer, "1 +" on the chalkboard, attempting to add. Another learner keeps on writing and erasing, and Mr. Zikode intervenes. He clarifies his question by asking another closed-ended question, referring learners back to 0.16, saying "we have zero comma…, zero comma what?" pointing at 0,16 (290). The first learner responds by saying "zero comma ten" (291), and the second learner responds by completing the teacher's sentence by saying "sixteen" (292). Here Mr. Zikode is attempting to use formal mathematical language to clarify questions about expanded decimal fractions, though he was not successful because the learners named the decimal fractions as whole numbers. He is attempting to build mathematical knowledge about the placevalue of decimal fractions where he links the digits in decimal notation with the concepts of the tenths and hundredths.

I noted at the beginning of Section 6.4 that Mr. Zikode prioritizes English language as a language practice. However, he code-switches to IsiZulu and also allows the learners to use IsiZulu when he clarifies his questions about the place value of digits (202, Episode 5). He asks them a close-ended question in the form of an instruction, saying "Can you go and write the headings for that one, zero comma one?" referring to 0.1. When the learners need clarity on where to write 'tenths' they ask in isiZulu Saying "for yiphi? yiphi sir (*for which one*)" (203,205). Mr. Zikode also decides to clarify his question by responding in isiZulu (206), showing the learners the digits where they must write 'tenths', saying "bhala i answer yakho ngale (*write your answer that side*)" referring to the top of the digits in 0.1 (206). When one of the learners writes tens instead of tenths on top of the digit 1 in 0.1, he clarifies by asking another closed- ended question saying "ses' bhala kanjalo manje (*is that how we write now*?) (208)". He is allowing code-switching by directing learners where to write the place value in utterance 206, in utterance 208 he is asking for feedback, wanting to know if that's how the headings shouldbe written. He is building identity and relationships by speaking one of the languages the learners are familiar with at school and in the community, which is IsiZulu.

6.4.4. Summary of the language practices used

Though Mr. Zikode introduced his lesson as addition and subtraction of decimal fractions, most of his it mainly focuses on the description of the representations of the part-whole concept of proper fractions in decimal notation. Expanded notation of decimal fractions and addition and subtraction of decimal fractions comes minimally towards the end of the lesson. His pattern of describing the meaning of proper fractions involves using three representations, where he moves the representation of proper fractions smaller than one from diagrammatic form to common fractions notation and then to decimal notation. Mr. Zikode uses English language throughout, but very minimally code-switches to isiZulu and Setswana, when clarifying questions. When learners struggle to respond to his questions, he clarifies his questions by drawing from images, thus building conceptual meaning of decimal fractions, sometimes counting the squares together with the learners. His use of these language practices shows thathe is building procedural and conceptual mathematical knowledge.

In addition to English language, in his attempt to build mathematical knowledge, he uses formal mathematical language, revoicing, different forms of questions, previously learned mathematical concepts, different forms of questions, and images as language practices relatively consistently. Whenever learners seem to struggle, he goes back to the images to givemeaning to the decimal representations, focusing on the place value of digits.

He then focuses on the building of procedural knowledge for representing decimal fractions in expanded notation, using a place value column, and combining it with addition and subtraction. Towards the end of the lesson he asks for ‘yes’ or ‘no’ answers to check if learners are performing the correct operation and if their answers are accurate, without prompting for justification or employing images as he did earlier to deepen understanding.

As he uses these language practices, Mr. Zikode is building politics, making English language more important than the learners’ home language. Mr. Zikode and the learners use isiZulu when code-switching instead of Setswana, though this was a Setswana speaking class, giving more value to isiZulu than Setswana. He also builds a sign system by using images, attempting to enable conceptual understanding of decimal fractions. While building mathematical knowledgehe sometimes uses the previously learned mathematical concepts, thus building connections with the learners’ prior knowledge.

When learners respond to close-ended questions during groupwork feedback on behalf of the group, they mostly write the responses quietly on the board and the teacher just asks if the answer is correct or not. I give a more detailed exploration of such implications for mathematical knowledge in Section 6.5. His revoicing mostly happens after the learners have responded to his close-ended questions and it is done to affirm the answers and as a point of departure for another question.

6.4. MR. ZIKODE'S PROCEDURAL AND CONCEPTUAL MATHEMATICAL DISCOURSE

In this section, I look in further detail at the building task mathematical knowledge in the analysis, as identified first in Section 6.4. This involves exploring how Mr. Zikode creates opportunities for the development of procedural and conceptual mathematical knowledge when he describes things and actions, asks informational questions, and clarifies his questions as set out in the Analytical Framework (Table 2.1, Column 3).

Regarding the procedural mathematical Discourse, as set out in the Analytical Framework (Table2.1, Column 3) and the conceptual and procedural analytical tool (Appendix M), I focus on what and how the teacher describes how to perform a mathematical action, how he requires the learners to complete an action, how he asks for the answer to a calculation and how he requires that the learners memorize some of the rules. Regarding conceptual knowledge, as noted in Table 2.1, I look at how the teacher describes the meaning of mathematical concepts for understanding and communicating mathematical ideas, how he asks the learners to explain and justify why they used a particular action, and also how he encourages learners to compare, contrast and integrate related concepts.

While Section 6.4 is structured using Pozzi's functions, this section is structured according to the flow of the lesson. This structure brings into view how Mr. Zikode, in the lesson as a whole, attempts to build procedural and conceptual Discourse. I use the activities in Table 6.1 to structure the analysis in this section. For ease of reading, I have repeated the key figures already analyzed in Section 6.3.

6.5.1 Description of the concept of hundredths in a proper fraction, using 100-square diagram notation (Activity 3)

After marking their mental mathematics with the learners, Mr. Zikode directs the learners to a 100-square diagram (Figure 6.1) on the board. He points at the diagram and says, “Okay we want to talk about decimals, okay, we want to talk about this square first, you look at this big square first”, and then asks, “How many small squares do you see?” Here Mr. Zikode is expecting the learners to see that the 100-square-diagram which is ‘one whole’ is made up of a hundred small squares and thus this whole represents hundredths. He is attempting to build conceptual meaning for the concept of hundredths using images as a language practice.

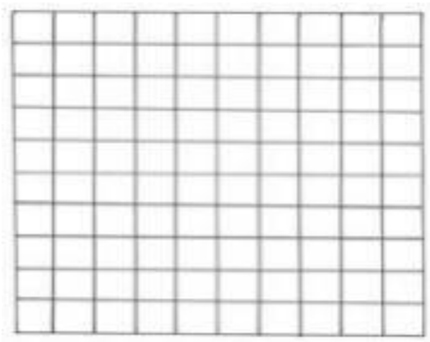


Figure 6.1: 100-square diagram

When the learners do not respond to his informational question about the total number of squares in Figure 6.1, he repeatedly asks and clarifies the question while the learners are quiet. He asks questions such as, “…How many small squares are there?…How many small squares are there?... How many?” The learners eventually give an incorrect answer saying “ten” instead of ‘one hundred.’ Mr. Zikode then asks another question, saying, “She says there are ten small squares that make up this big one, is it true?” He revoices the learners’ previous incorrect answer and asks another closed question again saying, “Is it true?” His question seems to require learners to confirm if the squares are ten or not. When the learners continue to give him the incorrect answer, Mr. Zikode decides to clarify his question by saying “Thank you, let’s count” pointing at the image in Figure 6.1.

When the learners keep quiet while he is still counting the squares in Figure 6.1 with them, he asks them another question saying, “Why you are stopping?” He is using different forms of questions, wanting the learners to use the action of counting the squares together with him so that they can find out that these are hundredths and not tenths. Through the action of counting the squares with the learners, using images, revoicing, and closed questions, he is attempting to build procedural knowledge so that they may be able to build the conceptual meaning of a ‘whole’ in the concept of hundredths.

After one learner has responded by saying “hundred squares,” Mr. Zikode points at the 100-square diagram (Figure 6.1) and revoices by saying “Yes there are a hundred small squares”. He further describes, saying “One of these squares represents that fraction, are we together…? It represents one hundredth here”, still pointing at one square out of one hundred squares in Figure 6.1, using formal mathematical language and images as language practices. Here he is giving conceptual meaning for the part-whole concept. He is also building procedural mathematical knowledge by using an action of counting the total number of squares in a ‘whole’ which is a 100-square diagram to build conceptual meanings for hundredths using images, different forms of questions, revoicing, and formal mathematical language as language practices.

6.5.2 Description of the concept of tenths in a proper fraction, using 10-square diagram notation (Activity 4)

Mr. Zikode then points at the 10-square diagram (Figure 6.2) on the board. He starts by asking a similar informational question to the previous step of counting the hundred squares, but this time about the image of a 10-square diagram saying, “How many blocks are making up this square?”

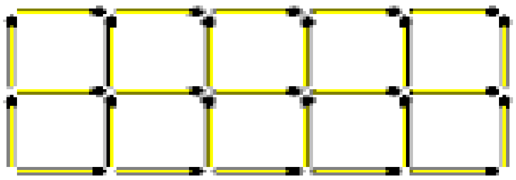


Figure 6.2: 10 square diagrams

He is asking for the answer to a closed question that requires the action of counting the squares in Figure 6.2, using images as a language practice. His question requires the learners to observe the 10-square diagram and count the total number of squares. Learners now give the correct answer immediately. Mr. Zikode then gets into a series of describing and asking questions, using images as language practices, saying: “One of the blocks represents that fraction, are we together? …It represents one part out of 10 parts … One part out of how many parts?” In his description of the part-whole concept of diagram fraction notation, he interchangeably uses the words “block” and “parts” for the squares in Figure 6.2, using images as a language practice. He is describing the conceptual meaning of one-tenth in diagram notation using images. His questions require the learners to count the total number of squares so that they determine whatthe ‘whole’ is and thus be able to indicate the common fraction represented by Figure 6.2.

Up to this point in the lesson Mr. Zikode is starting to develop the conceptual meaning of hundredths and then tenths by representing each, using the language practice of images in diagram notation. Specifically, he is building procedural mathematical knowledge by focusing on the action of counting the total number of squares in a ‘whole,’ which is 10-square and 100-square diagrams to gradually build conceptual meanings for tenths and hundredths. His description shows the difference between 10-square and 100-square diagrams thereby giving meaning to a ‘whole’ in a ‘part-whole’ concept using formal mathematical language, previously learned mathematical concepts, different forms of questions, revoicing, and images as language practices.

6.5.3 Describing the concept of tenths in a proper fraction represented in a 10-square diagram notation, common fraction notation, and decimal notation (Activities 5, 6, and 7)

After starting by describing the action of finding ‘one-tenth’ and ‘one-hundredth’ to support the learning of the concepts of tenths and hundredths using the 10-square and 100-square diagrams, Mr. Zikode links to other forms of representation, namely common fraction notationand decimal notation**.** To do this, he draws a table on the chalkboard with columns and differentheadings written ‘diagrams’, ‘common fractions’, and ‘decimal fractions’ as indicated in Figure 6.3. He asks learners to work in pairs.

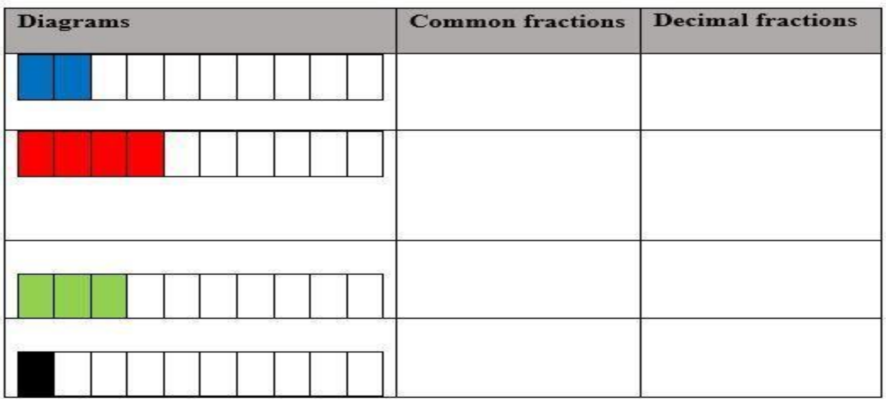


Figure 6.3: First pair task on tenths

Mr. Zikode then asks a closed question about the first task in Figure 6.3 saying “I want us quickly to note the fraction which is represented by blue, how many?” The first part of the question requires the learners to look at the number of shaded squares in a 10-square diagram and determine what the numerator is, as represented by “blue”. The second part requires the learners to perform the action of counting the number of shaded squares and the total number of squares in the same figure to indicate the name of the common fraction being represented. While the learners are still listening, he clarifies his question by asking it in a different way saying “On this one first, the colour blue, … how many blocks are coloured blue here? … Howmany blocks are coloured blue?…" using images and formal mathematical language aslanguage practices.

When the learner responds by saying “there are two” and writes ‘zero comma two’ on the board, Mr. Zikode asks another closed question saying “So, okay can we call that, can we call that as a fraction, don’t say two only. We say…?.” His question requires the learners to use formal mathematical language by naming the fraction represented in the diagram format as a common fraction. When he says, “can we call that a fraction” one learner says, “two tenths” and Mr. Zikode writes $^{2}/_{10}$ in the column of fraction notation in Figure 6.3. Thus, in this sequence, he gets the learners to count, focusing on the formal mathematical language for the concept of tenths. The learners respond by mentioning the numerator only and the teacher puts it together with the denominator to make meaning, that is, “two-tenths.” When the learner responds by saying “tenths,” he revoices to affirm by saying “Yes that is two tenths.” His revoicing is attempting to help learners think about “two” as ‘part of a whole,’ not as a ‘whole number.’ Thus, he is building conceptual meaning of verbal and written symbolic notation for common fractions by using diagram format of proper fractions using previously learned mathematical concepts, formal mathematical language, and images as language practices.

When getting to tasks two, three, and four in Figure 6.3, Mr. Zikode gives learners another opportunity to do the action of counting the squares in 10-square diagrams, name the fraction using formal mathematical language, and represent it in a common fraction notation. It is evident that he follows a general pattern as he proceeds through the rest of the tasks, using similar language practices. He adapts his practice as he assesses that learners are giving the necessary responses. The learners seem to have a sense of what is required when Mr. Zikode asks similar close-ended informational questions at the beginning of these tasks, which are “How many blocks are coloured red (Task 2), are coloured, green (Task 3) and are coloured black (Task four)” using images as a language practice. In all three tasks, as per the teacher’s questions, learners respond by naming the common fractions using formal mathematical language, instead of indicating the number of squares (as they initially did for Task 1). For task two the teacher revoices, and learners write a common fraction notation in the second column of Figure 6.3. They, however, do not write the common fraction notation for the third and fourth tasks after giving the formal mathematical language of these fractions.

Mr. Zikode is using procedural knowledge, by representing diagram fraction format in a common fraction notation, to give conceptual meaning to the representation of equivalence of part-whole concept of proper fractions, by using images, formal mathematical language, revoicing, and different forms of questions as language practices.

6.5.4 The concept of hundredths in a proper fraction represented using a 100-squarediagram and common fraction notation (Activity 8)

After describing the concept of the 'tenths,' Mr. Zikode moves to the concept of hundredths using images of 100-hundred square diagrams (Figure 6.4), before focusing on the column of decimal fractions in Figure 6.3. He draws the following table on the chalkboard:

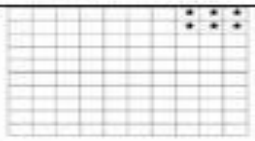
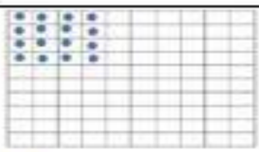
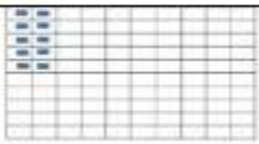
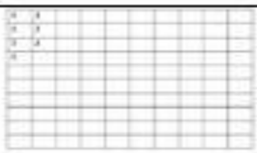
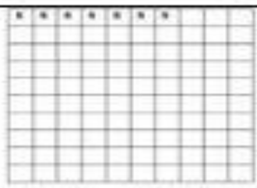
	Diagrams	Common fractions	Decimal fractions
a)			
b)			
c)			
d)			
e)			
f)			

Figure 6.4: Diagram for the task on hundredths

After writing the tasks as shown in Figure 6.4, Mr. Zikode asks: "Let's move on to our big square now, …how many squares have black stars in them?" He is using images as language practice, asking a closed question that requires the learners to look at the 100-square diagram as a 'whole' and count the number of shaded squares to determine what the numerator is. When the learners are quiet, he repeats the closed question by saying "How many squares have black stars?" When the learner responds by saying "six", Mr. Zikode asks another closed-ended question saying, "As a fraction?" He seems to be following the pattern he followed when building mathematical knowledge on the concept of tenths, using formal mathematical language. His question now requires the learners to count the number of shaded blocks and name the fraction by using formal mathematical language for common fractions, focusing on the concept of hundredths. When the learner says "six tenths" which is the incorrect answer, Mr. Zikode directs the question to another learner saying "yes? She says…?" His question is not clear as it sounds as if he wants the learners to repeat what the other learner has said. Other learners respond by saying "Six hundredths." Mr. Zikode revoices by affirming and justifies theanswer saying "Yes, because there are a hundred parts altogether" pointing at the first task in Figure 6.4, using formal mathematical language and images as language practices. When getting to Figure 6.4 Mr. Zikode still follows a general pattern as he proceeds through the rest of the tasks, using similar language practices as he did in Figure 6.3.

After his description Mr. Zikode repeats the question: "So we say six …?" writing $^{6/}100$ on the chalkboard under the column of common fraction notations, expecting the learners to completehis sentence by naming the denominator 'hundredths'. His description of the hundredths is different from his description of the tenths as he talks about "hundred parts altogether" where as he did not mention the total number of squares in a whole in Figure 6.3. When describing the tenths, he focuses more on the number of shaded squares than on the total number of squares in the diagram. The pattern that he follows is that the learners give the name of the common fraction verbally, and he does the writing in the correct notation in the second column of Figure 6.4.

Next, Mr. Zikode refers the learners to the second task in Figure 6.4 saying "How many squares have circles in them?" using images as a language practice. He is asking a question that requires learners to count the number of squares that represent a numerator. He describes the second task differently from the first one because here he only focuses on the number of shaded squares, which is the numerator. The learners seem to have grasped the pattern because instead of counting and indicating the number of shaded squares, they just give the formal mathematical name of that particular fraction, saying "Sixteen hundredths". Mr. Zikode also follows the same pattern of asking "can we count" referring to the shaded squares and writing the common fraction notation in the second column, which is $^{16}/_{100}$ in the second column, using images and formal mathematical language as language practices.

Mr. Zikode follows the same pattern of focusing on the numerator up to the sixth task in Figure 6.4. He uses closed questions that require the action of counting shaded squares saying, “how many.” Whenever he asks, “how many”, learners just give the formal mathematical name for that particular fraction. Regarding Figure 6.4, Mr. Zikode’s description is giving conceptual meaning of hundredths by using the action of counting the total number of squares in a 100-square diagram using images as a language practice. He is using procedural mathematical knowledge by the counting of squares to build the conceptual meaning of common fractions, using images, revoicing, formal mathematical language, different forms of questions, and previously learned mathematical concepts which are common fractions as language practices.

6.5.5 Description of decimal notation

6.5.5.1 Focus on tenths (Activity 9)

After focusing on the diagrams of squares and the common fractions in the tables (Figures 6.3 and 6.4), Mr. Zikode indicates to the learners that these fractions can also be represented in decimal notation, saying, “We can write these fractions as decimals” using formal mathematical language as a language practice. His description is making the learners aware of the concept of equivalence in representations for proper fractions, that in each task in the tables, the three representations, which are the diagram, common fraction notation, and decimal notation, represent the same proper fraction.

He firstly refers the learners back to the first task on the concept of tenths (Figure 6.3) and asks, “Number one, who can write that as a decimal, …?” using formal mathematical language as a language practice. Through this closed question, he is building the concept of equivalence in representations of common fraction notation and decimal notation in proper fractions. The teacher gives each learner who responds a chance to write an answer in the column of decimal notations on the chalkboard (Figure 6.3). After the learner has written “0.2” in the third column, next to $^{2}/_{10}$, Mr. Zikode asks another closed question saying “Okay, is that correct?” His question requires learners to remember that zero comma two has one decimal place and how it should be represented in a decimal notation of a 10-square diagram with two shaded squares.

In the second, third, and fourth tasks that follow (Figure 6.3), Mr. Zikode follows the pattern he started in the first task. He says, “next”? pointing at the common fraction notation in the second column. Learners respond each time by writing the decimal notation in the third column. He either asks a yes/no closed question: "is it correct?" or he says, "thank you, the next one." He asks closed questions in the form of instructions. Even when the learners give the incorrect answer "0.04" for the common fraction $^{4}/_{10}$, he accepts the answer and says, "Thank you, and the next?" He is attempting to build conceptual mathematical knowledge, by using procedural knowledge so that learners may see the equivalence in proper fractions in part-whole concept represented in three different proper fraction notations in Figure 6.3. He is using images, revoicing, different forms of closed questions, and formal mathematical language as language practices.

6.5.5.2 Focus on hundredths (Activity 9)

Next, Mr. Zikode moves to the first task in Figure 6.4, which is a decimal notation column focusing on hundredths, and says "…you're going to write the next one." He asks a closed question that sounds like an instruction, pointing at the common fraction notation $^{6}/_{100}$ on the board (Figure 6.4). When the learner responds by writing 0.06 for $^{6}/_{100}$ on the chalkboard, the teacher then asks the class: "Is that correct?" His yes/no closed question requires the learners to indicate the equivalence between the common fraction notation $^{6}/_{100}$ and the decimal notation 0.06, focusing on the concept of hundredths. He is following the same pattern of asking questions that are similar to the ones he asked when asking informational questions in the task in Figure 6.3. However, in this instance, the learners do not just respond with 'yes' or 'no' responses. This time they disagree with each other, where for $^{6}/_{100}$, one learner writes 0.06 and the other one writes 0.16.

When some of the learners agree and others disagree with each other regarding 0.16 for the common fraction notation $^{6}/_{100}$, Mr. Zikode follows a pattern, asking which one is correct between the two representations of common fraction notations, 0.06 and 0.16. He asked: "Is it wrong? ... Is it correct? I want you to show us your answer here" (4) "is it correct? … Which one is correct then?" When one learner says the answer is 0.06, he asks a closed question "This one is correct?" pointing at 0.06, some learners say yes. He asks again saying "This one is correct?" pointing at 0.16, other learners also say "yes".

6.5.5.3 Introduction of the place value notation headings (Activities 10, 11 and 12)

When the learners seem not to be sure which answer is correct between 0.16 and 0.06, Mr. Zikode decides to clarify his question by asking the learners to write place value notation headings at the top of the digits in 0.16. He asks informational questions repeatedly, one after another, while learners struggle to respond. When the learners are quiet, he says, “Okay, let me remind you, can someone write the heading here? The headings…?” pointing at the top of the digits, using images as a language practice. He focuses on place value, using the word ‘headings’ for place value notation to build place value concepts. But when he says “headings” the learners seem not to know what he means.

When Mr. Zikode decides to clarify his question by giving them a clue, saying “…Units, Tens…” using the previously learned concepts as a language practice, one learner writes “tens” instead of tenths on top of digit ‘one’ in zero comma one. Then the teacher asks in isiZulu: “ses’ bhala kanjalo manje (is that how we write now).” He is using code-switching as a language practice, referring to the concept of place value learned from the previous lessons. When the learner writes “tenth” on top of zero comma one on the board, which is the correct answer, Mr. Zikode revoices by saying, “okay these are just the tenth columns neh,” pointing at the digit ‘1’ in zero comma one. By putting headings on top of the digits, Mr. Zikode is attempting to build conceptual meaning, relating tenths to place value in decimal fractions using images, formal mathematical language, and different forms of questions as language practices.

Mr. Zikode continues with his description of the concept of place value by drawing the place value notation table (Figure 6.5). Here he is using an image to show where the column for ‘tenths’ is. He adds the column for ‘hundredths’ and says, “and that’s the hundredths,” using formal mathematical language. He then adds another column for thousandths and asks, “this one should be…?” (Figure 6.5). The teacher’s question requires the learners to indicate the formal mathematical terminology for place value that comes after the ‘hundredths’, which is ‘thousandths’.

Units	Tenths	Hundredths	Thousandths

Figure 6.5: Place value notation column for decimal fractions

The learner gives the incorrect answer for the next column that comes after the hundredth’s column saying “hundredths” instead of ‘thousandths’. Mr. Zikode then decides to tell them that it is “thousandths column,” again using formal mathematical language.

Next, Mr. Zikode refers the learners back to $^{16}/_{100}$, which is the second task in Figure 6.4, saying “okay?

If this is our answer, if we, you are saying this is our answer (pointing at $^{16}/_{100}$) … it means you have that situation", pointing at the place value notation column in Figure 6.5. He then goes back to his closed question again saying, "Which one is the correct answer?" pointing at 0.16 and 0.06 on the chalkboard, using formal mathematical language and images as language practices. His question requires the learners to link the digits in these two decimal fractions with the place value column to decide which answer is correct between the two responses given by the learners. Before the learners respond, Mr. Zikode asks "How many parts are we having here, we said we have how many parts?" pointing at the diagram with one hundred squares where sixteen of them are shaded (Figure 6.6). Mr. Zikode decides to use images in the form of 100-square diagram notation to clarify his question, using images as a language practice. Here, he is again referring the learners to the action of counting the total number of squares in a whole, which is the 100-square diagram in Column One of Figure 6.4.

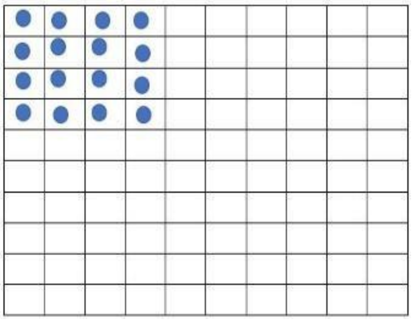


Figure 6.6: Sixteen hundredths

When one learner responds by saying "sixteen" the teacher asks, "out of how many?" Consistent with his earlier practice, as described in Section 6.5.4**,** he is expecting the learners to do the action of counting the number of squares that represent the denominator or the 'whole'in this proper fraction, still using images as a language practice. When the learners respond by saying "out of hundred" he continues and asks the learners if they have thousandths in this common fraction saying, "do we have thousands?," pointing at the diagram of $^{16}/_{100}$ in Figure 6.6. When the learners respond by saying 'no' to having 'a thousandths' column, he continues to use images in the form of a 100-square diagram (Figure 6.6) to clarify his question, asking the yes/no question again saying "do we have a thousandths column? Do we have that?" His question requires the learners to confirm that the denominator is 'one hundred' and not 'one thousand' so that they may determine the decimal notation for the represented diagram fraction format. Through this question, he wants the learners to check if in $^{16}/_{100}$ there should be a digitunder the thousandth's column in the table in Figure 6.5 when writing a representation of a decimal notation, using images.

When the learners say "no" to the question about the "thousandths column," Mr. Zikode asks again saying “which is correct then?” The learners indicate that 0.16 is correct. The teacher accepts the answer without asking for any justification, saying “This one is correct. Okay” referring to $^{16}/_{100}$ = 0.16. Mr. Zikode also does not describe or ask the learners why there is no need for the column of thousandths when referring to Figure 6.6.

Mr. Zikode is using actions of counting the squares in a 100-square diagram to give conceptual meaning for the decimal notation in the concepts of hundredths (Figure 6.4), using images as a language practice. He is attempting to build conceptual mathematical knowledge using procedural mathematical knowledge so that learners may see the equivalence in proper fractions in part-whole concept represented in three different proper fractions notations in 6.4. He does all this by using images, revoicing, different forms of closed questions, and formal mathematical language as language practices.

Next, Mr. Zikode goes back to Tasks 3 and 4, wanting the learners to fill in the third column for decimal fractions. He continues to use the same pattern of asking short, closed questions that require learners to look at the common fraction notation and recall how it should be represented in decimal notation. His questions are similar in all the remaining tasks in Figure 6.4. For instance, he asks: “this one as a decimal? Yes? … is that correct?” Whenever the learners say, “yes” he then moves to the next task, saying, “the next one?” Whenever the answer is incorrect, he asks “It’s wrong? … Come and correct, can you correct that? Is it correct?” Immediately when learners write the correct answer he just says, “Right, next one?” For all these questions in Figure 6.4 whenever they say “yes” or “no” or disagree, he does not ask for the reasons, instead he moves to the next question, thus missing the opportunity to get at the conceptual and procedural Discourse.

Taken together, in Activities 10, 11, and 12, Mr. Zikode shows how he uses the different forms of representation and related language practices to address learners’ difficulties. This involves taking them back to previous things he has done in the lesson. He is attempting to use the action of counting the squares to build conceptual mathematical knowledge of the given proper fractions. He is specifically, using a part-whole concept using 100-square diagrams to show the relationship between the three forms of fraction representations. To do this, he uses formal mathematical language, different forms of questions, revoicing, and English language as language practices. When it comes to different forms of questioning, he seems to miss opportunities to strengthen the conceptual work by limiting the forms of questions.

6.5.6 Description of expanded notation (Activity 13)

After describing the concept of place value using the place value notation column in a table and 100-square diagrams (Figures 6.4, 6.5, and 6.6), Mr. Zikode says to the learners "Now we want to move a step further, we want to expand…When you're expanding, we want to show the value of each digit in a number, okay?" He describes by referring learners to the third columns of Figures 6.3 and 6.4 and chooses the following tasks, naming them as: (a) 0.2; (b) 0.4; (c) 0.3; (d) 0.1; (e) 0.06 (f) 0.16. He thereafter asks a question "We are saying here? we have zero comma …?" referring to 0.2 in (a), expecting the learners to complete his sentence. He is now focusing on reading the decimal notation in formal mathematical language. His focus on asking the learners to read the decimal notation in formal mathematical language in this task from the third column of Figure 6.4 suggests that this is what he defines as "expanded notation."After the learner says "two" Mr. Zikode says "zero comma two, zero comma two. Okay? We can't expand that further, it's fine as it is" (1). He, however, does not explain what he means by saying "We can't expand that further, it's fine as it is", instead he refers learners to the next task, which is (b) 0.4.

When describing and asking informational questions in these tasks of decimal fractions with one decimal place, taken from Figure 6.3, Mr. Zikode continuously repeats the pattern for those fractions in his list, up to task (d) saying "This one as well is zero….? … this one as well is zero comma …? … We can't expand that further" "zero comma…?" His questions require the learners to read the decimal fractions using formal mathematical language. However, his closed questions channel learners to complete his sentences as if they are talking about whole number saying "four," "three," and "one" instead of requiring them to respond in full by using formal mathematical language for decimal notations. Mr. Zikode's description of expanded notation of decimal fractions with one decimal place seems to make him describe the symbols by only using the correct formal language.

Mr. Zikode thereafter proceeds to decimal notations with two decimal places. He first focuses on 0.06 by asking: "how do we expand this one? We have zero plus…plus what?", pointing at 0.06. It seems there is a shift in his wording here when he describes decimal fractions with two decimal places. When the learners are quiet, he clarifies his question by rephrasing it, saying "We have zero plus…? plus what?" When the learner says "zero… plus zero" he continues asking, saying "zero comma…?" In his description, he is using an operational sign of addition, adding digits from different place values, asking for the full description in words. This question requires learners to recall the concept of a place value. The learners still say "six" instead of saying 'zero comma zero six', which may be caused by his limited form of questioning and the use of formal mathematical language when he expects them to complete his sentences. Mr. Zikode responds by completing his own sentence saying, “zero six.” He further asks, “or you can write it just as it is… zero comma zero…?.” He still does not explain why he says they are“expanding”, and he still does not ask for reasons or describe why they have to use these actions.

Next, Mr. Zikode moves to Task (f) which is 0.16, and says, “can someone expand this one? zero comma one…?” He still requires the learners to think about the place value of digits in decimal fractions. When one learner writes the symbol “1 +” on the chalkboard, the teacher goes back to his teaching pattern he used when describing decimal fractions with one decimal place. He asks a series of different forms of closed questions saying, “is it correct? Quickly please…. we have zero comma… zero comma what?” When the first learner responds by saying “zero comma ten” and the second one responds by saying “sixteen” Mr. Zikode decides to give an answer without explaining how he got it, saying “plus zero comma zero six” “plus zero comma one.”

Next, Mr. Zikode asks a closed question saying, “can we try to add that and check, 0.1 plus 0, 06, what is the answer?” His question is attempting to require the action of adding decimal fractions. When a learner says the answer is “zero comma sixteen” Mr. Zikode revoices the incomplete answer saying, “zero comma…?” the whole class says “sixteen” instead of saying‘one six.’ Mr. Zikode accepts it without asking how they got the answer. He also does not make learners aware that they should use formal mathematical language by saying ‘zero comma one six’ because this is a decimal fraction, not a whole number. Mr. Zikode is attempting the action of expanding the decimal fractions with two decimal places. However, his ways of questioning limit the building of conceptual meanings for expanded notation. As much as he is using formal mathematical language to build procedural mathematical knowledge of expanded notation in decimal notation, allowing learners to name decimal fractions as whole numbers may hamper the conceptual meaning of a decimal fraction.

6.5.7 Description of addition and subtraction of decimal fractions (Activity 14)

After confirming that 0.1 plus 0, 06 is equal to 0.16, Mr. Zikode then gives a groupwork task written on the chalkboard and says, “Can we quickly add this one in our books?” referring to 0.53 + 0.43 and 0.15 + 0.04 on the board. Mr. Zikode thereafter asks each group to present the solution on the chalkboard saying, “okay which group would like to show us the solutions?” His question requires the learners to write the full written solution on the board. When a learner writes 0,95 as an answer to

0,52 + 0,43 without saying anything to the class, Mr. Zikode asks aquestion: “is that correct?” Without asking how the calculation was done, he asks another group to come and write: “number two, Thabang’s group…?” When the learner from another group writes on the board:

	0.15
+	0.04
=	0.19

Mr. Zikode asks the class saying, “is it correct?” When some of the learners are not sure, saying‘yes’ and others saying ‘no’, Mr. Zikode does not ask them the reason why they are disagreeing with each other, instead, he gives them other new tasks about addition and subtraction of decimal fractions with one and two decimal places: (a– 1.06 + 0.4); (b) 0.91 - 0.1) from the textbook. He then asks: “what are we doing here… are we adding or subtracting?” pointing at the two tasks of addition and subtraction of decimal fractions. When the learners say, “we are adding” Mr. Zikode then says, “show that…”, his question requires the learners to put an appropriate operational sign for the action of adding the decimal fractions.

His questions require answers to an action of calculating when adding proper fractions that are in the decimal notation of two decimal places. Each time he asks the learners to share their solutions, he only asks for yes/no and does not discuss the actions. While working in groups, the teacher moves around, evaluating answers without any description of concepts and actions, without asking questions or clarification thereof. He just comments to the groups saying that most of them responded correctly. When the bell rings, Mr. Zikode gives learners homework.

6.5.8. Summary of how Mr. Zikode builds procedural and conceptual mathematical knowledge

When attempting to build procedural and conceptual mathematical knowledge about addition and subtraction of decimal fractions up to two decimal places, Mr. Zikode follows a particular pattern in his lesson. In his introduction, he uses two images, a 10-square diagram and 100- square diagram representations to describe, ask, and clarify questions about decimal fractions. He focuses on the concepts of tenths and hundredths, using formal mathematical language and images as a point of departure. His pattern of describing the proper fractions involves using three representations, moving from one notation to another which are a 10-square diagram anda 100-square diagram. His focus is on the part-whole concept to give meaning to the representations of equivalence of proper fractions in diagram format, common fraction notation, and decimal format in tables. Mr. Zikode starts with these diagrams and uses them for multiple purposes. They are key images that he returns to as he seeks to develop conceptual understanding of tenths and hundredths in the most part of his lesson. After the description of decimals, he uses expanded notation for decimal fractions with two decimal places.

Whenever the learners seem to struggle, he uses a 10-square and a 100-square diagram and the place value notation column, which are previously learned mathematical concepts to clarify his questions. He revoices to affirm the answers and he also uses revoicing as a point of departure to ask another question especially if the answer is incorrect. Sometimes his revoicing is not attached to building any mathematical meaning, it seems to be happening haphazardly.

Mr. Zikode's use of language functions gives two different pictures about the building of conceptual and procedural mathematical knowledge. When describing the proper fractions that were represented in different fraction formats as well as place value, though he uses closed questions, his way of asking creates opportunities for the development of mathematical Discourse. He supports his different forms of questions by using images, formal mathematical language, previously learned mathematical concepts, and different forms of question, and thus builds conceptual mathematical knowledge.

However, towards the end of his lesson, his way of asking informational questions becomes limited because they are no longer accompanied by images like he did at the beginning. When attempting to build mathematical knowledge on addition and subtraction of proper fractions in decimal notation, Mr. Zikode mostly uses procedures without connections. Sometimes he gives them correct the answer without explaining where it is coming from. Mr. Zikode is using procedures when attempting to build conceptual mathematical knowledge for place value in decimal fractions using formal mathematical language, revoicing, and different forms of close-ended questions.

The closed questions are no longer clarified. If the answer is incorrect, he either gives the answer or asks another learner to respond. Sometimes learners respond by completing the teacher's sentences. When the learners complete Mr. Zikode's sentences, he does not pay attention to the use of formal mathematical language for decimal notation. His questions lead to short answers which are mostly "yes" and "no", one-word answers, short sentences, or execution of an action without explanation or justification, mostly leading to procedures without connections. Sometimes he accepts incorrect answers without noticing, which may be caused by the fact that he does not ask for justification of answers. This may lead to misconceptions and consequently impact negatively on conceptual understanding of the difference between whole numbers and decimal fractions.

6.6 REASONS WHY MR. ZIKODE CHOSE SUCH LANGUAGE PRACTICES

In the lesson analyzed, Mr. Zikode used different kinds of language practices during the emergence of mathematical Discourse when teaching decimal fractions. Mr. Zikode gave reasons for choosing the language practices he used when describing things and actions, when asking informational questions, and when clarifying questions (Pozzi; 2004). The reasons are based on the reflective interview (RI) that took place immediately after the lesson presentation as well as the focus group interview (FGI) that took place after I analyzed the lessons of each of the three teachers. While looking at why Mr. Zikode used such language practices, I also look at the six building tasks he built (Gee; 2005) as he gave the reasons why he used such language practices. I explore how Mr. Zikode positioned himself in relation to the use of all these language practices in his multilingual mathematics classroom, looking at the kind of benefits he gets when using such language practices. In the interviews, Mr. Zikode mentioned the importance of some language practices that I did not observe in his lesson.

Like the other two teachers, Mr. Zikode justified his predominant use of English language by stating: "Because mathematics must be taught in English. They know, I can't compromise that one" (Zikode, 42, POI). The justification for the use of English language is related to curriculum and policy requirements. He mentioned that knowing English language makes it easy for learners to understand mathematics, citing the following reasons: it helps learners understand formal mathematical language for the current grade and in the upcoming grades. He further says, "I must use correct mathematics language when I teach them and there is no mathematics language in Zulu or Setswana and the best way is to stick to English". In Gee's (2011) terms, he is building politics, making English important for the development of mathematical Discourse. He regarded not using English language when teaching mathematics as a 'compromise' and may thus affect understanding of mathematical concepts.

Mr. Zikode justified the use of English language by saying "You know mathematics language is close to English, though it's not actually English language per se" (Zikode, 44, POI). His reason for saying "…. the best way is to stick to English…mathematics language is close to English" may suggest that he used English language because the mathematics register is in English language in the form of formal mathematical language, which he used in almost the entire lesson. Mr. Zikode explained that he used formal mathematical language by indicating that it was important for mastering mathematics in grades six and higher grades. He, however, explained that his choice of English language over the learners' home language did not mean learners would automatically know the formal mathematical language.

In Gee's (2011) terms, Mr. Zikode is building a sign system by rendering formal mathematical languageimportant for the development of mathematical Discourse. By saying "sticking to English… the best way", he is building politics by making English language the only language that can give learners access to mathematics, thus giving it more status than the learners' home language.

The other explanation for choosing English was to market the school because parents match English fluency with quality education. Here Mr. Zikode is building politics by equating English language with quality education. English language also protected him from being ridiculed by learners because he is not fluent in Setswana, a reason that has nothing to do with the building of mathematical knowledge.

When asked why he used more of IsiZulu than Setswana, Mr. Zikode justified his rare use of Setswana by saying: "If you are not fluent, they correct you, they correct me sometimes….." He further indicated that the learners made him "…feel comfortable in Zulu so I don't have to stress with Tswana" (36, POI). Here, isiZulu becomes the teacher's and the learners' comfort zone, as they meet each other halfway. Though he admitted that sometimes it happens spontaneously, the other reason he gave was that it was "just to capture their attention, to focus" (38, POI). He is building identity and relationships with the learners by making use of the language they are familiar with at home and in the community.

Mr. Zikode used images and justified the use thereof by indicating the following reasons:

> *"If the learners see practically where the fraction comes from it becomes easy, you see, I think it becomes easy for them to see the difference between tenths and hundredths….and they then understand how the comma comes in after the whole number, in other words we are moving from diagrams to symbols together"* (15, POI; 26, POI).

In another interview he further justified the importance of the use of images by indicating that:

> *"This diagram helps them to see that it is no longer a whole" (28, POI) "The headings tell them the value of each digit that they are writing" (30, POI) "You see, I don't want to keep ontelling them the answer. It's better if there is a way of showing them how they can help themselves instead of depending on me for the correct answer. For me, the heading is the key to the correct answer"*

(Zikode, POI, 32).

Here, Mr. Zikode argued that images helped to explain procedures that learners see. Images also helped learners to practically differentiate between different concepts because of the displayed visuals. The learners were able to process knowledge on their own without depending on the help of the teacher. Mr. Zikode said images reminded learners about procedures and concepts whenever they have forgotten. In Gee's (2011) terms, he was building sign systems by highlighting the importance of images when building mathematical knowledge. He was also building politics by making Setswana less important through the use of images when building mathematical knowledge.

Mr. Zikode indicated that he used learners' everyday context and previously learned mathematical concepts because it becomes easy to understand mathematics if he starts with what they already know, hence he asked learners to put place value headings on top of digits. Here, the teacher is building connections by rendering learners' everyday context and previously learned mathematical concepts relevant to the building of new mathematical knowledge.

6.7 CONCLUSION

In the entire lesson, it is evident that Mr. Zikode mostly used English language, formal mathematical language, images, and different forms of questions as language practices. Though his forms of questions were close-ended, his way of combining them with images and previously learned mathematical concepts in most parts of the lesson was building conceptual mathematical knowledge. His lessons focused more on the building of procedural mathematical knowledge to give conceptual meaning to fractions in the form of a diagram, proper fractions as well as decimal format. His lesson seemed to depend on various images to develop mathematical procedural and conceptual Discourse. This was different from his initial way of asking informational questions, see page. Later in the lesson, he started asking low-order questions, but he did not clarify them. Mr. Zikode started to use lower-order questions, he lost an opportunity to ask the reasons for the answers thus missing an opportunity to build procedural and conceptual mathematical Discourse.

Mr. Zikode's explanation on using the language practices was similar to Mr. Ndlela's and Mr. Dubazana's, which was for the understanding of formal mathematical concepts and procedures. In his explanation, Mr. Zikode indicated that the nature of his topic made him use images and procedures because it was about the addition and subtraction of decimal fractions. Like Mr. Ndlela and Mr. Dubazana, he used images to manage the tensions caused by his wanting to useEnglish but also wanting to use Setswana and isiZulu. As much as he argued for the use of home language to help learners understand mathematical concepts, he also said images saved him from explaining in Setswana. Here, there is tension in his building tasks as he builds politics by rendering Setswana important for the building of mathematical knowledge but at the same time making it less important because learners must understand LoLT.

CHAPTER 7: DISCUSSION AND CONCLUSION

7.1 INTRODUCTION

This chapter entails discussions regarding the whole investigation of language practices of immigrant mathematics teachers and presents short conclusions as well as recommendations and limitations of the study based on the Analytical Framework (Table 2.1) I used in the study. In this chapter, I answer the three research questions I asked. I first respond to Question Three, looking at what they said regarding the choices of language practices they used when building mathematical knowledge. I discuss the common threads on the reasons for the use of the language practices and the exceptions and how they were used across the three teachers. Secondly, in responding to Questions One and Two, I discuss the common threads on how the teachers used language practices to give meaning to procedural and conceptual mathematical knowledge, focusing on each of the different concepts taught.

Combining the key findings on the teachers' use of various language practices focusing on the three different mathematical topics helped me to offer insights for teaching practices that support the development of procedural and conceptual mathematical Discourse for particular topics in particular contexts, without comparing the teachers' use of language practices, as the comparison was not the focus of the study.

7.2 DISCUSSIONS ON THE RESEARCH QUESTIONS

In this key findings chapter, I am focusing on the overall teachers' use of language practices by the three teachers when they were using Pozzi's (2004) language functions across the lessons, and across different contexts. I am consolidating the main reasons given by teachers for these language practices used across different contexts and topics. The focus is on understanding the overall trends and reasons for these language practices, offering insights that are applicable beyond the specifics of individual cases.

The discussion in this chapter looks at each of these lessons as stand-alone lessons, not intending to compare. The focus of the discussion was to explore how each teacher used various language practices during their lessons, specifically when using Pozzi's language functions: describing procedures and concepts, asking informational questions, and clarifying questions. The intent of the discussion was, but to understand how these language functions were applied within different mathematical contexts. Their application of language practices varied depending on the mathematical topic being taught. For example, the way Mr. Ndlela used language practices when teaching functional relationships differed from how Mr. Dubazana used language practices when teaching transformational geometry or how Mr. Zikode used language practices when teaching decimal fractions.

The study aimed to explore the language practices teachers used in mathematics classrooms when creating opportunities for the development of procedural and conceptual mathematical Discourse. In Tables 7.1 and 7.2 language practices used are represented separately, and I looked across the three teachers when they were using Pozzi's (2004) language functions, which were a description of things and actions, asking of informational questions, and clarification of questions. As indicated in Chapters Two and Three, the language practices in Tables 7.1 and 7.2 are the language practices I identified when I conducted the reflective interviews and focus group interview.

The two tables (Tables 7.1 and 7.2) are informed by the Analytical Framework I used in my study (Table 2.1). The three teachers used a range of language practices and gave the reasons why they chose them, as displayed in Table 7.1. Across one lesson, each teacher followed a particular structure of building both procedural and conceptual mathematical knowledge, but the Discourse of each teacher included other meanings, namely, connections, politics, identity, relationships, and sign systems, (Gee, 2011). See Table 7.1 Column Four and Table 7.2, Column Five, for all these meanings.

The use of language practices in teaching varied, with some being consistent, like the use of English, while others depended on the mathematics topic. Teachers often used multiple language practices simultaneously, and their application of Pozzi's (2004) language functions varied across lessons. There were moments when the chosen language practices did not effectively convey the intended meaning. This could be due to the spontaneous use of these practices in class or a lack of prior testing before implementation.

Findings in my study show some similarities with other studies in classrooms where learners have home languages other than English (although these varied), and in which teachers are not immigrant teachers. However, as indicated earlier, unlike these studies, my research did not solely focus on English language, code-switching, prior knowledge, gestures, and images; it also examined a broader range of language practices aimed at enabling conceptual mathematical understanding during knowledge-building. Also, unlike in my study, participants in these studies were not immigrant teachers and they also shared home languages with the learners.

7.2.1 Teachers' explanation of their use of language practices

This section focuses on the reasons given by the three teachers for their choices of language practices when creating opportunities for the development of mathematical Discourse in the three English additional language mathematics classrooms (Table 7.1, Columns 2 and 3). I decided to start with Question Three because when I get to know about the reasons for the teachers' use of language practices first, I will have an understanding of how they (reasons) shaped their use from the beginning of the lesson to the end of it. The third column in Table 7.1 indicates the reasons provided by the teachers for their use of each language practice when using Pozzi's (2004) language functions.

Table 7.1 Teachers' explanations for their use of language practices

Language practices	**Teachers**	**Reasons for the choices as teachers were describing things and actions, asking informational questions, and clarifying questions (Pozzi (2004).**	**Gee's (2005) Building tasks (meanings built)**
1. English language	Mr. Ndlela Mr. Dubazana Mr. Zikode	• English language will benefit learners in grade six and beyond. • English will make learners mathematically and linguistically well-prepared for an English-dominant education system.	Procedural and Conceptual knowledge Politics
2. Code-switching	Mr. Ndlela Mr. Dubazana (justified but did not use) Mr. Zikode (justified but code-switched to isiZulu)	• Some code-switching helps to clarify questions for the understanding of mathematical procedures and concepts. • Code-switching enhances conceptual meaning when it becomes difficult to describe formal mathematical language in English. • Reason for not code-switching in the township context: the assumption that learners in townships have increased English exposure through resources like televisions. • Code-switching in the rural context: empathy because of lack of resources.	Procedural and Conceptual knowledge
3. Code-switch to Setswana during group work	Mr. Ndlela Mr. Dubazana Mr. Zikode	• Learners have fruitful discussions about mathematical concepts, using the language that they understood for conceptual meaning.	Identity Relationships

Language practices	Teachers	Reasons for the choices as teachers were describing things and actions, asking informational questions, and clarifying questions (Pozzi (2004).	Gee's (2005) Building tasks (meanings built)
4. Formal mathematical language in English	Mr. Ndlela Mr. Dubazana Mr. Zikode	• Formal mathematical language will make learners mathematically well-prepared for an English-dominant Education system.	Procedural and Conceptual Knowledge Politics
5. Informal mathematical language 'simplified English' or 'easy English'	Mr. Ndlela Mr. Dubazana Mr. Zikode	• Helps teachers describe mathematical procedures and concepts and also clarify questions about complex formal mathematical language with ease and without using the learners' home language. • Helps to clarify questions about complex formal mathematical language with ease.	
6. Gestures	Mr. Ndlela Mr. Dubazana Mr. Zikode (justified but did not use)	• Primarily minimizes the need for an extensive description of formal mathematical language in English. • Helps to build mathematical knowledge without describing abstract mathematical concepts in English, • Helps to clarify questions about complex formal mathematical language because teachers can just demonstrate or display an image without much explanation. • On a smaller scale: was influenced by the level of English proficiency in learners and the teachers' level of proficiency in Setswana.	Procedural and Conceptual Knowledge Sign systems
7. Images	Mr. Ndlela Mr. Dubazana Mr. Zikode		
8. Previously learned mathematical conceptsin English	Mr. Ndlela Mr. Dubazana Mr. Zikode	• Helps learners link the new knowledge with what they already know so that they understand the new mathematical concepts much more easily.	Procedural and Conceptual Knowledge Connections
9. Learners' everyday context in English.	Mr. Ndlela Mr. Dubazana Mr. Zikode (justified but did not use)		

These discussions in Sections 7.2.1.1 and 7.2.1.2 are based on the data analyzed in Chapters Four, Five, and Six (Sections 4.6, 5.6, and 6.6) produced from the post-observation interviews, which entailed reflective interviews with each teacher immediately after the lesson observation, as well as the focus group interview which was conducted after the first data analysis process. The sections that follow are the common thread in the teachers' reasons for choosing language practices as well as the exceptions emerging from the teachers' reasons fortheir choices of language practices.

7.2.1.1 Common thread emerging from the teachers' reasons for choosing language practices

The teachers' explanations for their use of language practices when using Pozzi's (2004) language functions demonstrate a common thread, which is the importance of using formal mathematical language in English, as well as code-switching to the learners' home language, for the building of conceptual and procedural mathematical knowledge. They, however, did not give the two language practices (code-switching to Setswana and English language) equal status, where Mr. Zikode even indicated in the interview that to him 'teaching mathematics is business and when it is business time, he speaks English only' because learners should learn mathematics in English. As stated in Table 7.1, Number One, in Column Three, the teachers highlighted both the short-term and long-term advantages of using formal mathematical language in English, such as benefiting learners in Grade Six and beyond, by enhancing their conceptual and procedural mathematical knowledge. Findings show that teachers support the importance of formal mathematical language in English for the building of mathematical knowledge. Their support for the use of formal mathematical language aligns with what was found by Mahlambi & Mawela ((2021) and Robertson & Graven (2018) where teachers indicated that learners need to be proficient in their LoLT so that they may not struggle to understand concepts. In various research studies that were conducted in South Africa (Maluleke, 2019; Mahofa & Adendorff, 2014; Chikiwa & Schäfer, 2014), teachers indicated that they had to prioritize English language so that learners may access mathematics even in higher grades.

Teachers in my study justified the importance of formal mathematical language in English indicating that using this language practice makes learners linguistically and mathematically well-prepared for an English-dominant education system. By giving more status to the use of English language and less status to code-switching to Setswana when building mathematical knowledge, in Gee's (2005) terms, the three teachers were building politics more than building identity and relationships.

Giving more status to the use of English language in mathematics classrooms has been found in various studies conducted in multilingual mathematics classrooms in South Africa. Findings show that even some of the English additional language teachers prefer not to use learners' home languages to develop mathematical knowledge, instead, they opt for simplified English, referred to as an informal mathematical language, when explaining mathematical concepts or clarifying questions (Sikhondze & Goosen, 2010; Mahlambi & Mawela, 2021). Teachers in these studies indicated their rationale for using simplified English, stating that it was to demystify formal mathematical language, prioritizing the development of mathematical understanding (Chikiwa & Schäfer, 2014; Mahofa & Adendorff, 2014; Sikhondze & Goosen, 2010; Mahlambi & Mawela, 2021). Teachers in these studies justified their use of English language in the mathematics classroom, citing that mathematics concepts are primarily explained in English textbooks (Chikiwa & Schäfer, 2014; Mahofa & Adendorff, 2014). They also mentioned the difficulty of explaining mathematics content in the learners' home languages, which led them to the use of basic English to simplify complex mathematical language.

As stated earlier, despite their firmly stated view of the importance of using English, the three teachers also justified the value of the learners' home language in building mathematical knowledge. Though in the interviews, the three teachers indicated that they preferred not to code-switch to the learners' home language in their teaching, they indicated that they did see the value that home language brings in building mathematical knowledge, thus building identity and relationships (Gee, 2011) (Table 7.1, No 2, Column 3). They indicated that some code-switching to the learners' home language is still important for clarifying questions when the learners do not understand the mathematical procedures and concepts. They also indicated that code-switching enhances conceptual meaning when it becomes difficult to describe formal mathematical language in English when building mathematical knowledge. The three teachers also indicated the importance of allowing the learners to code-switch to Setswana during group work. They indicated that they wanted learners to have fruitful discussions about mathematical concepts, using the language that they understood for conceptual meaning in the groups (Table7.1, No 3, Column 3).

What I found in my study resonates with the research findings from other mathematics education research studies, which show that while teachers prioritized English language for building mathematical knowledge, they also acknowledge the important role that is played by the learners' home language (Botes & Mji, 2010; Robertson & Graven, 2018; Shinga & Pillay, 2021). Teachers in these studies indicated that they had to use learners' home language to ensure that no learner was excluded because of language barriers. Other, researchers such as Adler (1998), Setati (2005), Chikiwa & Schafer (2014), Robertson & Graven (2019), Mahlambi & Mawela (2021), and Chikiwa (2021) have all found that teachers justified the use of code-switching as a language practice in their mathematics classrooms to enable conceptual understanding. In Gee's (2011) terms, recognizing the importance of the learners' home language in building mathematical knowledge suggests that while the teachers in my study emphasized the importance of English for learning mathematics, they were also building identity and relationships by valuing the role of the learners' home language in the process (Table7.1, No 1, 2, and 3, Column 4).

In the sociocultural approach adopted for my study, the three teachers recognized both English and the learners' home language as valuable resources for building mathematical knowledge, which led to the notion of the dilemma of code-switching, identified by Adler (1998). I used Adler's (1998) notion of the dilemma of code-switching because it captures the tension teachers experience when prioritizing English while also acknowledging the value of the learners' home language when building mathematical knowledge. Unlike in Adler's (1998) study, where two of the six teachers were Setswana-speaking, who shared their home language with learners, my study involved immigrant English additional language teachers. While Adler's focus on these two Setswana-speaking teachers was primarily on code-switching as a language practice, my study explored a broader range of language practices used by teachers in building mathematical knowledge and the meanings constructed through the use of various language practices. Despite differences in language contexts, both studies highlight the inherent dilemma of code-switching that teachers must navigate when balancing the use of English and learners' home language when building mathematical knowledge.

To build mathematical knowledge while also navigating this inherent dilemma of code-switching, the teachers in my study indicated that they used a variety of language practices in addition to formal mathematical language in English. In other words, though they valued the learners' home language, they indicated that they preferred not to always resort to it, but rather use other language practices. Also, using various language practices was not only about navigating the dilemma of code-switching as the teachers indicated, but it was to ensure that mathematical knowledge was being built. They highlighted the benefits of the use of other various language practices, which included informal mathematical language in English, gestures, images, previously learned mathematical concepts, and learners' everyday contexts, to build mathematical knowledge (Table 7.1, No 5, 6, 7, 8 and 9, Column 3).

When simplifying complex formal mathematical language in English, the three teachers indicated that they used 'simplified English' or 'easy English' to describe things (concepts) and actions (procedures), which I interpret as informal mathematical language in English in this study. They indicated that a simplified English language could help teachers describe mathematical procedures and concepts. It also helps to clarify questions about complex formal mathematical language with ease and without resorting to the learners' home language. They indicated that, because informal mathematical language uses the language that the learners are mostly familiar with, it, therefore, helps to clarify questions about complex formal mathematical language with ease (Table 7.1, No 5, Column 3).

In the interviews, all three teachers further indicated that when learners seem not to understand formal and informal mathematical language in English they use images and gestures, especially when clarifying questions about mathematical concepts and procedures. They all acknowledged that using images and gestures primarily helped them to build mathematical knowledge without describing abstract mathematical concepts in English, thus minimizing the need for an extensive description of formal mathematical language in English. Using images and gestures helped to clarify questions about complex formal mathematical language because teachers can just demonstrate or display an image without much explanation. Teachers in this study highlighted that one of the reasons for choosing images and gestures was influenced by the level of English proficiency in learners and their own level of proficiency in Setswana (Table 7.1, No 6 and 7, Column 3). In Gee's (2011) terms, by seeing the value in using images and gestures as language practices, teachers were building sign systems, making non-verbal language practices important when building mathematical knowledge (Table 7.1, No 6 and 7, Column 4).

These findings in my study align with what was found by Cohen (2017) in his study on the role of gestures in supporting mathematics learning in multilingual classrooms. Teachers in Cohen's (2017) study indicated that gestures complement verbal explanations, particularly during clarifying questions, which helps bilingual learners grasp mathematical concepts more effectively. However, Robertson & Graven (2019) in their study involving Grade 4 English additional language teachers teaching isiXhosa home language learners, indicate that teachers highlighted that they were using concrete objects and gestures when the learners did not understand English language. Botes & Mji (2010), in their study on the exploration of the effectiveness of a multilingual visual explanatory mathematics learner companion, indicated that teachers highlighted that images and gestures helped clarify complex mathematical concepts. Teachers in their study highlighted the usefulness of visual representations (images) alongside mathematical terms in English, which improved learners' marks and facilitated their understanding of mathematics terms in their own languages (Botes & Mji, 2010), This was also found by Chikiwa (2021) who observed Grade Eleven teachers, where they (teachers) indicated that using gestures to link verbal language and diagrams in teaching trigonometry, facilitated meaning-making and conceptual understanding.

The teachers indicated that when developing formal mathematical language in English, they also believe in the importance of supporting it by using previously learned mathematical concepts and learners' everyday context in English. They indicated that these language practices helped learners link the new knowledge with what they already know so that they understand the new mathematical concepts better (Table 7.1, No 8 and 9, Column 3). In Gee's (2011) terms, teachers were building connections by making learners' prior knowledge important for the building of mathematical knowledge (Table 7.1, No 8 and 9, Column 4).

The findings in my study resonate with the findings from Chikiwa et al.'s (2019) study that explored how learners' prior knowledge is used in the context of mathematics instruction, particularly in multilingual classrooms. In the interviews, teachers highlighted the importance of drawing on learners' everyday experiences to make abstract mathematical concepts more relatable and easier to understand. The teachers noted that by connecting new mathematical ideas to what learners already knew, they were able to foster deeper engagement and comprehension, especially in multilingual classrooms where language barriers can pose challenges to learning (Chikiwa et al., 2019). Next, are the differences in their reasons for their choices of language practices when building mathematical knowledge.

7.2.1.2 Exceptions emerging from the teachers' reasons for their choices of languagepractices

While there were commonalities in the teachers' perspectives, there were exceptions in their reasons for choosing specific language practices. I am viewing the differences in these teachers' reasons with an understanding that they all said their ultimate goal was to develop formal mathematical language in English for the building of mathematical knowledge.

The three teachers' reasons for code-switching or not code-switching to Setswana when building mathematical knowledge differed (Table 7.1, No 2 and 3, Columns 2 and 3). One of Mr. Dubazana's reasons for not code-switching when describing mathematical procedures and concepts assumed that learners in townships, where his school was situated, have greater exposure to English at home due to the availability of resources such as televisions (Table 7.1,No 2, Columns 3) compared to the learners from rural communities. He strongly believed that television sharpens the learners' command of English, a language that they need to learn mathematics (Table 7.1, No 3, Columns 3).

Mr. Ndlela justified why he used code-switching when clarifying questions, by indicating that it was because of empathy (Table 7.1, No 2, Columns 3). His assumptions were based on his understanding of the circumstances in the rural areas where learners come from homes with little or no support for English language use due to a lack of resources. In the interviews, he indicated that this reason propelled him to use code-switching when other language practices seemed not to be helpful when clarifying questions. According to him, the need to code-switch arose in the specific stage of his lesson about the meaning of the input and the output values as indicated in Chapter Four. He highlighted that he did not want those learners who were struggling with English language 'to be left behind'. Mr. Ndlela's justification for his use of the learners' home language aligns with Robertson & Graven (2019) where teachers in their study indicated that they were torn between code-switching to learners' home language because of empathy and adhering strictly to English because of the curriculum demands. Here, by seeing the importance of code-switching to Setswana when building mathematical knowledge, in Gee's (2005) terms, Mr. Ndlela was also building identity and relationships.

Mr. Zikode indicated that he spontaneously code-switched to isiZulu, which was not the learners' home language, whenever he was giving instructions. His reason was based on his context because he taught isiZulu alongside mathematics at his school. Thus, Mr. Ndlela and Mr. Dubazana seemed to have adjusted their choices of language practices to accommodate their perceived linguistic needs of the learners based on the available resources at home, while Mr. Zikode's choices were influenced by his exposure to the isiZulu language as a subject he taught at his school.

The particular choices made by the teachers (whether the same or different) helped them to describe mathematical procedures and concepts. They were able to clarify questions when learners seemed not to understand the different forms of questions. In the process of building mathematical knowledge, in Gee's (2011) terms, various meanings were built. They were also able to navigate the dilemma of code-switching when the need arose. Also, their use of language practices was based on their positioning in and positioning of the learners in their specific contexts.

7.2.2 The language practices teachers used and the meanings these language practices give to procedural and conceptual mathematical Discourse (Questions 1 And 2)

This section focuses on the discussions about the language practices the teachers used and how they used them when creating opportunities for the development of mathematical Discourse in the three

English additional language mathematics classrooms, using Pozzi's (2004) three language functions. These discussions are based on the data analyzed in Chapters Four, Five, and Six, focusing on the data that was obtained through classroom observation. Table 7.2 displays the language practices used by the three teachers when building mathematical knowledge. In Gee's (2011) terms, I look at the meanings the teachers built when building procedural and conceptual mathematical language, I look at the common threads and the exceptions in their use of language practices when they describe things (concepts) and actions (procedures) and when asking and clarifying questions (Pozzi, 2004).

The discussion in this section is informed by the justification of the choices made by the three teachers in Section 7.2.1. The discussion regarding the use of language practices takes cognizance that in Section 7.2.1, the three teachers valued the use of formal mathematical language in English, and while they also saw the importance of code-switching to Setswana when creating opportunities for the development of procedural and conceptual mathematical Discourse. It also takes cognizance that they also valued various language practices other than code-switching when building mathematical knowledge.

Table 7.2. Language practices used by the three teachers.

Language practice used when describing mathematical procedures (actions) and concepts (things), asking informational questions, and clarifying questions (Pozzi, 2004)	**Mr. Ndlela** **Topic: Functional relationships**	**Mr. Dubazana** **Topic: Transformational Geometry**	**Mr. Zikode** **Topic: Addition and subtraction of decimal fractions**	**Meanings enacted when using language practices (Gee, 2011)**
1. Ordinary English language	Throughout the lesson.	Throughout the lesson	Throughout the lesson	Politics Procedural and Conceptual knowledge

Language practice used when describing mathematical procedures (actions) and concepts (things), asking informational questions, and clarifying questions (Pozzi, 2004)	**Mr. Ndlela** **Topic: Functional relationships**	**Mr. Dubazana** **Topic: Transformational Geometry**	**Mr. Zikode** **Topic: Addition and subtraction of decimal fractions**	**Meanings enacted when using language practices (Gee, 2011)**
2. Code-switching to the learners' home language	Minimal use of code-switching by the teacher and learners. Kamohari (inside) Kontle (outside) Learners are allowed to use their home language in group work only.	None Learners are allowed to use their home language in group work only.	Very minimal, when giving instructions. Learners are allowed to use their home language in group work only.	Identity Relationship Procedural and Conceptual knowledge
3. Decomposition	Decomposing mathematical concepts using prefixes and verbs to give meaning to mathematical concepts e.g., the meaning of 'flow' in the flow diagram, 'in' in input, 'out' in output. 'put' in input and output values.	None	None	Procedural and Conceptual knowledge Connections
4. Formal mathematical language in English	Throughout the lesson Flow diagram, input, output, rule, inverse operations, four operational signs	Throughout the lesson Transformation Rotation, Reflection, Translation, triangle, angles, 90 degrees, 180 degrees, grid,symmetry.	Throughout the lesson Decimal fractions, common fractions, addition, subtraction, tenths, hundredths,	Politics Procedural and Conceptual knowledge
5. Informal mathematical language	Forward, backward, opposite, going up, going down, flow, in, out, put	Change, flip, slide, turn, twist, clockwise, mirror-image, anticlockwise, the mirror line.	Small square, big square, plus, minus, what happened? 'how many?' 'let's count'	Procedural and Conceptual knowledge

Language practice used when describing mathematical procedures (actions) and concepts (things), asking informational questions, and clarifying questions (Pozzi, 2004)	Mr. Ndlela Topic: Functional relationships	Mr. Dubazana Topic: Transformational Geometry	Mr. Zikode Topic: Addition and subtraction of decimal fractions	Meanings enacted when using language practices (Gee, 2011)
6. Images	Flow diagrams, number patterns, flashcards, and tables showing different representations of functional relationships	Grids, and triangular shapes with dots and arrows to describe the procedural and conceptual meaning of translation, reflection, and rotation.	Fractions in the form of 10- and 100-square diagrams Place value notation column. Headings on top of digits	Sign system. Procedural and Conceptual knowledge
7. Gestures	To describe mathematical concepts in line with the ordinary English language e.g. ○ 'flow' in the flow diagram, ○ 'in' in input, ○ 'out' in output. ○ 'put' in input and output values.	To describe the three different types of transformation when using informal mathematical language e.g. ○ Slide for translation horizontally moving from one floor tile to another. ○ Flip for reflection using hands. ○ Turn for rotations turning clockwise and anticlockwise. Done to simplify difficult mathematical concepts that have been decomposed.	None	
8. Previously learned mathematical concepts	Four operational signs Number patterns	Triangle, clock. angles, symmetry,	Four operational signs, common fractions, place value notation column	Connections Procedural and Conceptual knowledge

Language practice used when describing mathematical procedures (actions) and concepts (things), asking informational questions, and clarifying questions (Pozzi, 2004)	Mr. Ndlela Topic: Functional relationships	Mr. Dubazana Topic: Transformational Geometry	Mr. Zikode Topic: Addition and subtraction of decimal fractions	Meanings enacted when using language practices (Gee, 2011)
9. Everyday context	Cooking porridge to describe the meaning of the mathematical term 'rule'	Mirror to describe the meaning of mirror-image and mirror-line in reflection. Clock to demonstrate the clockwise rotation.	None	Connections Relationships Identity Procedural and Conceptual knowledge
10. Different forms of questions	Throughout the lesson. Close-ended questions. e.g. Are they going up or down? Yes/No answer questions. e.g. Are these arrows going backward? Open-ended questions e.g. How did you check the first two numbers?	Throughout the lesson. Close-ended questions e.g. How many degrees is the right angle? Yes/No answer questions. e.g. Did I twist it? Open-ended questions e.g. Why do we call it clockwise?	Throughout the lesson. Close-ended questions. e.g. How many blocks are coloured red? Yes/No answer questions. e.g. Is it correct? Open-ended questions e.g. None	Connections Relationships Identity Sign system Procedural and Conceptual knowledge
11. Revoicing	Done mostly after learners responded to a question(s).	Done mostly after learners responded to a question(s).	Done mostly after learners responded to a question(s).	Procedural and Conceptual knowledge

The teachers' use of language practices was explored based on their use of Pozzi's (2004) language functions (Table 7.2, Row 1, Column 1). As indicated in Section 7.2, the use of language practices in the lessons did not adhere to a linear or distinct approach.

7.2.2.1 Common thread (Based on classroom observations)

The lesson observations show that the three teachers' descriptions of things (concepts) and actions (procedures) and clarification of questions mostly focused on prioritizing formal mathematical language in English while they were using other language practices to build mathematical knowledge. As they described in the interviews, from the first mention of the mathematical concepts, at the beginning of the lessons, the three teachers used formal mathematical language in English, supporting it with the use of other language practices. The teachers shared a specific common thread in navigating the complexities, using various language practices, mostly in English language, and building mathematical knowledge as well as other meanings as indicated by Gee (2005). Mr. Ndlela, in Pozzi's (2004) terms, described the concept flow diagram, Mr. Dubazana described the concept transformation, and Mr. Zikode described the concept decimals (Table 7.2. Number 4, Columns 2, 3, and 4). Here, in Gee's (2005) terms, while building other meanings, they were building politics, making English language important for the building of mathematical knowledge.

More language practices seemed to be drawn in whenever the teachers started to clarify questions when they were developing formal mathematical language in English. When the learners did not respond to different forms of questions when the teachers were using different language practices to build mathematical knowledge, the three teachers had to draw in other language practices that would assist with the clarification of questions. Here, the teachers used informal mathematical language in English to supplement the use of formal mathematical language in English.

Mr. Ndlela's use of various language practices demonstrates an interwoven approach when using language practices. Here, he drew on the decomposition of the mathematical term 'flow diagram' and focused on the word 'flow' which is informal mathematical language in English, to give meaning to the concept flow diagram (one of the representations of functional relationships) (Table 7.2. No 3 and 5, Column 2). The effectiveness of using decomposition as a language practice was found by Adendorff, et al. (2018) in their study on the Foundation Phase teachers' use of manipulatives to teach number concepts in South Africa. Their findings emphasized that decomposition helped learners break down complex concepts to their level of understanding, which improved their performance on mathematical tasks.

Mr. Ndlela and Mr. Dubazana's use of formal and informal mathematical language in an interwoven manner is similar to what was found by Barwell (2013) in his study on the use of formal and informal language in mathematics classroom interaction which involved Grades Five and Six with two official languages, English and French in Canada. With a focus on a dialogic perspective on formal and informal language in mathematics classrooms, Barwell (2013) emphasizes that the relationship between the two is not one-way. Instead of a linear progression from informal to formal language, teachers must skillfully navigate varying levels of formality. While learners need to learn formal mathematical language, informal language remains essential and is not just a stepping stone. Both forms of language are necessary and coexist in the learning process (Barwell, 2013). In their study that involved learners from a rural United States school, McGinn and Booth (2018) highlight the value of using both formal and informal language for exact mathematical communication in algebra. McGinn & Booth (2018) found that teachers used formal language in their classrooms but were not discouraged when their students struggled with it initially. Instead, they allowed the use of informal mathematical language, also referred to as learners' everyday language to develop their understanding of mathematical concepts.

Mr. Zikode, after drawing squares of tenths and hundredths and describing them as 'small square' and 'big square' which are images, asked different forms of questions, using informal mathematical language in English: 'How many?', 'Let's count', wanting to know the number of squares that were in the 100-square diagram (Table 7.2. Number 5, Column 4). In Gee's (2005) terms, the three teachers were building politics by making the informal mathematical language in English language important for the building of mathematical knowledge.

When attempting to clarify questions, after realizing that the learners could not respond to the different forms of questions, using informal mathematical language in English, the three teachers decided to clarify their questions by using images with the support of different forms of questions. During classroom observation, it was evident that non-verbal language practices (images) were mostly used when the three teachers wanted to clarify questions that were mostly related to formal mathematical language. For example, Mr. Ndlela used number patterns when attempting to clarify questions about the meaning of the mathematical concept rule; Mr. Dubazana used the grid with the arrows to clarify questions about the meaning of the mathematical concept reflection, and Mr. Zikode used a 100-square diagram to clarify a question about finding the procedure for representing the decimal fraction 'sixteen hundredths'(Table 7.2. Number 6, Column 2, 3 and 4).

The teachers may have also said that non-verbal language practices (images and gestures) helped them to avoid Setswana in the interviews, as discussed in Section 7.2.1. However, the way they used them during classroom observation revealed that they made instructional decisions to assist in the clarification of questions whenever different forms of questions appeared to be unclear. This shows that the three teachers did not merely use images to avoid Setswana but to ultimately build conceptual and procedural mathematical knowledge, though they all supported the use of images by using English language. In Gee's (2005) terms, while building politics the use of images is aligned with the meaning of building sign systems, where images are given more value in building mathematical knowledge. The findings on the three teachers in my study resonate with what was found by Chikiwa (2021) in his study conducted in the Eastern Cape, indicating that gestures and verbal languages, whether in LoLT or the learners' home language, complement each other and were used as resources for clarifying mathematical concepts. Smith & Cekiso (2020) argue that images assist learners, especially those with language challenges, in understanding complex mathematical concepts by offering a universal form of communication. Combining images with text and speech supports different learning styles, reduces cognitive load, and helps multilingual learners grasp mathematical ideas more effectively (Moschkovich, 2007; Smith & Cekiso, 2020). Researchers highlighted the complementary nature of gestures and language in facilitating teaching and learning in multilingual classrooms (Robertson, 2020; Chikiwa & Schäfer, 2019; Chikiwa, 2019).

The three teachers also clarified questions about things (concepts) and actions (procedures) by drawing in other language practices when learners were not responding to the different forms of questions when building mathematical knowledge. They also used previously learned mathematical concepts in English. Mr. Ndlela continuously used the four basic operational signs, when clarifying questions about the procedural action for finding inverse functions. Mr. Dubazana clarified his question by using the mathematical concept of symmetry when clarifying a question about the meaning of the mathematical concept of reflection. Mr. Zikode clarified his questions by using a place value notation column when clarifying questions about the procedure for finding a place value of digits in decimal fractions (Table 7.2, Number 8, Columns 2, 3, and 4). The three teachers strategically drew upon previously learned mathematical concepts in English to assist learners who needed clarification of things (concepts) and actions (procedures). While building politics, the three teachers were also building connections by making the learners' prior knowledge important for building mathematical knowledge (Gee, 2011).

The other common thread was found when the three teachers allowed the use of code-switching during group work (Table 7.2, Number 2, Columns 2, 3, and 4). Here, in Gee's (2011) terms, teachers were building identity and relationships by giving value to the learners' home language when building mathematical knowledge. Barwell (2005) and Moschkovich (2002) argue that when used strategically, code-switching serves not only as a communication tool but also as a pedagogical approach that acknowledges and values learners' multilingual resources, promoting inclusion and enhancing comprehension in mathematics education.

7.2.2.2 Exceptions in the use of language practices

The discussion in this section focuses on the differences across the three teachers in their instructional practice, and their use of language practices when building mathematical knowledge. In my discussion about the exceptions, I am considering that in the interviews the teachers indicated that they prioritized both formal mathematical language in English as well as the learners' home language when building procedural and conceptual mathematical knowledge, as explained in Section 7.2.1. I discuss what was different concerning the language practices used, based on the teachers' use of Pozzi's (2004) language functions as well as the meanings that were built according to Gee's (2005) building tasks.

Though the teachers used informal mathematical language in English to describe mathematical procedures and concepts, their approaches were different. For example, Mr. Ndlela, initially, prioritized building conceptual mathematical meaning by using various language practices, including formal mathematical language in English (Table 7.2. Number 4, Column 2), informal mathematical language in English (Table 7.2. Number 3 and 5, Column 2), gestures, images (utilizing flashcards) (Table 7.2. Number 6 and 7, Column 2), previously learned mathematical concepts, learners' everyday context, (Table 7.2. Number 8 and 9, Column 2), and even code- switching to Setswana (Table 7.2. Number 2, Column 2). Mr. Ndlela later shifted his focus from describing mathematical meanings to describing actions (procedures) to develop conceptual mathematical knowledge, particularly in finding the rule, output value, and input value in a function, using tables that were images. This approach shows how he used language practices and language functions to demonstrate the interwovenness between procedural and conceptual mathematical knowledge he was attempting to build. He was showing how the understanding of procedures and mathematical concepts are related to each other, and how they can be used together to build mathematical knowledge.

Mr. Dubazana's approach reveals an integration of various language practices to build conceptual and procedural mathematical knowledge. He started by emphasizing the conceptual meaning of the mathematical concepts by using both formal and informal mathematical language to describe the meanings of the concepts of transformation, rotation, reflection, and translation (Table 7.2. Number 4 and 5, Column 3). Rather than presenting concepts and procedures in isolation, Mr. Dubazana weaved in and out of describing both, which showed the interrelated nature of mathematical concepts and procedures. To enhance the understanding of procedures, Mr. Dubazana used images in the form of grids and supplemented them with gestures to describe the action of rotating, translating, and reflecting (Table 7.2. Number 6 and 7, Column 3). He also used the previously learned mathematical concept ‘symmetry’ to give meaning to the concept of reflection and the learners' everyday contexts, which is ‘a clock’ forthe concept of clockwise and anticlockwise rotation (Table 7.2. Number 8 and 9, Column 3).

Mr. Zikode's teaching approach was centered around the use of different representations, which were the 10- and 100-square diagrams, to describe the difference between tenths and hundredths, building conceptual meaning of decimal fractions (Table 7.2. Number 6, Column 4). He used formal and informal mathematical language in English right from the beginning ofthe lesson, supplementing them with images as language practices (Table 7.2. Number 4, 5, and 6, Column 4). Mr. Zikode weaved in the procedures for representing proper fractions in different formats, including diagrams, common fractions, and decimal fractions (Table 7.2. Number 6, Column 4). Here, he was describing the concept of equivalence in the three different representations of different forms of fractions. His use of images as language practices as well as different ways of representing fractions suggest an intentional effort to give meaning to the concept of decimal fractions in comprehensible ways for learners as he showed the connection between procedural and conceptual mathematical knowledge.

In Gee’s (2005) terms, while building mathematical knowledge, the three teachers were building politics (English language), sign systems (gestures and images), connections (previously learned mathematical concepts and learners’ everyday context) as well as identity and relationships (code-switching to the learners’ home language).

In Gee’s (2005) terms, by describing things (concepts) and actions (procedures) using formal and informal mathematical language in English more than code-switching to Setswana, they were building politics by making English language important for the building of conceptual and procedural mathematical knowledge. By clarifying questions, using gestures and images, the three teachers were building sign systems, making gestures and images more important for the building of conceptual and procedural mathematical knowledge. By clarifying questions using previously learned mathematical concepts and learners’ everyday context, in Gee’s (2005) terms, the teachers were building connections, making learners' prior knowledge important for building conceptual and procedural mathematical knowledge. The three teachers were also building identity and relationships by making the learners' home language important for the building of conceptual and procedural mathematical knowledge (Gee, 2005). Similar to my study, Chikiwa & Schäfer (2019) argue that when using the learners' everyday context, mathematics teachers must carefully choose the language and visuals that precisely demonstrate the intended mathematical ideas if they cannot bring the actual objects from the learners' everyday context into the classroom. Images support in forming a deeper grasp of abstract ideas by connecting them to students' prior knowledge and real-world experiences, making mathematical content more accessible. Images aid in forming a deeper grasp of abstract ideas by connecting them to learners' prior knowledge and real-world experiences, making mathematical content more accessible (Westaway, Chikiwa & Graven, 2019; Smith & Cekiso, 2020).

Another difference in the use of language practices was the way the teachers used the learners' home language. While Mr. Dubazana and Mr. Zikode only allowed the use of Setswana during group work, Mr. Ndlela code-switched when he was clarifying questions about the meaning ofthe concept input value, and he allowed the learners to use Setswana when he was asking informational questions about the meaning of the concept output value. Mr. Ndlela's use of code-switching, along with different forms of questions aligns with Chikiwa's (2016) findings. Chikiwa's (2016) study, conducted in South Africa with three Grade 11 Mathematics teachers, reveals that code-switching was mostly used during questioning and the clarification of questions.

7.2.2.3 When the choice and use of language practices work against the teachers'intentions

When creating opportunities for the development of procedural and conceptual mathematical Discourse, in my analysis of the lessons, I have identified moments where the use of language practices seemed to work against the teachers' intentions to enable conceptual meaning and the related mathematical knowledge that is being built. The opportunities may have been missed because of the way the language practices were used. In this section, I have summarized specific examples for each teacher.

Language practices seemed to have worked against Mr. Dubazana's intentions when he was describing the action of rotating. For instance, through images, he presented a composite translation on the grid, which showed the action of translating and rotating at the same time. While describing the concept of rotation, using gestures, he portrayed a rotation that happens at a fixed point. This suggests that through the use of these two different language practices, he did not get to describe that rotation turns an object around a fixed point called the center of rotation, and thus he ended up building different meanings. Mr. Dubazana could have missed the opportunity because his focus may have been more on the change of direction when doing the action of rotating than focusing on the holistic understanding of the concept of rotation.

Mr. Dubazana also missed the opportunity to build mathematical knowledge about the concept of rotation because of his choice of language practice, which was learners' everyday context. While he may have used the example of a face clock in the language practice, as explained in Section 7.2.2.2, building connections with the learners' everyday context, at some point, his choice of context may have been unfamiliar to some learners**.** When using the example of the face clock to ask about the action of rotating clockwise and anticlockwise, some of the learners continuously responded incorrectly to his questions until the end of the lesson. Continuously telling the learners that some of them were copying from others because they were turning incorrectly, suggests that the teacher's explanation of a face clock may have been unfamiliar to some learners. The challenge may have been caused by the fact that the teacher did not have a physical face clock to demonstrate the action of rotating when he was presenting the lesson or was not able to provide a good explanation of a face clock. He was using words to get the learners to visualize. The reason for not responding correctly could have been that some of those young learners may not have been exposed to analog clocks. This, therefore, suggests that when creating opportunities for the development of procedural and conceptual mathematical knowledge, teachers may choose certain language practices that may not be productive for the enablement of conceptual understanding. These choices may, thus, lead to missed opportunities.

Early in his lesson, Mr. Zikode used language practices in an interwoven manner to build procedural and conceptual mathematical knowledge, however, later in the lesson his use of language practices in this manner seemed to work against his intentions. When he was asking informational questions about the action of adding and subtracting decimal fractions using different forms of questions as a language practice, he got into a pattern of continuously asking different forms of closed-ended questions to find out if the answers were correct or not. Learners were constantly responding with a 'yes' or a 'no', and Mr. Zikode would just move onto the next question, missing an opportunity to ask for justification. He missed an opportunity to build conceptual mathematical knowledge by not allowing learners to explain how they got their answers. Another missed opportunity for Mr. Zikode was when he was asking different forms of questions. When he asked the learners to name the given decimal fractions, they were just completing his sentences. For instance, for 0,16, learners completed the teacher's sentence by saying '…sixteen' instead of 'zero comma one six', and the teacher revoiced it as 'sixteen'. His revoicing, using the whole number 'sixteen' while the learners were completing his sentences may cause some learners not to perceive the given number as a fraction. His revoicing did not create the opportunity for the development of procedural and conceptual mathematical Discourse. Moschkovich (1999), in a study on revoicing in multilingual United States mathematics classrooms with Spanish-speaking learners, found that revoicing enhanced learner participation and supported the development of conceptual and procedural knowledge by making mathematical ideas more explicit and accessible.

Mr. Zikode could have used the same squares of tenths and hundredths as well as the place value notation column to describe the conceptual meaning of tenths and hundredths. His different forms of questions were no longer supported by the action of counting with the learners, using the images he used earlier in the lesson. He could have used those language practices to ask for the justification of answers, whether they were correct or not, and also asked why perhaps, to enable the conceptual meaning of a decimal fraction. Planas (2014) and Moschkovich (2007) highlight the role of different forms of questions in supporting multilingual learners in mathematics classrooms. Their work shows how questioning strategies help engage learners bridge prior knowledge and facilitate a deeper understanding of mathematical concepts.

On the overall, the teachers may have missed the opportunity to build mathematical knowledge as well as other meanings because of the kind of language practices they use, and/or the manner in which they use them (Gaoshubelwe, 2011).

Research studies conducted in multilingual mathematics classrooms in South Africa also show that opportunities to build mathematical knowledge were missed because the teachers' body movements or gestures that were made during communication did not align with the accompanying verbal content (Chikiwa, 2021; Chikiwa, 2020, 2021; Robertson & Graven, 2019, 2020). In their study that explored the use of assessment for learning in the Grade Six mathematics classroom, Mahlambi et al. (2022) also caution that mathematics teachers should interact with the appropriate activities first and make necessary adjustments regarding the learners' specific context before using them as examples in any activity.

7.3 REASONS FOR THE COMMON THREADS

As explained in Chapter Three, all three teachers were Ndebele-speaking, coming from the same context in Zimbabwe, and were all qualified as mathematics teachers in Zimbabwe as stated in Chapter Three. They did not share the home language with the learners they were teaching and all taught grade six Setswana-speaking learners who were English additional language speakers from [1]no-fee paying schools at the time of data collection. This common background likely to some extent influenced their choices of language practices, where they employed similar strategies and approaches when describing things (concepts) and actions (procedures), asking and clarifying informational questions as stated in Section 7.2.2.1. Setati (2008) indicates that teachers' own linguistic backgrounds, including their proficiency in English and any additional languages they speak, can shape their language practices in the classroom. The reason is that they may draw on their home language or other languages they are proficient in to facilitate communication and support learners' understanding of mathematical concepts. As I argue in this section, each teacher's context, including their understanding of or assumptions about the learners' background and the resources available to learners influenced their decisions regarding their use of various language practices when building mathematical knowledge.

As noted for Question Three, teachers shared some similar ideas on language practices in the interviews (Sections 4.6, 5.6, and 6.6). They all justified the importance of the development of formal mathematical language when building mathematical knowledge. The teachers' own experiences as mathematics education students in Zimbabwe, where they trained as teachers, can influence their teaching approaches and the language practices they adopt. They may replicate language practices used by their own teachers or adopt new strategies based on their experiences as students. Studies by Adler (1998) and Setati (2003) suggest that educators often replicate language practices used by their teachers or adopt new strategies based on their own experiences as learners.

The three teachers may have developed similar instructional strategies to bridge the linguistic gap with learners while building conceptual and procedural mathematical knowledge. They may have aligned their language practices with curriculum guidelines as they emphasized that the textbooks and the assessments are written in English language. The curriculum policy that requires them to teach

[1] No-Fee paying school: Schools that do not charge fees, which are allocated a larger amount of funding from the national budget per learner to make up for the fees that would have been charged.

mathematics in English language may have also shaped the teachers' language practices. Educational policies and curriculum standards may have shaped teachers' language practices in English additional language mathematics classrooms. Studies by Tyler (2016) and Robertson & Graven (2019) indicate that teachers often align their language practices with prescribed curriculum guidelines or language proficiency standards, incorporating specific terminology and language structures as required.

7.4 REASONS FOR THE EXCEPTIONS

As explained in Chapter Three, the school contexts were different, which were, the rural community, informal settlement, and the township, which present distinct challenges and opportunities for teaching. These three school communities have different character traits and thus this educational environment could lead to differences in teaching strategies, classroom dynamics, and choices of language practices. As explained in Chapter Three, the learners come from different home backgrounds with different resources, which suggests that the teachers wanted to adapt their language practices to accommodate the diverse resources available to the learners. For instance, Mr. Ndlela was the only one who code-switched when clarifying questions about the input and output value because of his assumptions about the non-availability of resources at the learners' homes because they lived in rural contexts. This is similar to what was found by Planas & Civil (2013) in their study that explored the concept of 'language-as-resource' in mathematics education, particularly in multilingual settings. They argue that decomposition in multilingual mathematics classrooms involves breaking down complex problems into simpler steps to support learners' understanding in diverse linguistic settings (Planas & Civil, 2013). Mr. Dubazana's decision to only allow the use of his home language in group work could have been that he perceived the township community as the context that has resources that help learners not to struggle with English language, Mr. Zikode code-switched to isiZulu because of the context where he was teaching isiZulu, as explained in Section 7.2.

The three teachers may have adapted their language practices based on the linguistic needs of their learners, particularly English additional language learners. Chikiwa (2020) and Graven & Robertson (2019) highlight that teachers often incorporate language practices that reflect the linguistic diversity of their learners' backgrounds, such as code-switching or translanguaging, to create inclusive learning environments. Another reason for the exceptions could have been the different mathematical topics they were teaching. In the interviews, they each indicated how the topics influenced their choices of language practices. Mr. Dubazana indicated that the topic of isometric transformations forced him to use gestures much more than other language practices. Mr. Zikode also indicated that his lesson did not allow him to use gestures and the learners' everyday context because he had a lot of procedures of working with numbers to describe and clarify to the learners, so his assumption was that there was no need for the use of gestures.

7.5 THE CONTRIBUTION OF MY STUDY

7.5.1 The empirical contribution

My study is not just about procedural and conceptual mathematical knowledge, which is one of the thinking on the knowledge part of Gee's (2011) big 'D' Discourse. I am also arguing that other meanings are being built, for instance, how politics, sign systems, identities, and relationships are built. It is also about how connections are made to things. It is about the activities that are built, which is the key part of my analysis because I structured it according to the activities as structured in Tables 4.1, 5.1, and 6.1 Columns One and Three.

This study shows how immigrant teachers use language practices regardless of the complexities that are in the Gauteng province as stated in Chapter One. I am offering empirical results about these immigrant teachers who are from a particular context, teaching in a particular context, and how their language practices enhance mathematical understanding. I particularly refer to those kinds of classrooms where they might have immigrant teachers and their possible particular identity issues related to them (immigrant teachers). This study offers an understanding of the immigrant teachers' context, where in multilingual classrooms there are immigrant teachers who do not share the home language with the learners, teaching English additional language learners.

These results also apply to classrooms with non-immigrant teachers, as these language practices can still be implementable in multilingual mathematics classrooms where teachers don't share the learners' home languages. The findings suggest that effective language practices can be used regardless of whether the teacher and the learners have the same linguistic background or not. The study therefore provides a rich understanding of how teachers who work with multilingualism policy in the curriculum environment deal with teaching mathematics. It also helps us understand how these teachers build meanings as well as procedural and conceptual mathematical knowledge using multiple language practices, in Gee's (2011) terms.

The value of my study may be seen through its contribution in terms of thinking about mathematical topics. Observing three different teachers teaching different concepts means that I have got different mathematical topics in detailed tools about how teachers can use language to teach functional relationships, transformational geometry, or decimal fractions (see Chapters Four, Five, and Six).

When analyzing these topics in 4.5, 5.5, and 6.5 I looked at the procedural and the conceptual mathematical knowledge the teachers built, step by step, right from the beginning of the lesson to the end. I also looked at the teachers' missed opportunities. Having identified those areas suggests that these findings will be able to support the procedural and conceptual mathematical knowledge of the teachers who would be teaching these mathematical concepts.

The findings highlight the importance of context, including mathematical topics in the use of language practices in mathematics education. The variability observed across different lessons emphasizes the need for flexibility in the use of language practices, allowing teachers to respond to the unique challenges and opportunities presented by different mathematical topics and contexts. While there was no clear or linear approach in the application of Pozzi's language functions across the lessons, this variability may be a function of the teachers' responsiveness to the specific procedural and conceptual mathematical knowledge that is being built, thereby providing a richer understanding of how language practices can be effectively used in diverse educational contexts.

The strength of this combined discussion is that I was able to capture the diversity and adaptability of language practices across different mathematical contexts. By examining how the three teachers teach various mathematical topics, ranging from functional relationships to transformational geometry and decimal fractions, the analysis reveals how different mathematical concepts and procedures necessitate distinct language practices. My study allows for a comparison of how the same language functions and language practices are used differently or similarly across various mathematical topics, providing insights into effective teaching practices that can go beyond specific content areas. The variability in how the language functions were used suggests that teachers adapt their language practices to the specific demands of the mathematical content they are teaching.

7.5.2 Theoretical and methodological perspective

From a theoretical and methodological perspective, the study is important because, on the one hand, as I have said I did not focus on one or two language practices like code-switching or gestures, I have actually looked at what language practices they used, how they used them teachers use all of them together and why. The value of my study is seen in that I have taken Gee (2011) and I have used it for mathematics. I have taken Gee (2011) and have refined it and have also brought in Pozzi's particular language functions for the practice of teaching and brought it within Gee (2011) for the building of mathematical knowledge. Though other researchers have used Gee (1996) in mathematics education, like Nkambule (2012), Moschkovich (2007), and Setati (2001) as indicated in Chapter Two, in this study I have combined his work with Pozzi's (2004) work, who is also not from the mathematics education background. The particular hard work that I did was that of developing the notion of mathematical knowledge about Pozzi's language functions, which I have used to develop the criteria for procedural and conceptual mathematical knowledge that other people could use. (Table 2.1). I have developed some tools for looking at procedural and conceptual mathematical knowledge (Table 2.1, Column 3). I started with the concept of procedural and conceptual which was with Setati (2001), Kilpatrick et al. (2001), and Stein et al. (2000), and now I have taken Gee (2011) and I have brought those concepts together productively.

Other researchers could adapt my Analytical Framework to their contexts. They may adapt by looking at the building of procedural and conceptual mathematical knowledge when using Pozzi's language functions. I have packaged the building of both procedural and conceptual mathematical knowledge by giving examples of the knowledge that can be described by the teachers when teaching the topics my teachers presented. I have put examples of the different forms of questions the teacher may ask when building procedural and conceptual mathematical knowledge. I have also given examples of building procedural and conceptual mathematical knowledge when clarifying questions, using the examples of the content that was presented by the teachers (Table 2.1, Column 3). In Chapters Four, Five, and Six I have given details of the work the teachers did.

I have developed tables of activities that I presented in Tables 4.1, 5.1, and 6.1. These tables have detailed mathematics activities with the figures the teachers used. I have done an in-depth analysis of the activities together with meanings that teachers were building, in Gee's (2011) terms when they were building procedural and conceptual mathematical knowledge.

7.6 RECOMMENDATIONS

The key findings that I have discussed in this chapter point to the important aspects that pre-service teacher education and in-service teacher development programmes can focus on in improving the quality of teaching and learning mathematics in the three topics that were taught by the teachers in my study (functional relationships, transformational geometry, and decimal fractions). As stated in the previous Section 7.5.2, though the study focuses on immigrant teachers, it offers learning for all multilingual mathematics classrooms. For example, teachers who teach mathematics in English additional language classrooms, as well as English first language mathematics teachers who teach in multilingual mathematics classrooms can draw detailed learnings about the use of language practices for diverse meanings on specific topics. The recommendations emerging from this study focus on recommendations for practice as well as recommendations for research. The conceptualization, planning, and dissemination of the findings and recommendations will be done in line with the ethical considerations in my study.

7.6.1 Recommendations for practice

In my study, the comparisons between different topics serve to highlight how teachers uniquely adapt their language practices to fit specific contexts rather than to determine which practices are more effective, especially related to multilingualism in mathematics education.

7.6.1.1. Provide guidance on using the tool developed for the building of procedural and conceptual mathematical knowledge

The Analytical Framework that I have developed (Table 2.1), informed by Pozzi's (2004) language functions, the teachers' use of different language practices, and Gee's (2005) building tasks and Appendix M (procedural and conceptual tool), could be used in pre-service training (teacher educators at universities) and in-service training (professional development programmes for teachers). I am using this Analytical Framework from a socio-political practice perspective and therefore the reasons for the use of various language practices by the three teachers in my study when building mathematical knowledge suggest that teacher professional development, teacher education programs, and other teacher support programs using my study should make the theoretical approach to language explicit. The form that any teacher professional development should take should be informed by a particular perspective on language, that is as of language as functional.

As part of teacher education courses, the focus can be on how teachers can use a range of language practices to describe procedures and concepts, ask informational questions, or clarify questions. For in-service teacher professional development, the tool provides a structured approach for helping teachers think about how they can create opportunities for the development of both procedural and conceptual mathematical Discourse while using various language practices. The structured approach involves the careful use of Pozzi's language functions when using different language practices. The structured approach also relates to the teachers' ability to identify Gee's building tasks that are being built when they use a range of language practices when building mathematical knowledge. Using the tool (Appendix M) taken from my Analytical Framework in the third column, which has categorized the use of language practices according to three of Pozzi's (2004) language functions, teachers can engage in collaborative discussions, and case studies that facilitate a deeper understanding of how to effectively integrate procedural and conceptual mathematical knowledge into their teaching practice.

This Analytical Framework as a whole can also enable teachers to refine their instructional practices and tailor their teaching strategies to meet the diverse needs of learners when using various language practices, as seen in the analysis chapters (Chapters 4, 5, and 6). It can be used as a reference to assist teachers in carefully thinking and planning about the language practices they would want to use for any mathematical topic they want to teach, taking into account the context, and the ideas about language mathematics teachers bring to the context. For example, in Mr. Ndlela's lesson on functional relationships, the focus could be to exploreand discuss how he moved from describing concepts at the beginning of his lesson to how he described mathematical procedures using images, previously learned mathematical concepts, gestures, and other various language practices (see Tables 4.1 and 7.2). In Mr. Dubazana's lesson on transformational geometry, teachers can explore and discuss how he integrated the use of both procedural and conceptual mathematical knowledge, using images, gestures, learners' everyday experiences, previously learned mathematical concepts, and other various language practices (see Tables 5.1 and 7.2). Teachers could also see how Mr. Zikode in his lesson on decimal fractions combined the building of procedural and conceptual mathematical knowledge, using different fraction representations as he was moving from a fraction in the form of a diagram to a common fraction, and to the decimal format using different language practices (see Tables 6.1 and 7.2).

The analysis gave me insights and a more in-depth understanding of how language practices can be used in different areas of mathematics rather than focusing on one topic, thus avoiding a surface-level overview. The analysis gave me insights and a more in-depth understanding of how language practices can be used in different areas of mathematics rather than focusing on one topic, thus avoiding a surface-level overview. The support may extend to other mathematical topics, besides the ones taught by the three teachers in this lesson. Teachers might be able to reflect on and plan for how they might use language practices to teach a section.

7.6.1.2. Provide guidance on the building of the detailed lesson activities when creating opportunities for the development of procedural and conceptual mathematical Discourse

Tables 4.1, 5.1, and 6.1 in the analysis chapters are detailed lesson activities that unpack mathematical concepts step by step, aligning each activity with the language practices the teachers used to build procedural and conceptual mathematical knowledge. The tables can be used by teacher education and departmental subject advisors who work with in-service teachersfor other mathematical concepts and topics when building mathematical knowledge. Extracts could be taken from Chapters Four, Five, or Six, to show how each teacher used various language practices using the three Pozzi's (2004) language functions, and how meanings were built through Gee's (2005) building tasks for different mathematical concepts. The sequence of activities in the three tables could be linked with the reasons stated in Table 7.1, showing how teachers can use language practices in an interwoven manner when creating opportunities for the development of procedural and conceptual mathematical Discourse in line with the given reasons. The reasons for the use of various language practices given by the teachers in my study can be used to encourage mathematics teachers to carefully think and plan about the language practices they would want to use for any mathematical topic they want to teach within their contexts as stated in Section 7.6.1.1. Through the meanings that are being built in the extracts, using different language practices and language functions, teachers can create effective and inclusive learning experiences for all learners when building mathematical knowledge. The same Analytical Framework for this study could be used on the use of language practices bymathematics teachers in any context, strengthened and adapted as necessary for another specific study focusing on other mathematical topics.

7.6.2. Recommendations for research

7.6.2.1. Use of the Analytical Framework for other research studies

The Analytical Framework (Table 2.1) that I have developed for this specific study, categorized according to three Pozzi's (2004) language functions, the different language practices, and Gee's (2005) building tasks with the detailed procedural and conceptual mathematical knowledge may be used by other researchers who are conducting similar research studies. When conducting research, these particular tools can be used as theoretical concepts. I can also use these kinds of tools as a lens to reflect on the practice of the Department of Education because I do have that opportunity as a researcher. I can share these theoretical concepts with my colleagues in research, which can strengthen the reflective practice. I can flexibility to test and adapt my Analytical Framework to suit the context of different mathematics concepts, especially when I developed the procedural and conceptual tools (Table2.1). Because I managed to develop the tool for three different topics, this suggests that it canbe further developed for other topics using the same Pozzi's (2004) language functions that I chose.

When conducting research these particular tools can be used as theoretical concepts and tools, the way I have used them for my study. I have developed an Analytical Framework that can be adapted for any research study in any gradefocusing on particular content. There is potential to analyze my data using a heteroglossia perspective because I can still lookat Discourses, modes, etc. in my suite of language practices, where I will view the language used in the fluid way that Tyler (2016) does. When conducting research, these particular tools could be used as theoretical concepts. I can share them with my colleagues which can strengthen the reflective practice. I can use the Analytical Framework (Table 2.1, Column Three, and Appendix M) as a lens to reflect on thepractice of the Department of Education because I do have that opportunity as a researcher.

7.7 METHODOLOGICAL REFLECTIONS

Focus on the following issues may be important for further research:
As much as my study is not focusing on learners' learning, I need to explore if learners understand the mathematical concepts and procedures when teachers use different language practices to build mathematical knowledge. This raises the need to interview learners after conducting classroom observations and also look at their performance, doing document analysis, and looking at the learners' scripts, employing a combination of these methodologies can bring insight into whether the teachers' use of language practices is effective or not.

7.8 LIMITATIONS OF THE RESEARCH

In this section, I highlight the limitations of my study, looking at what my lens and methodological choices have enabled me to see and not to see. I have identified methodologicalgaps as well as theoretical issues. A case study design was used in this study, which included a small sample of mathematics teachers. This could affect the generalizability of findings, as the study may not reflect how consistently or effectively teachers create opportunities for mathematical Discourse across multiple lessons or topics. Though it is a small-scale study, it has enabled the exploration of the complexities, interactions, and unique characteristics of multilingual mathematics classrooms that may not be captured by quantitative methods and other types of qualitative studies. These findings are contextually relevant as I have developed a profound and detailed understanding of these specific similar contexts.

Having three different topics allowed me to focus in depth on how teachers used a range of language practices identified in the wider literature, specifically for a topic for English additional language learners who are taught by immigrant teachers. In my study, the different topics serve to highlight how teachers uniquely adapt their language practices to fit specific contexts and topics effectively. By examining various mathematical topics, I reveal the complex ways in which teachers craft their language practices, showing that even commonly reported practices must be tailored to the particular context of each lesson. Gee's (2011) framework helps me understand how these practices build different meanings relevant to building mathematical knowledge. My rich data demonstrates not only how teachers skillfully adjust their language practices but also the challenges they face in this process. This approach enables me to offer detailed insights and thus make strong recommendations for tailoring language practices to different mathematics classrooms.

However, the focus on the three different topics by three teachers also portrays a limitation in my study and as such I could not compare their choices of language practices and the reasons for their choices. I am aware that if I observed the same topic, I may have been able to identify patterns, similarities, and differences that provide a broader perspective regarding the use of language practices for a particular concept. I might have got a deeper understanding of one topic because I may have been able to see three different approaches to the same topic. I, however, also acknowledge that my study was not focusing on the comparisons, I was just focusing on individual teacher's choices based on the context where the schools were situated.

The other limitation is that each teacher only taught one lesson, which restricts the scope of analysis regarding their use of language practices and language functions across different mathematical topics. Since mathematical Discourse development varies with the complexity and nature of each topic, observing only one lesson per teacher limited the ability to fully capture the breadth and adaptability of their language practices within and across topics. In light of this, the study does not reflect how teachers create opportunities for mathematical Discourse across multiple lessons or topics.

The methodological gaps identified in my study were that my reflective interviews and focus group interview missed an opportunity to ask the teachers why they used some of the language practices they chose because of the time both interviews were conducted, that is, immediatelyafter the lesson and a year after data was collected from the three teachers. I only realized some of the language practices that transpired in the lessons at a much later stage of my analysis and therefore did not get an opportunity to ask the teachers the reasons why they used them. For instance, I did not get an opportunity to ask the teachers the reasons for using different forms of questions the way they did, as one of the language practices. I could not interview the teachers at a later stage because there could have been factors that might have influenced them from the time data was collected to the time I was finalizing my data analysis process, which would have affected my study's credibility.

My lens was limited to the monoglossic perspective of language, which led me as a researcher to see language practices as more bounded and fixed. A heteroglossic perspective would have propelled me to see these as fluid, changing (e.g., not clearly identifying some text as English and others as Setswana codes). As argued by Sapire (2021), I may have missed opportunities to see the rich practice of translanguaging, as indicated in Chapter Two.

7.9 CONCLUSION

My study has attempted to provide insights for thinking about the meanings made when immigrant teachers use language practices to promote procedural and conceptual mathematical Discourse in multilingual mathematics classrooms. The research study provided some understanding regarding the choice and the use of language practices by immigrant mathematics teachers. Their justifications for the use of such language practices show the complexity of teaching mathematics in multilingual classrooms, especially if teachers are immigrant teachers in South Africa.

The complexity is further created by the fact that South African policies are not clear on how English additional language immigrant teachers should use language in multilingual mathematics classrooms. Amid complexities, in this journey, I learned that there was an interwovenness of language functions with language practices and the skill to use those language practices by teachers. The skill is knowing when to describe the concepts, when and how to ask questions, as well as when and how to clarify questions for the development of formal mathematical language, which is essential for the building of mathematical knowledge. It should be noted that whatever language practices are used in the classroom, certain meanings are being enacted in these mathematics classrooms and that may impact learning. Teachers may be very certain about the language practices that they bring into the classroom, however, some of those language practices may not be easily understood by the learners and thus make access to mathematical knowledge a challenge. It is acknowledged therefore that, in the process of trying to address one problem in mathematics teaching, other problems may emerge which also need attention.

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APPENDICES

APPENDIX A: INFORMATIONAL LETTER TO THE PRINCIPAL[4], UNIVERSITY OF CAPE TOWN

MATHEMATICS RESEARCH PROJECT

Research title: Language practices of immigrant mathematics teachers in multilingual grade 6 classrooms in South Africa
Researcher: Faith Lindiwe Tshabalala

Supervisors: Prof M. Phakeng

Dear Principal
My name is Lindiwe Tshabalala. I am currently doing my PhD in Mathematics Education. As part of my studies, I am doing a study investigating language practices that the immigrant English additional language teachers use to support the learning and teaching of mathematics.

I am requesting you as the Principal of the school to give me permission to work with one of the educators and Grade Six learners in your school in this research project. Should you allow them to participate, they would be asked to contribute in two ways. First, allow me to observe his teaching in one of his mathematics classrooms for a week at agreed-upon times. Second, I would ask him to participate in a reflective interview focusing on his observed lessons. With your permission, the lessons will be video-recorded, and interviews tape-recorded so that I can ensure that I make an accurate record of what he says and does. When the tape has been transcribed, he will be provided with a copy of the transcript, so that he can verify that the information is correct.

I intend to protect their anonymity and the confidentiality of their responses to the fullest possible extent. Their names and contact details will be kept in a separate file from any data that they supply. This will only be able to be linked to their data by me. In any publication emerging from this research, they will be referred to by pseudonyms. I will remove any references to personal information that might allow someone to guess their identity; however, they should note that as the number of people involved in the research is very small, it is

[4] Regarding the consent forms for my participants, I drew on from the ones that were initially developed and used in my Masters programme (Tshabalala, 2006).

possible that someone may still be able to identify them. If, however, for any reason they would like their real names to be used in the publications they will need to make a written request to me. Also, note that the name of your school and its exact location will not be revealed.

Once the research has been completed, a brief summary of the findings will be available to the educator. It is also possible that findings will be presented at academic conferences and published in national and international academic journals.

Please be advised that the participation of your school in this research project is completely voluntary. Should you wish to withdraw at any stage, or withdraw any unprocessed data you have supplied, you are free to do so without prejudice. Your decision to participate or not, or to withdraw, will be completely independent of your dealings with the University of Cape Town.

If you would like to participate, please indicate that you have read and understood this information by signing the accompanying consent form and returning it to me.

Should you require any further information do not hesitate to contact me, see my telephone numbers are below.

Ms. Lindiwe Tshabalala

APPENDIX B: CONSENT FORM FOR THE PRINCIPAL[5]

UNIVERSITY OF CAPE TOWN, WESTERN CAPE

MATHEMATICS LANGUAGE PROJECT

Research title: Language practices of immigrant mathematics teachers in multilingual grade 6 classrooms in South Africa

Researcher: Faith Lindiwe Tshabalala

Supervisors: Prof M. Phakeng

I, ………………………………………………………………………. agree that the school can participate in the project named above, particulars of which (i.e., details of lesson observations and interviews) have been explained to me. A written information letter has been given to me to keep. I give consent to the following:

- Video recording of the lessons in which the teacher and the learners might appear as part of the videotext.
  Yes ☐ No ☐
- The possible future use of the videotext for teaching purposes.
  Yes ☐ No ☐
- The participants being interviewed at some point during the research.
  Yes ☐ No ☐
- Tape recording of the participants' interview sessions with the researcher.
  Yes ☐ No ☐

I understand that my school, my teachers, and my learners will be shown and asked my permission for the use of particular images in the research")

…………………………………………..	……………………………..
Signature of the principal	Date
…………………………………………..	……………………………..
Signature of witness	Date
…………………………………………..	……………………………..
Signature of researcher	Date

5 Regarding the consent forms for my participants, I drew on from the ones that were initially developed and usedin my Masters programme (Tshabalala, 2006).

APPENDIX C: INFORMATIONAL LETTER TO THE TEACHERS [6]

UNIVERSITY OF CAPE TOWN MATHEMATICS RESEARCH PROJECT

Research title: Language practices of immigrant mathematics teachers in multilingual grade 6 classrooms in South Africa

Researcher: Faith Lindiwe TshabalalaSupervisors: Prof M. Phakeng

Dear Sir

My name is Lindiwe Tshabalala. I am currently doing my PhD in Mathematics Education. Aspart of my studies, I am doing a study investigating language practices that the immigrant English additional language teachers use to support the learning and teaching of mathematics.

Your Principal has given me permission to send you this letter to invite you to participate in this research project. Once you have read the letter you can decide whether you want to take part or not. Should you agree to participate, you will be asked to contribute in two ways. Firstly,allow me to have a pre-observation interview with you. Secondly, I will observe your teaching in one of your mathematics classrooms for a week at agreed times. Thirdly, I will ask you to participate in a reflective interview and focus group interview focusing on your observed lessons. With your permission, the lessons will be video-recorded, and interviews tape-recorded so that I can ensure that I make an accurate record of what you say and do. When thetape has been transcribed, you would be provided with a copy of the transcript, so that you canverify that the information is correct.

I intend to fully protect your anonymity and the confidentiality of your responses. Your nameand contact details will be kept in a separate file from any data that you supply. This will onlybe able to be linked to your data by me. In any publication emerging from this research, you will be referred to by a pseudonym. I will remove any references to personal information that might allow someone to guess your identity; however, you should note that as the number of people involved in the research is very small, it is possible that someone may still be able to

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Regarding the informational letter for my participants, I drew on from the ones that were initially developed andused in my Masters programme (Tshabalala, 2006).

identify you. If, however, for any reason, you would like your real name to be used in the publications you will need to make a written request to me. Also, note that the name of your school and its exact location will not be revealed.

Once the research has been completed, a brief summary of the findings will be available to you. It is also possible that findings will be presented at academic conferences and published in national and international academic journals.

Please be advised that your participation in this research project is completely voluntary. Should you wish to withdraw at any stage, or withdraw any unprocessed data you have supplied, you are free to do so without prejudice. Your decision to participate or not, or to withdraw, will be completely independent of your dealings with the University of Cape Town.

If you would like to participate, please indicate that you have read and understood this information by signing the accompanying consent form and returning it to me.

Should you require any further information do not hesitate to contact me, using my telephone numbers below.

Ms. Lindiwe Tshabalala

APPENDIX D: CONSENT LETTER FOR THE TEACHERS[7] UNIVERSITY OF CAPE TOWN, WESTERN CAPE MATHEMATICS LANGUAGE PROJECT

Research title: Language practices of immigrant mathematics teachers in Multilingual Grade Six Classrooms in South Africa

Researcher: Faith Lindiwe Tshabalala

Supervisors: Prof M. Phakeng

I, …………………………………………………………………………. agree to participate in the project named above, particulars of which (i.e., details of lesson observations and interviews) have been explained to me. A written information letter has been given to me to keep.

I give consent to the following:

- Video recording of my lessons in which I might appear as part of the videotext.Yes ☐ No ☐
- The possible future use of the videotext for teaching purposesYes ☐ No ☐
- Being interviewed at some point during the researchYes ☐ No ☐
- Tape recording of my interview sessions with the researcher.Yes ☐ No ☐

- I understand that I will be shown and asked my permission for the use of particularimages in the research")

Yes ☐ No ☐

…………………………………………..	……………………………..
Signature of participant	Date
…………………………………………..	……………………………..
Signature of witness	Date
…………………………………………..	……………………………..
Signature of researcher	Date

[7] Regarding the consent forms for my participants, I drew on from the ones that were initially developed and usedin my Masters programme (Tshabalala, 2006).

APPENDIX E: INFORMATIONAL LETTER TO THE PARENT[8]

UNIVERSITY OF CAPE TOWN, WESTERN CAPE

MATHEMATICS RESEARCH PROJECT

Research title: Language practices of immigrant mathematics teachers in Multilingual Grade Six Classrooms in South Africa

Researcher: Faith Lindiwe Tshabalala

My name is Lindiwe Tshabalala. I am currently doing my PhD in Mathematics Education. As part of my studies, I am doing a study investigating language practices that the immigrant English additional language teachers use to support the learning and teaching of mathematics.

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Your child's mathematics teacher and Principal have given me permission to send you this letter to invite your child to participate in this research project.

Children whose parents agree that they participate in this study will be interviewed using a video camera. The focus in the videorecording will be on the lesson observations on the immigrant teacher's language practices when teaching mathematics in a grade 6 class.

I intend to protect learners' anonymity and confidentiality. Their real names will not be used in the final report. I will remove any reference to personal information that might allow someone to guess the identity of the learners and teachers. Remember that your child is not obliged to participate. Should you wish your child to withdraw at any stage or withdraw any unprocessed data he/she has supplied, he/she is free to do so without prejudice. Should you require any further information do not hesitate to contact me – my telephone number is below.

If you agree that your child be part of this research project, please complete the consent form on the next page and sign in the space provided.

Ms Lindiwe Tshabalala

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Regarding the informational letter for my participants, I drew on from the ones that were initially developed and used in my Masters programme (Tshabalala, 2006).

APPENDIX F: CONSENT LETTER FOR THE PARENT[9] UNIVERSITY OF CAPE TOWN, WESTERN CAPE MATHEMATICS LANGUAGE PROJECT

Research title: Language practices of immigrant mathematics teachers in Multilingual Grade Six Classrooms in South Africa

Researcher: Faith Lindiwe Tshabalala

Supervisors: Prof M. Phakeng

Consent form for learners' parents in the study.

I, ………………………………………………………………………. agree that my child participates in the project named above, particulars of which (i.e., details of lesson observations and interviews) have been explained to me. A written information letter has been given to me to keep.

I give consent to the following:

- Video recording of the lesson in which my child might appear as part of the videotext.
  Yes ☐ No ☐
- Being interviewed at some point during the research
  Yes ☐ No ☐
- The possible future use of the videotext for teaching purposes
  Yes ☐ No ☐
- I understand that my child will be shown and asked for his/her permission for the use of particular images in the research.

  Yes ☐ No ☐

…………………………………………….. ……………………………..

Signature of participant Date

…………………………………………….. ……………………………..

Signature of witness Date

…………………………………………….. ……………………………..

Signature of researcher Date

8 Regarding the consent forms for my participants, I drew on from the ones that were initially developed and usedin my Masters programme (Tshabalala, 2006).

APPENDIX G: INFORMATIONAL LETTER TO THE LEARNERS

UNIVERSITY OF CAPE TOWN, WESTERN CAPE MATHEMATICS RESEARCH PROJECT

Research title: Language practices of immigrant mathematics teachers in multilingual grade 6 classrooms in South Africa

Researcher: Faith Lindiwe Tshabalala

Supervisors: Prof M. Phakeng

My name is Lindiwe Tshabalala. I am currently doing my PhD in Mathematics Education. As part of my studies, I am doing a study investigating language practices that the immigrant English additional language teachers use to support learning and teaching of mathematics.

Your mathematics teacher and Principal have given me permission to send you this letter to invite you to participate in this research project.

If you agree to participate in this study, you in this study will be interviewed using a video camera. The focus in the videorecording will be on the lesson observations on the immigrant teacher's language practices when teaching mathematics in a grade 6 class.

I intend to protect your anonymity and confidentiality. Your real name will not be used in the final report. I will remove any reference to personal information that might allow someone to guess your identity and that of your teacher. Remember that you are not obliged to participate. Should you wish to withdraw at any stage, or withdraw any unprocessed data you have supplied, you are free to do so without prejudice. Should you require any further information do not hesitate to contact me – my telephone number is below.

If you agree to be part of this research project, please complete the consent form on the next page and sign in the space provided.

Ms Lindiwe Tshabalala

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[10] Regarding the informational letter for my participants, I drew on from the ones that were initially developed and used in my Masters programme (Tshabalala, 2006).

APPENDIX H: CONSENT FORM FOR LEARNERS[11]

UNIVERSITY OF CAPE TOWN, WESTERN CAPE

MATHEMATICS LANGUAGE PROJECT

Research title: Language practices of immigrant mathematics teachers in multilingual grade 6 classrooms in South Africa

Researcher: Faith Lindiwe Tshabalala

Supervisors: Prof M. Phakeng

I, ……………………………………………………………………… agree to participate in the project named above, particulars of which (i.e., details of lesson observations and interviews) have been explained to me. A written information letter has been given to me to keep.

I give consent to the following:

- Video recording of the lesson in which I might appear as part of the videotext.
  Yes ☐ No ☐
- Being interviewed at some point during the research
  Yes ☐ No ☐
- The possible future use of the videotext for teaching purposes
  Yes ☐ No ☐

I understand that I will be shown and asked my permission for the use of particular images in the research")

………………………………………….. ……………………………..

Signature of participant Date

………………………………………….. ……………………………..

Signature of witness Date

………………………………………….. ……………………………..

Signature of researcher Date

[11] Regarding the consent forms for my participants, I drew on from the ones that were initially developed and usedin my Masters programme (Tshabalala, 2006).

APPENDIX I: STRUCTURED PRE-OBSERVATION QUESTIONNAIRE

1. Indicate your level of fluency in the following languages:(tick the appropriate block indicating whether you are good, fair or poor in a particular language)

Language	Speaking	Reading	Writing
Zulu			
Setswana			
IsiXhosa			
Sesotho			
Venda			
Tsonga			
Ndebele			
SiSwati			
Pedi			
English			
Afrikaans			

2. What is your home language?
   ____
3. How long have you been in South Africa?
   ____
4. What is the main language of the majority of learners in your mathematics class?
5. Before you came to South Africa, did you perhaps teach mathematics in your country?
6. If yes, how is the situation in your country different/similar to the South African context with regard to language?
7. ____
8. What are the challenges of teaching mathematics to English additional language learners in South Africa?
9. With reference to your country, how does English affect the teaching and learning of mathematics?
10. What views do you hold about teaching mathematics to South African English additional language multilingual classrooms?
11. How do you linguistically support English additional language learners in South Africa to ensure understanding of mathematical concepts?

APPENDIX J: CLASSROOM OBSERVATION SHEET

1. What is the topic of the lesson?
2. Interaction between the teacher and the learners?
3. What is the teacher saying and doing when describing mathematics concepts and procedures, asking and clarifying questions?
4. How does the teacher use the three language functions which are:
    - describing things and actions?
    - asking informational questions?
    - clarifying questions?
5. What are the language practices is the teacher using when using these language functions stated in number 4?
6. When does he use these language practices?
7. What mathematical knowledge is the teacher building when using language practices?

APPENDIX K: REFLECTIVE INTERVIEW PROTOCOL

Thank you for allowing me to record your lesson today and thank you for the interesting lesson. I would like us to discuss about what transpired in your lesson as I indicated in our first meeting. Please note that this meeting is recorded for reference purposes as I indicated in your letter. As promised, this interview will be used for my research study only and will be treated with a high level of confidentiality as promised.

Guiding questions for the individual interviews.

8. What was the topic of your lesson?
9. Was this your first lesson on this topic?
10. What was the previous lesson about?
11. For each teacher I will pick up the language practices used and then focus on each language practice used and ask why they were used in that way.

    Proposed question:

    - I noticed that you used this particular language practice (I will mention the language practice), can you explain why?
    - I noticed that you used this particular language practice more than others, can you explain why? (I will mention the language practice), can you explain why?
    - I noticed that you used this particular language practice minimally, can you explain why?
    - I noticed that you did not use this particular language practice at all, whereas it is commonly used in South African multilingual mathematics classrooms, can you explain why?
12. The teachers' responses will also guide me on the mathematical knowledge they wanted their learners to know.

APPENDIX L: FOCUS GROUP INTERVIEW PROTOCOL

Thank you for allowing me to see you again, after such a long time. The purpose of this meeting is for us to reflect together about how you enabled mathematical understanding in your lessons, especially because you are in another country, coming from the same country. Please note that this meeting is recorded for reference purposes as I indicated in your letters. As promised, this interview will be used for my research study only and will be treated with a high level of confidentiality as promised.

In this interview, I will just share what transpired in each lesson, but I will not tell you who the teacher was, I just want us to discuss your thoughts regarding the language practices each of you used and why it is important or not important to use them in multilingual mathematics classrooms.

Guiding questions for the focus group interview

1. For each teacher I will pick up the language practices used and then focus on each language practice used and ask why they were used in that way. All three teachers are free to comment about the use of those language practices even if they did.

   Proposed question:

   - I noticed that some of you used this particular language practice (I will mention the language practice), can you explain why?
   - I noticed that some of you used this particular language practice more than others, can you explain why? (I will mention the language practice), can you explain why?
   - I noticed that some of you used this particular language practice minimally, can you explain why?
   - I noticed that some of you did not use this particular language practice at all, whereas it is commonly used in South African multilingual mathematics classrooms, can you explain why?
2. The teachers' responses will also guide me on the mathematical knowledge they want their learners to know.

APPENDIX M: PROCEDURAL AND CONCEPTUAL MATHEMATICAL KNOWLEDGE ANALYTICAL TOOL

Indicators for procedural and conceptual mathematical Discourse
What is it that he wants the learners to know, How? Procedural or conceptual? **Procedural: focuses on what procedure and how is procedure done/ which steps to follow.** **1.** The teacher **describes** how to perform a mathematical action, e.g., how to move from input value to output value, how to add, **how to rotate, how to move from the object to the image when rotating, and how to represent a fraction in a diagram.** **2.** The teacher **describes** the use of an action in a way that encourages memorization, e.g., telling the learners that they must know that add is the opposite of subtract, **telling the learners the procedure for translation, and telling the learners to put headings on top of the digits.** **3.** The teacher **describes** the use of an action by giving a clue to the learners' e.g., just look at the operational signs if you want to take the opposite direction. **Look at the dots in the object and the image and they will tell you the type of transformation; look at the total number of squares in the diagram and you will know if it's tenths or hundredths.** **4.** The teacher **asks** the learners to complete an action, e.g., find the output value when the input value and the rule are given, what is the rule? **I want you to turn 90 degrees clockwise** without explanation; **complete the table by representing this fraction in the form of a diagram.** **5.** The teacher **asks** for the answer to a calculation e.g., if we add two to nine in the number pattern, what will be the next number in the pattern, without requiring an explanation; **how many small squares do you see?** **6.** The teacher **asks** a question that requires the learners to recall a memorized procedure e.g., what is an inverse operation for 'add', **what is 90 degrees rotation for this shape? How do we write this in the form of a decimal fraction?** **7.** The teacher **asks** a question that requires a 'yes' or 'no' answer focusing on action, e.g., **did I rotate 90 degrees clockwise? Are we adding or subtracting?** **8.** The teacher **asks** the learners to describe the action they have used or how the action happened e.g., how the learners got the rule, or how they got to the next number in the pattern; **how did you move from the object to the image? How did you get 0.06?** **9.** The teacher **clarifies** a question by giving a clue for finding the correct action to the learners e.g., just look at the operational signs if you want to take the opposite direction. **Just look at the dots in the object and the image; just look at the headings and you will know the name of the decimal fraction.** **10.** The teacher **clarifies** a question by using another similar mathematical term e.g., using number patterns to clarify the question about how the rule works in flow diagrams, **using the example of the clock to clarify the question about clockwise rotation. Using the place value notation column to clarify a question about decimal fractions.**

11. He **clarifies** a question by using another procedural question in a different way e.g., first question: 'can you see my arrows, which direction are they going?' second question: 'are these arrows going backward?' **Q1: why do we call this transformation a turn? Q2: Am I still facing the same direction? Q1 how do we write 0.16 in expanded form? Q2 "boys and girls we have zero comma, zero comma what?"**

12. He **clarifies** a question by describing the action e.g., question: what happens if there is no 'input value'? He then describes when we are going backwards the operational signs in the given rule should change. **Q: what is a clockwise turn? C you need to look at how the arms of the face clock turn: Q: which answer is correct between 0.16 and 0.06? C: you need to put headings on top of the digits.**
13. He **clarifies** a question by repeating the question to the learners e.g., question: "when we are going backwards what happens to these signs, these operational signs? Question again: 'We are now going backwards, what happens to them?' **1st Q: does the shape change? 2nd Q: has the shape changed? 1st Q "do we have thousands?" 2nd Q: do we have a thousand column? Do we have that?"**

Conceptual focuses on the 'what' meaning of mathematical concepts and their relations represented using terms, visuals, and so on, and 'when' and 'why' to use mathematical procedures.

14. The teacher **describes the meaning** of an individual mathematical concept, e.g., when describing the meaning of 'input' he focuses on the meaning of the word 'in'. **The teachers focus on the meaning of the word 'transformation'; "When you're expanding, we want to show the value of each digit in a number, okay?"**
15. The teacher **describes** how an individual mathematical concept relates to another. e.g., the relationship between 'input' and 'output'. **Difference between the three types of transformations. The difference between a fraction in the form of a diagram and a fraction in decimal form.**
16. The teacher **asks** the learners to explain **why** they used a particular action, e.g., why they used a particular rule in a flow diagram. Q. **Why is the image facing the opposite side of the object in this transformation? Why do you put hundredths on top of that digit?**
17. The teacher **asks** the learner to explain **the meaning** of mathematical concepts, e.g., Q. gives the meaning of 'flow' 'input', or 'output'; **transformation, rotation, translation, etc. explain the meaning of expanded notation.**
18. The teacher asks learners to explain the difference between concepts or to represent mathematical concepts in different ways, e.g., Q. represents functional relationships in the form of a flow diagram, a table, or a number pattern. **Explain the difference between rotation and reflection using a grid. Represent decimal fractions as common fractions.**
19. The teacher **asks** a question that encourages the learners to compare, contrast and integrate related concepts, e.g., asks the learners to explain the difference/relationship

between 'input value' and 'output value'. Asks **the learners to explain the difference between translation and rotation. What is the difference between the tenths and the hundredths?**

20. He **clarifies** a question by **describing** the meaning of the mathematical concept e.g., after asking a question about the meaning of 'flow diagram' he clarifies the question by focusing on the meaning of the individual word 'flow'. **Clarifies the question by describing the meaning of 'translation' saying that it means 'slide.' Clarifies the question by describing the meaning of expanded notation.**

21. He **clarifies** a question by **asking another question** that focuses on the meaning of the concept he is teaching about. After asking a question about the meaning of 'flow diagram' he clarifies the question by asking about the meaning of the individual word 'flow.' **After asking about what translation means he clarifies his question about asking about the meaning of the word 'slide.' After asking about the name of the fraction he clarifies it by explaining the meaning of the mathematical term 'hundredths'**

22. He **clarifies** a question by **giving a clue** on why the action has to be done. **Why do you have to look at the dots of the object and image when doing translations? Why do we put headings on top of the digits when we want the name of the decimal fraction?**

23. The teacher **clarifies a** question by **describing** how an individual mathematical concept relates to another, e.g., how input value, output value, and the rule relate to each other. **How rotation relates to transformations. How the fraction in the form of a diagram relates to a decimal fraction.**

24. The teacher describes why a particular procedure has to be followed.

25. The teacher **clarifies** a question by **comparing and contrasting** related concepts, e.g., clarify the difference between output value and input value, and **clarify the difference between a slide and a flip. The difference between the fractions in theform of a diagram relates and a fraction in the form of a decimal.**

26. The teacher **asks** a question that requires a 'yes' or 'no' answer focusing on the meaning e.g., **did I change the size when I was turning? Is this the expanded form for this fraction?**

APPENDIX N: UNIVERSITY ETHICS APPROVAL LETTER

SCHOOL OF EDUCATION

Dr Carolyn McKinney
Associate Professor

University of Cape Town, Private Bag X3, Rondebosch, 7701
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Tel: +27 (0) 21 650 2757 / 2772 Fax: +27 (0) 21 650 3489
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EDNREC2017-05-01

31 May 2017

Faith Lindiwe Tshabalala
PhD Programme
UCT

Dear Ms Tshabalala,

RE: Ethical Clearance for Student Research Project

I am pleased to inform you that ethical clearance has been granted by the School of Education Ethics Review Committee of the Faculty of Humanities for your PhD research project entitled: 'Language practices of immigrant mathematics teachers in multilingual grade 6 classrooms in South Africa'.

I wish you all the best with your study.

Yours sincerely,

Associate Professor Carolyn McKinney
Chair, School of Education Research Ethics Committee

"Our Mission is to be an outstanding teaching and research university, educating for life and addressing the challenges facing our society."