CHAPTER 1

BACKGROUND TO THE STUDY

1.1 <u>Introduction</u>

This report presents a study that examined how a Grade 11 mathematics teacher in a multilingual class used learners' home languages as a support in learning and teaching Linear Programming concepts. My experiences as a mathematics learner and teacher whose home language is Sesotho triggered my interest in wanting to explore how mathematics teachers in multilingual classrooms use learners' home languages in order to support learners' understanding of mathematical concepts. My experiences on the importance of language in learning and teaching of mathematics can be described from two different levels. As a student going through an educational trajectory from primary to secondary schools, I was taught mathematics in English and yet during peer discussion we spoke mathematics in Sesotho to explain procedures and clarify concepts. Such discussions in our home language benefited me. As a mathematics educator, who shared a home language with learners, I taught mathematics in English, which is the official language of learning and teaching in Lesotho. But I also used Sesotho for explaining those concepts that learners were finding difficult to comprehend in English. It therefore became imperative for me to carry out this study, which investigated how a teacher uses learners' home languages in mathematics lessons to help learners comprehend demanding mathematical concepts. Barwell (2003) who does research on multilingualism in mathematics education poses the following questions:

> How many languages do you speak?
> How do you use different languages in your work as a teacher?
> (Barwell, 2003: 37)

These two questions asked by Barwell are crucial for all members of the community of mathematics education but even more critical to mathematics teachers in multilingual classrooms. In this study I refer to a class as being multilingual if any of the participants (learners, teachers or others) is potentially able to draw on more than one language as they go about their work (Setati & Barwell, 2006). Given the multilingual nature of the South African society it is logical to conclude that many schools in this country are multilingual. Furthermore a majority of learners in South Africa learn mathematics in a language that is not their home, first or main language. It is also well accepted that a majority of teachers are fluent in at least two languages. Barwell's question however remains; how do teachers use such different languages in their teaching? But we could also ask: How do teachers in multilingual mathematics classrooms utilize learners' home languages to support learners' understanding of mathematical concepts?

1.2 The purpose of the study

The purpose of this study was to explore how a Grade 11 mathematics teacher in a multilingual classroom used learners' home languages in order to support their understanding of key concepts in Linear Programming. Moschkovich (1996) argues that being bi/multilingual should not be viewed as an impediment to learning mathematics, it should rather be thought of as an advantage. In her view, the situated-sociocultural model is a more meaningful perspective through which interactions that take place in a bi/multilingual classroom could be better understood and interpreted. She argues that main languages of learners and their everyday situations are rich resources for the teaching and learning of mathematical concepts in bi/multilingual classrooms. Other resources include code switching, gestures, objects, and mathematical representations such as diagrams, tables, and graphs. The study was guided by the following critical questions:

a. How does a Grade 11 mathematics teacher in a multilingual classroom use learners' home languages when teaching linear programming?
b. How does the way in which the teacher uses learners' home languages support learners' understanding of key concepts in linear programming?
c. Why does the teacher use learners' home languages in the way in which he does?

1.3 Why this study?

It is well known that many students do not do well in Grade 12 mathematics in South Africa. Kahn (2005) argues that the majority of African learners are found in state schools, which do not in general perform well in mathematics and science. These state schools are multilingual in nature and are settings where the majority of learners do not speak the language of learning and teaching (LoLT), which is English as their main language. Kahn argues that those African learners who do well in mathematics are those who come from elite families and therefore are able to afford "ceiling level of fee payment in private and quasi-private schools" (Kahn 2005: 146). According to Kahn both private and quasi-private schools are high-performing schools with qualified teachers, with the ability to get learners through the examination trouble, with better teaching resources, and have a practice of teaching mathematics and science at 'higher grade'[1]. The recent report on the Trends in International Mathematics and Science Study (TIMSS) of 2003 also indicates that in general South African learners performed far below their counterparts from other countries in mathematics, and South Africa was rated last on the list of all countries that participated in the study (http://nces.ed.gov/timss, 30/05/2006). While there could be many factors contributing to this trend, language related issues could also be playing a part.

[1] Before the introduction of the National Curriculum Statement (NCS) in 2006, the syllabus in South Africa was divided into two levels namely higher grade (HG) and starndard grade (SG). One of the differences between the two was that a HG subject had more content than a SG subject.

Some researchers in mathematics education argue that there are challenges unique to multilingual classrooms. Setati (2005) contends that the issue of teaching mathematics in multilingual classrooms is complex because the most preferred language for teaching and learning in South Africa's schools is English, which is not the main language of a majority of learners. Despite the efforts that the government has put in place to give African languages status equal to English through the language-in-education policy, many parents and their children still choose English as their preferred language of learning and teaching. Setati (2003) argues that 'mother tongue instruction' has a bad image among speakers of African languages because it is associated with apartheid and hence inferior education. She further points out that although English is the main language of the minority in South Africa, it remains the language of power, educational and socio-economic advancement. Recently there has been on going debate in the media in South Africa about language and learning in schools. In these debates some African parents express their worries that teaching learning areas like mathematics in their home languages will further disadvantage their children, and learning home languages as learning areas will deny their children access to some reputable institutions of higher learning.

When commenting on the complexity of multilingual classrooms in South Africa, Chronaki and Christiansen (2005: 30) maintain that African students in historically white schools are "positioned in a lower stream of mathematics classes due to their lack of fluency in English and their supposed lack of experience". They further argue that these students can only participate in a limited way in mathematical activities, and their identities in mathematics classrooms are viewed as lacking, slow learners, and troublemakers. The issue here is that English as LoLT is used as a measure of learners' potential to learn and understand mathematics. It is also used as a basis for giving learners negative identities in mathematics classrooms.

In the following section I provide rationale for focusing on Linear Programming.

1.4 Why Linear Programming?

Linear Programming is a mathematics topic that was introduced in the mid eighties into the South African high school curriculum. Since its introduction, it has been offered only to learners who take mathematics at Higher Grade in Grade 12. However, with the introduction of the National Curriculum Statement (NSC) in January 2006 for the Further Education and Training (FET) band the differentiation between Standard and Higher Grades has been discontinued and thus all learners who take Mathematics instead of Mathematics Literacy have to study Linear Programming.

In terms of the South African NCS, Linear Programming falls under Learning Outcome (LO 2), which states that the learner is expected to "investigate, analyze, describe, and represent a wide range of functions and solve related problems" (DoE, 2003: 30). Learners are introduced to Linear Programming concepts for the first time in Grade 11 and continue with it up to Grade 12. Linear Programming is a linguistically demanding mathematical topic for many learners. As Laridon (1992) aptly put it, the language barriers in Linear Programming are too formidable. It involves significant mathematical terminology such as feasible region, objective function, constraints, and optimization. The question is: How can teachers use resources from learners' everyday contexts, learners' mathematical knowledge, and learners' ability to speak various languages (Moschkovich, 2002) in order to assist learners to cope with Linear Programming demands? Realizing the linguistic demands of some mathematical problems Tobias (2006: 23) advises mathematics teachers as follows:

> I believe that it is worthwhile to invest some time in ensuring that students are firstly not intimidated by new and unfamiliar words, and that secondly they are afforded the opportunity of becoming familiar with them before having to contend with them in problem solving.

While Tobias' admonition cuts across many mathematics topics, it is more so in Linear Programming. Linear Programming uses systems of inequalities to maximize or minimize such quantities as cost, profit, and allocation of raw materials subject to certain conditions. It is used extensively in commerce and industry. Below is an example of a typical Linear Programming task for learners taken from 2004 Grade 12 examination paper:

> *A group of students plan to sell x hamburgers and y chicken burgers at a rugby match. They have meat for* ***at most*** *300 hamburgers and* ***at most*** *400 chicken burgers. Each burger of both types is sold in a packet. There are 500 packets available. The demand is likely to be such that the number of chicken burgers sold is* ***at least*** *half the number of hamburgers sold. Write the* ***constraint*** *inequalities. Represent the* ***constraint*** *inequalities on the graph paper. Shade the feasible region on the graph paper. A* ***profit*** *of R3 is made on each hamburger sold and R2 on each chicken burger sold. Write the equation which represents the* ***total profit****, P, in terms of x and y. The objective is to* ***maximize profit****. Draw the search line (****objective function****) on the graph paper by indicating it as a dotted line in its* ***optimum position****. How many, of each type of burgers should be sold to maximize profit?*
>
> (DoE, 2004, page 9)

In the above task, I have highlighted some words and expressions in order to show the linguistic demands of a typical linear programming task and not to suggest that this study is informed by the two theoretical perspectives (acquiring vocabulary and constructing multiple meanings), which Moschkovich (2002) refer to as discontinuity models limited to stressing bilingual learners' deficiencies and incompetence in learning mathematics. By linguistic demands here I mean the level of language complexity that a learner has to come to grips with in order for them to successfully complete the task. The linguistic demands of the above task are high because the highlighted words are not only part of the ordinary English language but they are also mathematical English words (Pimm, 1982). According to Pimm mathematical classes take place in a mixture of ordinary English and mathematical English in which ordinary words are used with a specialized meaning as a result

> Many children's difficulties with mathematics may be due more to the complexity of wording of written material, rather than the mathematical task being requested
> (Pimm, 1982: 149).

While it is important for teachers to assist learners to distinguish between ordinary English words and mathematical English words, it is even more crucial for teachers to empower learners to use both ordinary English words and mathematical English words to communicate mathematically. In this study I am informed by the situated-sociocultural perspective (Moschkovich, 2002) in order for me understand the teaching and learning of linear programming. As I will discuss in Chapter 2, this perspective advocates the realization of context through which vocabulary is used. Therefore in the above task, the mathematical terms used need to be understood in contexts instead of striving to acquire their individual meaning. It is also important to think and explore how learners would utilize various resources to work out the solution.

In Linear Programming, learners are expected to use mathematics representations (diagrams, tables and graphs). Thomson (1994) refers to the notion of 'function as a correspondence' in order to explain various forms that a function can take. Those forms include an equation, table, and graph. But if learners have not understood the meanings of the highlighted words/expressions in the above task, they might not be able to translate and represent expressions like *at most* and *at least* into symbolic form (inequalities). Learners also have to be competent in sketching linear graphs. Laridon (1992: 363) contends, "Linear Programming tests the pupil's ability to interpret graphs. Dealing successfully with intersecting lines, areas and half planes has to be taught to most pupils – it does not come naturally to all". This means a considerable amount of time must be spent on tasks that require participation in sketching graphs. While Laridon (1992) argues that there is no "best" strategy for teaching Linear Programming, he suggests that helping learners gain competence in dealing with straight-line graphs is crucial.

Linear programming could be learned meaningfully by means of available technology. The mathematics syllabus in South Africa suggests that the minimum technology could be a scientific calculator. De Villiers (1995) argues that there is great need for learners to use technology in investigations because any experimental exploration by hand is extremely tedious. He further argues that pencil and paper work is relatively inaccurate and advocates the use of appropriate technology in the classroom such as *graphic calculators* or computer programs like *Geometer Sketchpad*. Luthuli (1995) agrees with De Villiers that with the introduction of graphing calculator and many computer programs that display algebraic graphs on the screen, it becomes quite instructive to use this technology to investigate, explore and draw various graphs.

Linear Programming involves rich real-world contexts. The researchers in the Realistic Mathematics Education (RME) project in the Netherlands argue that mathematics is best learned from realistic situations that are relevant and challenging to learners. According to Vos (2002), mathematical activities in RME are termed mathematising. Vos identifies two main dimensions of mathematising namely horizontal and vertical. Horizontal mathematising occurs when learners use their own methods and strategies such as making models, graphs, diagrams, tables and equations to solve mathematics problems. On the other hand, vertical mathematising takes place when learners' informal methods lead them to find a suitable algorithm to solve a realistic problem. The challenge is that when the context is too rich with language multilingual learners are likely to find it extremely hard to mathematize horizontally. By language here I mean both ordinary and mathematical language (Pirie, 1998). When pointing to the importance of language in teaching and learning of mathematics Pirie (1998: 8) argues that "Language in its broadest sense is the mechanism by which teachers and pupils alike attempt to express their mathematical understandings to each other". In this study, I explore how a teacher uses learners' home languages in addition to English to teach Linear Programming concepts.

Conclusion

In this introductory chapter, I have provided description of the background to this study. I have also given the rationale for carrying out this study, and began to link the study to the existing literature. In the subsequent chapters, I explore the related literature further and establish the theoretical framework for the study. I also discuss research methodology and design. I focus on data analysis and end the report by discussing the results and implications for teaching.

CHAPTER 2

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

Situated-sociocultural perspectives to learning and teaching, and empirical work done in bi/multilingual settings informed this study. In this chapter, I discuss and explore such theories and review the related literature.

2.2 Situated theory

The situative theorists contend that learning is part of social practice. Participation of learners as novices and teachers as masters in a schooling community of practice is extremely important. Lave and Wenger (1991) argue that knowledge is situated within a community of practice. The communities of practice consist of what Lave & Wenger refer to as newcomers and old-timers. Newcomers join the community by working through less challenging tasks and learn to linguistically interact with other newcomers. Through the use of language, old-timers scaffold newcomers' utterances and thinking. As they gain confidence in the culture of the community, newcomers increase their participation. Lampert (2001) argues that for this community of learners to function well and efficiently, it must have a common goal clearly articulated to all members of the community. The goal for a community of mathematics learners would be to explore and investigate mathematical concepts together as a group. Another goal would be to allow learners to discuss mathematical concepts through the use of their home languages. In this community a teacher is a more knowledgeable member but has to put his/her knowledge at the back of his/her mind in order for him/her to function as a co-explorer and co-producer of knowledge with learners (Schoenfeld, 1996).

Other researchers in mathematics education have termed mathematics practices authentic activities. According to Brown, Collins, and Duguid (1989) authentic activities are defined as the ordinary practices of a culture. The term culture here refers to the means and ways in which mathematicians work. Therefore, communities of learners are helpful in socializing learners in the manner in which mathematicians work. According to the RAND Mathematics Study Panel (2002: 24) mathematical practices are "what mathematicians and proficient mathematics users do". The Panel identified three core practices as "representation, justification, and generalization" (p. 31). These three major practices encompass many other activities such as being able to produce, discover, comprehend, perform, use, and enjoy mathematics. While it is true that sometimes mathematicians work individually, it is also true that most of the time they collaborate with others and work as a team (community). Allowing learners to fully participate in mathematical conversations in the language of their choice in group-work and/or in whole class discussion gives them a feel of how mathematicians work within their practice.

The strongest feature of theories that advocate the notion of teaching and learning as participating in a culture is that they allow us to talk optimistically about how learners gain competence through participation in a community of practice. Sfard (1998: 8) admits that, "the vocabulary of participation brings the message of togetherness, solidarity, and collaboration". When learning is viewed from the situative perspective, the consequences could be positively considerable in many schools in South Africa where many African students were historically denied access to mathematics learning on the false premise that they were not capable of comprehending it. The participation perspective assumes that all learners have a potential of being active participants in mathematics. It could be argued from this perspective as well that home languages of learners are resources for learning and teaching mathematics.

2.3 Situated-sociocultural theoretical framework

According to Moschkovich (2002) research done in bi/multilingual settings used analytical models that focused on acquiring vocabulary and constructing multiple meanings. She critiques these two perspectives for failing to consider resources that bi/multilingual learners utilize as they participate in mathematical communication and when mathematising situations. Moschkovich draws on her work in bilingual mathematics classrooms in the United States of America (USA) and argues that vocabulary perspective may have been useful in describing traditional mathematical classrooms where emphasis used to be on acquiring technical vocabulary, solving word problems, and mastering algorithms. However, in today's mathematics classrooms students are expected to participate in classroom mathematical practices that go beyond solving computation or word problems. She further argues that

> If we focus on a student's failure to use a technical term, we might miss how a student constructs meaning for mathematical terms or uses multiple resources, such as gestures, objects, or everyday experiences. We might also miss how the student uses important aspects of competent mathematical communication that are beyond a vocabulary list.
>
> (Moschkovich, 2002: 193)

The multiple meanings perspective is based on the notion of a mathematics register. According to Halliday (1978) in Moschkovich (1996), a register is a set of meanings that is appropriate to a particular function of language, together with the words and structures that express these meanings. When learning to communicate mathematically, learners have to move from ordinary English register to a precise mathematics register. In most cases such transition is problematic. Moschkovich (1996 & 2002) criticizes the multiple-meaning perspective for only highlighting the mathematics register and failing to regard other important aspects of mathematical discourse, which involve more than the use of technical vocabulary and construction of meanings. Again, she argues that this model disregards the situational context of the utterances that participants make:

> Although words and phrases do have multiple meanings, these words and phrases appear in talk as utterances that occur within contexts. Much of the meaning is derived from situational resources (Moschkovich, 1996: 29).

The two perspectives discussed above are some of the models that could be used to analyze interactions that take place in a multilingual classroom. However, their limitations are that they point to acquiring vocabulary and constructing multiple meaning as possible sources for misunderstandings in mathematics conversations and that they consider learners' everyday experiences and home languages as other possible complications in learning mathematics. Moschkovich (2002) uses a situated-sociocultural perspective, which moves away from the description of obstacles and deficiencies that bi/multilingual learners encounter to a description of resources and competencies in learning mathematics. She argues that

> A situated-sociocultural perspective can be used to describe the details and complexities of how students, rather than struggling with the differences between the everyday and the mathematical registers or between two national languages, use resources from both registers and languages to communicate mathematically (Moschkovich, 2002: 197).

According to this perspective, learning mathematics is inherently social and cultural and viewed as participating in mathematical practices where learners learn to mathematize situations and communicate about such situations. There are four important concepts that are embedded within a situated-sociocultural framework namely: practices, bi/multilingualism, code switching, and Discourses (Moschkovich, 2002). These four notions widen researchers' understanding of interactions that take place in multilingual mathematics settings and should not be viewed as isolated conceptions.

Practices

In a mathematics classroom, learners engage in unique mathematical activities that are different from activities of any other discipline. Some mathematical practices are:

abstracting, generalizing, conjecturing, being precise, explaining, justifying, proving, specifying situations for which a claim holds, and connecting claims to representations. Focusing on these practices in this study assisted me as a researcher to not only pay attention to how languages are used but also more importantly to identify the mathematical content being dealt with in each lesson.

Multilingualism

From a situated-sociocultural perspective, a multilingual learner is understood to be a learner who participates in multiple-language communities (Moschkovich, 2002). A multilingual learner uses one of the languages for certain functions and the other for other functions or situations. Such a learner is competent to utilize any of the known languages in communicating mathematically and in participating in mathematical practices. Multilingual learners' utterances need to be described and interpreted on the basis of their situational contexts. In this study it would be important for me to recognize each learner as an individual who uses languages (home-language and LoLT) for particular functions. I would also have to recognize situations from which utterances are made during classroom interactions.

Code Switching

In this study, code switching refers to a situation where a verbal statement is made in at least two languages (e.g. English and Sesotho). According to Moschkovich (2002) code switching is a rule and constraint-governed process and a dynamic verbal strategy in its own right rather than evidence that learners are deficient or semi-lingual. Code switching is a resource available to multilingual learners in communicating mathematically and participating in mathematics practices. I anticipate code switching to occur in this study during classroom conversations. I expect that both the teacher and learners would code switch between languages during learning and teaching of linear programming content. In situated-sociocultural perspective, language is perceived as a resource used in conversations within communities of practice.

Discourses

Gee (1996) in Moschkovich (2002: 198) defines a Discourse as

> A socially accepted association among ways of using language, other symbolic expressions, and artifacts of thinking, feeling, believing, valuing and acting that can be used to identify oneself as a member of a socially meaningful group or social network, or to signal (that one is playing) a socially meaningful role.

The above definition shows that a Discourse encompasses among others belonging to a community of practice, ones' identity within such a community, and mastering the culture of the community. Mathematical Discourses therefore include mathematical values, beliefs, and points of view of a particular situation. Moschkovich (2002) argues that the encompassing definition of Discourses highlights not only ways of talking, acting, interacting, thinking, believing, reading, and writing but also the use of gestures and artifacts, practices, and communities of mathematical communication. Therefore "participating in classroom mathematical Discourse practices can be understood in general as talking and acting in the ways that mathematically competent people talk and act" (Moschkovich, 2002: 199). In this study, it was helpful for me as a researcher to realize how the teacher socializes learners into the practice of using their home languages to learn mathematics concepts.

The situated-sociocultural perspective served as a lens through which I looked at the interactions that took place in the five lessons that I observed in this study.

2.4 Literature review

Recent studies in mathematics education perceive learning to communicate mathematically as a central aspect of what it means to learn mathematics (Pimm, 1987; Adler, 2001; Setati, 2005; Sfard, Nesher, Streefland, Cobb and Mason, 1998; Moschkovich, 1996, 1998, 1999, 2002). This is also reflected in curriculum (DoE, 1997; 2002) and Standards documents in the USA (NCTM, 1991, 2000). Learners are now expected to participate in a variety of mathematical oral and written practices, such as explaining solution processes, describing conjectures, proving conclusions, and presenting arguments. In the National Curriculum Statement for FET, mathematics is defined as follows:

> *Mathematics enables creative and logical reasoning about problems in the physical and social world and in the context of mathematics itself. It is a distinctly human activity practiced by all cultures. Knowledge in the mathematical sciences is constructed through the establishment of descriptive, numerical and symbolical relations. Mathematics is based on observing patterns; with rigorous logical thinking, this leads to theories of abstract relations. Mathematical problem solving enables us to understand the world and make use of that understanding in our daily lives. Mathematics is developed and contested through both language and symbols by social interaction and is thus open to change. (DoE, 2003; 9)*

The above definition emphasizes the role that language plays in the development of mathematics. It highlights language as a resource for communication and thinking in mathematics. According to the National Council of Teachers of Mathematics (NCTM) principles and Standards for School Mathematics (2000: 60), communication is an essential part of mathematics and mathematics education. It is a way of sharing and clarifying understanding. It is through communication that ideas become objects of reflection, refinement, discussion and amendment. Encouraging communication about mathematics during teaching helps build meaning for learners' ideas and makes them public. When learners are challenged to think and reason about mathematics and communicate the results of their thinking to others orally or in writing, they learn to be clear and convincing to themselves and those they are communicating with. The question that is important to ask for multilingual classrooms is, in which language is this communication?

Recent research in South Africa shows that in classrooms where teachers insist on the use of English only during teaching, communication of mathematics is limited to procedural talk (Setati, 2005). There are of course classrooms where teachers use learners' home languages. The question that this study explored was; how does a Grade 11 mathematics teacher in a multilingual classroom use learners' home languages in order to support learners' understanding of concepts in Linear Programming? While there is a growing body of research on teaching and learning mathematics in multilingual classrooms, to my knowledge, none of this research has specifically focused on the teaching of Linear Programming. However, it is worth noting that one of the sampled teachers in Adler's (2001) study, Thandi, was observed introducing learners to Linear Programming concepts. Even though Adler's study was not particularly focusing on Linear Programming, what emerged from the analysis of Thandi's lesson is that learners encountered problems in understanding the meaning of words and phrases like: *more than, less than, not more than, at least,* and *at most*. Adler argues that Thandi experienced the dilemma of code switching. According to Adler (2001: 83) Thandi's "overarching concern was that if she herself switched and explained in Setswana, then she would be denying her learners access to English, she was also concerned with how she would manage switching given that there were Zulu and Xhosa speaking learners in the class".

But what is a dilemma? According to the Concise Oxford English Dictionary (2002: 401) a dilemma is "a problem or a difficult situation in which choice has to be made between two or more alternatives". Lampert (1985) is one of the early researchers to point to dilemmas that mathematics teachers face on daily basis in their endeavor to help learners understand concepts. She argues that teachers may have to face dilemmas such as; "choosing between excellence and equality, between pushing students to achieve and providing a comfortable learning environment, between covering the curriculum and attending to individual understanding” (p.182). Lampert argues that as teachers we need to consider our role as dilemma managers. When providing a critique of Lampert’s work on management of dilemmas, Adler (2001) argues that teachers’ knowledge needs to be situated in time and place, and be extended beyond the personal and practical dilemmas of Lampert to encompass other forms of dilemmas such as code-switching, mediation, and transparency. What is of interest for this study is the dilemma of code switching because the focus of the study is on how a teacher uses learners’ home languages when teaching Linear Programming. It was interesting to observe and understand how the teacher in this study switched between languages in one lesson in order to help learners to comprehend key concepts. When learners were requested to use their home languages when communicating mathematically, the teacher in this study had to manage the dilemma of mediation.

Teachers in South Africa are aware that the new curriculum advocates new approaches to teaching such as learner-centered approach. According to this approach learners learn mathematics concepts through discussion in groups or participating in the whole class mathematics conversation. The teacher in Adler’s study argued that in many cases when her learners engage in mathematics communication, they lose track of expected mathematics knowledge. While this is true in all mathematics classrooms, the situation is worse in multilingual classrooms where learners are required to communicate mathematical concepts in English a language that they are not fluent in. So the dilemma for a teacher is in relation to his intervention. That is, when is it appropriate for the teacher to intervene in learners’ talk? If the teacher intervenes immediately when he feels that learners are losing track, the danger is that by so doing he might be discouraging learners’ participation. On the other hand if he delays to mediate, learners might eventually reach consensus on incorrect conception, which might be difficult for the teacher to correct.

Conclusion

In this chapter, I have discussed the situated-sociocultural theoretical framework as the theory that guided my study. This theory served as a lens through which as a researcher I observed and I was able to interpret the interactions that took place in the multilingual classroom. I have also highlighted some issues pertaining to the use of language as a means through which learners and teachers participate in communicating mathematically in class. It follows then, that learners' home languages in multilingual classrooms are critical in enhancing learners' participation in learning and teaching mathematics.

In the next chapter I pay attention to issues of research methods.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter focuses on the methodological matters dealt with in the study. I explain the nature of the study, the manner in which the subjects in the study were selected, the way data was collected and analysed, the ways in which I ensured that issues of validity and reliability were addressed, and how I attended to ethical issues.

This is a critical case study (Cohen and Manion, 1994), which seeks to obtain insights into how a carefully identified Grade 11 mathematics teacher in a multilingual classroom used learners' home languages in order to support learners' understanding of concepts in Linear Programming. Mouton (2001: 149) defines case studies as "studies that are usually qualitative in nature and that aim at providing an in-depth description of a small number of cases". The choice of a qualitative approach has been influenced by my epistemological orientation that knowledge is situated in a community of practice (Lave and Wenger 1991) and that it is inherently social and cultural (Moschkovich, 2002). This study describes the ways in which the teacher used learners' home languages. It also explains and interprets why the teacher in the study used home languages in the manner in which he did. The case in this study is a Grade 11 multilingual mathematics teacher together with his class of 29 learners, which was purposively selected (Cohen and Manion, 1994). According to Cohen and Manion,

> In purposive sampling, researchers handpick the cases to be included in the sample on the basis of their judgment of their typicality. In this way, they build up a sample that is satisfactory to their specific needs (1994: 89).

In what follows, I discuss the criteria that were used to select the case in this study.

3.2 Selection of case

In this study, it was important to have an appropriately qualified Grade 11 mathematics teacher who had been teaching for at least five years. The teacher needed to be multilingual, speak and/or understand more than two African languages and teaching multilingual learners. Furthermore, it was important to have a teacher who understood the complexities of teaching and learning mathematics in multilingual classrooms and also who regarded learners' home language as a resource. For purposes of convenience the teacher had to be teaching in one of the schools in Johannesburg.

To identify this kind of a teacher I looked through the database of former and current mathematics education honours students at the University of the Witwatersrand. I chose to identify a suitable teacher from this database because the B.Sc (hons) programme at the University of the Witwatersrand is an in-service teacher education programme specifically designed to meet the needs of specialist mathematics and science teachers in our schools. While there were a few students who fitted most of the criteria, there was one teacher in the group who was undertaking an action research in which he was transforming his teaching of linear programming in his multilingual class.

The teacher's home language is isiZulu, however, he is fluent in isiXhosa and understands Sesotho and Sepedi the other languages in his class. During exploratory talks with this teacher, he explained that he considered home languages of learners as important for teaching mathematics, and for the first time in his teaching had decided to use them to support learners' understanding.

3.3 Data collection

Data was collected through lesson observations and a reflective interview with the teacher. The lesson observation was aided by video recording of five consecutive lessons focusing on linear programming. Each lesson was about 45 minutes long, which means in all I collected 225 minutes of teaching data. The reflective interview with the teacher was conducted three months after the observation of the lessons. In order to do a meaningful reflective interview it was imperative for me to study the video recordings first. The time gap between the lesson videoing and the reflective interview offered me chance to transcribe all the five lessons, to study the lessons carefully, and to identify issues that I wanted to discuss with the teacher during the interview. The tasks that the teacher used in each lesson formed part of the data in this study. They were collected at the end of each lesson. They were later analysed for cognitive and linguistic demands embedded in them.

3.4 Video recording the lessons

Videoing lessons afforded me opportunities to record directly the teacher and learners' verbal interactions (Opie, 2004) during the lesson. Such interactions involve what they say to one another, the language the teacher and his learners use for questions, answers, and explanations. Videoing the lessons also allowed me as a researcher to observe how the teacher used resources like gestures and representations to reinforce understanding of concepts. Opie (2004: 125) argues that lesson observation is helpful in that the researcher is able to record non-verbal behaviour such as "movement, gesture, facial expressions like smiles and frowns", which could not be easily detected through the use of other instruments like questionnaires. Watching the videos of the lessons helped me as researcher to identify situations where the teacher and his learners deliberately used home languages to communicate mathematically and clarify meaning of concepts. Video recording also helped me as a researcher to capture a wider range of activities going on during the lesson. It captured a lasting record of conversations that took place during each lesson. While many incidents were recorded, the focus of the video was mainly on how the teacher used learners' home languages to teach key concepts in Linear Programming.

Unlike a tape recorder, videoing is powerful in that a researcher is not only able to hear voices but can also see and hear who does the talking and how they do it. This lasting record was used as a basis for the reflective interview. The teacher was given the digital versatile disc (DVD) of his five videoed lessons to watch in order to refresh his memory prior to the interview session. All five lessons were transcribed to enable analysis of the usage of home languages during teaching of Linear Programming.

3.5 Reflective Teacher Interview

The interview followed a semi-structured set-up in order to allow the teacher to provide as much information as he wished. According to Opie, semi-structured interviews are

> A more flexible version of structured interviews, which will allow for a depth of feeling to be ascertained by providing opportunities to probe and expand the interviewee's responses. It also allows for deviation from a prearranged text and to change the wording of questions or the order in which they are asked (2004: 118).

During the interview, amongst other things the teacher was shown carefully selected video clips of his own teaching and asked to reflect back and talk about what was happening in those incidents. The selected video clips focused mainly on the way the learners' home languages were used. The teacher was further probed about his views on the success of how he uses the learners' home languages during teaching. The interview with the teacher was tape-recorded, transcribed and served as data in this study.

3.6 Data analysis

According to Mouton (2001), the process of data analysis involves breaking up the data into manageable themes, patterns, trends and relationships. To analyze data in this study, I first transcribed all five lessons. I then worked carefully through all the transcripts of the five lessons identifying instances (situations), in which home languages were used, either by the teacher or by the learners. In total I identified six situations in which the learners' home languages were used. The learners' home languages were used for the following:

- The mathematical tasks given
- Questions asked by the teacher during interaction with the learners
- Learners' contributions during whole class discussion
- Re-voicing learners' ideas
- Giving instructions
- Learners discussing in their groups.

I counted the number of usage of either learners' home languages or English in each situation across the five lessons and recorded the results in Table 4.2 in the next chapter. The details of how I counted the occurrences of each situation are provided in the next chapter. This exercise of counting was not only necessary for the purposes of ensuring rigour in this study but also to enable me understand the extent to which home languages were used in each category. I then developed graphs based on each situation showing the frequencies at which the languages were used across the five lessons. Both the table and graphs are presented in the next chapter. This process enabled me to provide answers to the following research questions I stated in chapter one:

- How does a Grade 11 mathematics teacher in a multilingual classroom use learners' home languages when teaching Linear Programming?

- How does the way in which the teacher uses learners' home languages support learners' understanding of key concepts in Linear Programming?
- Why does the teacher use learners' home languages in the way in which he does?

In what follows I describe each of the identified six situations.

Mathematical tasks

Stein, Grover, and Henningsen (1996: 460) define a mathematics task as "a classroom activity, the purpose of which is to focus students' attention on a particular mathematical idea". In the teaching and learning of mathematics, a teacher plays a key role in selecting tasks from textbooks or in creating tasks that are appropriate for learners. When selecting tasks, a teacher is guided by the goal he wants to achieve. That is what learning opportunities will the selected task give to learners? He is also guided by his knowledge of the mathematics content and knowledge of his learners. A mathematics task can be given in class in the form of a worksheet, on the chalkboard, on the overhead projector (OHP), or from a textbook just to mention a few.

In this study, the teacher used mathematics tasks in each lesson. The tasks were carefully selected to satisfy the objective set by the teacher, which is to use learners' home languages to teach linear programming concepts. As will be seen in the next chapter, the tasks that were given in lessons 1 – 3 provided learners with prerequisite concepts for linear programming. Tasks that were used in lessons 4 and 5 were linear programming tasks.

Questions asked by the teacher

Teacher questioning is the most indispensable feature of meaningful teaching of mathematics. The teacher in this study asked learners various questions in each lesson. He asked questions when learners were working in their respective groups and during the whole class discussion. The questions that were used for analysis were only those that the teacher asked during the whole class discussion. It was not easy for the video recorder to capture the voices of learners and that of the teacher during group work session. The questions that the teacher asked during the whole class discussion were either in learners' home languages or in English. Such questions were counted from the transcripts of every lesson and recorded in Table 4.2 in the next chapter. The same scores were also represented in a graph (Chart 4.2) in order to show the frequencies at which learners' home languages were used in asking questions across all five lessons.

Learners' contributions

Learners' contributions were made in two sessions. In the first session, learners made their verbal contributions in their respective groups. I did not transcribe the contributions that learners made in their groups because they were not audible. The second session was when learners made their verbal contributions during the whole class discussion. During this session, one learner was called to the front to explain how they worked out the task in their group. Other learners asked questions, or gave different explanations. Such contributions were made either in learners' home languages or in English. All learners' contributions were counted and recorded in Table 4.2. The scores were also presented in Chart 4.3 in order to show frequencies of how languages were used by learners during the whole class discussion.

Re-voicing learners' ideas

Re-voicing learners' utterances is a common practice in mathematics lessons. What does it mean to re-voice learner's utterance? According to Brodie (2004: 192)

> Re-voicing is a move where the teacher repeats or rephrases a student's comment. Re-voicing amplifies the student's contribution, and sometimes reformulates it in

> more precise language, while still maintaining the student as owner of the contribution.

I carefully looked through the transcripts for the five lessons identifying sentences where the teacher re-voiced learners' utterances. In each lesson I counted such sentences and recorded the scores in Table 4.2. Learners' contributions were re-voiced in home languages and in English. Such learners' utterances were either made in home languages or in English or in both. However, I did not consider the language through which learners' contributions were made. I only focused on the languages that the teacher used each time he re-voiced learners' utterances. After recording all the scores in Table 4.2, I presented the scores in Chart 4.4 to show how languages were used for re-voicing across the five lessons.

Giving instructions

Instructions are necessary in any classroom so that order is maintained in class. Giving instructions forms a crucial part of classroom management. The teacher used learners' home languages and English to give instructions to learners across the five lessons. I studied all transcripts carefully and counted all sentences in each lesson where the teacher gave instructions. I then recorded the scores in Table 4.2 and represented them in Chart 4.5. In Chart 4.5, the frequencies at which home languages were used for giving instructions to learners across all five lessons are shown.

Group work discussion

Working in groups helps learners to communicate mathematically. The teacher in this study grouped learners according to their home languages. Grouping learners in this way was a deliberate effort by the teacher to ensure that learners discuss tasks in their home languages. As mentioned earlier, what learners said during group work session was not audible enough for transcription. As a result I did not consider this situation (*Use of learners' home languages during group work*) for analysis. This means, while I identified six situations where learners' home languages were used across the five video recorded lessons, I only focused on five such situations in the analysis chapter.

3.7 Validity and reliability

Validity and reliability are conceptions that have been extensively used in quantitative studies to ensure rigor in research. The thought-provoking question for any research report as asked by Bosk (1979) quoted in Maxwell (1992: 279) is: “why should we believe it?” While this question cuts across both quantitative and qualitative studies, it bears more weight on qualitative research because it is not easy for a researcher to ensure objectivity during data collection and analysis. According to Maxwell, what a researcher sees, hears, and says is to a large extent determined by their social and cultural background, hence difficult to ensure absolute objectivity. Secondly, in qualitative research validity and reliability do not rely entirely on the accuracy of the instrument used for data collection. Opie (2004) argues that validity and reliability in qualitative studies are the property of the whole data process. Which means it is the responsibility of the researcher to ensure that their study is trustworthy and credible.

3.7.1 Validity

In order to ensure trustworthiness and rigor in this study, I used Maxwell’s (1992) typology on validity. Maxwell’s categories of validity in qualitative studies are: “descriptive validity, interpretive validity, theoretical validity, generalizability, and evaluative validity” (284). Of relevance to this study are: descriptive validity, interpretive validity, and theoretical validity. Maxwell too argues that these three are critical in any qualitative study. Therefore below I only discuss descriptive validity, interpretive validity, and theoretical validity.

Descriptive Validity

The descriptive validity pertains to the question of the degree of accuracy when recording the actions of participants during the period of data collection. In Maxwell's words "are the researchers not making up or distorting things they saw and heard?" (285). The obligation for every researcher conducting research in a social setting is to make accurate records of physical and behavioural events. According to Maxwell, such records should be free from what the researcher views to be the meaning of such acts and events. They should be free from researcher's interpretation. In this study I transcribed all the utterances of the participants in the languages that they used. I watched the video recordings several times to ensure that I make note of all actions of either the teacher or learners such as gestures and movements to and fro the chalkboard or between groups of learners. When writing such actions and events I did not attach any meaning to them or my interpretation. This is reflected on the transcripts attached in the appendix. In other words, the process of transcribing was guided by the video.

Interpretive Validity

According to Maxwell, interpretive validity is concerned with the accounts made about objects, events, and behaviours identified in the empirical setting of the study. In order to ensure that there is an interpretive validity in a study, accounts relating to meaning of phenomena should be made from the perspective of the people involved in the study (i.e. the researched) and not on the basis of the researcher's perspective and predetermined categories. Maxwell (1992: 289) argues, "interpretive accounts are grounded in the language of the people studied and rely as much as possible on their own words and concepts". In this study I interpreted the teacher and learners' views on the basis of their own utterances. I further interviewed the teacher in order for him to assist me to comprehend his meaning of the events that transpired in each of his lessons. Therefore in this study I made accounts on the basis of the teacher's accounts and other evidence gathered from the lessons. All interpretations were backed by extracts from data.

Theoretical validity

Theoretical validity deals with the theoretical constructs that a researcher brings to, or develops during the study (Maxwell, 1992). Maxwell contends that since such theoretical constructs are used to explain data, there must be an agreement within the research community about the validity of them and the relationship between them. In this study, I attended to theoretical validity by using the following constructs discussed in chapter two; practices, bi/multilingualism, code switching, and Discourses, which provide insights about how a teacher in a bi/multilingual classroom could use learners' home languages as a support for understanding mathematical concepts. I also referred to socio-cultural and situated theories in order to understand how the teacher operated within his classroom and interacted with his learners. The categories that emerged from data in this study are by no means seen for the first time but have been dealt with in one way or another within the community of mathematics education researchers.

3.7.2 <u>Reliability</u>

According to Bell (1999) in Opie (2004: 66) reliability is defined as "the extent to which a test or procedure produces similar results under constant conditions on all occasions". In qualitative studies, it is not practically easy to ensure 'constant conditions' given the nature of the empirical fields from which data are gathered, which in most cases involve human beings. People's perceptions and behaviours change from time to time. However, Opie argues that in some qualitative studies, reliability could be ensured by employing what he calls 'test-retest' procedure as a means of gathering data from the same subjects, and then the results of the two tests be compared. According to Maxwell's (1992) view reliability is attained if different observers or methods produce descriptively similar accounts of the same events or situations. Maxwell further argues that in a case where observers produce descriptively different accounts of the same events or situations, different observers should come to agree on their descriptive accuracy, or they should establish that the differences were due to the differences in perspective and purposes of the observers.

In this study I attended to issues of reliability firstly, by watching the videos of all five lessons several times in order to ensure that my transcripts are correct and accurate. This involved recording the teacher's and learners' utterances in the languages they used together with movements within the classroom (e.g. going to the chalkboard) and gestures. Secondly, by checking the accounts I made against the accounts of the other two independent researchers who observed the same five lessons that I used as source of my data, and found that our accounts were descriptively similar. For example, in his report Duma (2006: 31) gives the following descriptive account:

> It was evident during the whole class discussion when one learner from Sepedi group said "*Rona re fumane ho le bonolo ha re e bala ka Sepedi*". This means they found the task easier when they read it in Sepedi. However some learners from Sesotho and Zulu group felt that the use of home languages in translating technical words like inequality which was translated as "*kgaello*" made it difficult for them to engage with the task. Whereas the Zulu group complained that the home languages hinder them from engaging with the task. For example, they said the word "*Ezingadalulwanga*" was not familiar to them; hence they spent more time trying to make sense of it instead of solving the problem.

The above account is similar to the descriptive account I made in chapter 4. Even though the three of us (researchers) went into these lessons with different research questions our descriptive accounts of the lessons are in harmony. In the following section I deal with issues pertaining to research ethics.

3.8 Ethical considerations

In educational research, the question of ethics is extremely important because data is sought from engaging human beings. According to Opie (2004: 25)

> Research comes into the lives of people who are the focus in various ways, taking up their time, involving them in activities they wouldn't otherwise have been involved in, providing researchers with privileged knowledge about them – and therefore, potentially, power over them.

The above account shows that ethical considerations involve both the process and power. Issues of process and power have to be dealt with jointly right from when a researcher applies to acquire access into a school up until when a researcher has analysed all data and returns to share findings with the researched. According to Setati (2005: 95) "negotiating access to schools involves hierarchical Power and individual power". Setati makes a distinction between Power and power. Where capital P power refers to the managerial and administrative authority that owners of schools have to either grant or deny a researcher access into their schools. To get access into the school where my study was carried out, I asked for permission from Gauteng Department of Education (GDE) and the principal of the school. I filled a request form to the GDE, which I submitted together with my research proposal and the research instruments. I wrote a letter to the principal of the school asking for permission to carry out research in their school. These two bodies – GDE officials and the school principal have Power, which upon scrutinizing my proposal and instruments they both exercised to give me permission to go on with my research. I was fortunate to have approval from these two bodies, because there is a possibility of getting approval from GDE and be denied access into the school by the principal. What about small p power?

According to Setati (2005: 95)

> There are stakeholders within a school who may not have much hierarchical Power but use their individual **p**ower (the ability to do or act) to deny the researcher access to the school. These may include ordinary teachers, parents or learners in the school who may refuse to participate.

In this study I had to write a letter to the teacher requesting him to participate in my study. Even though the teacher had verbally agreed I needed a written record of his agreement. I sent a letter and a consent form to parents asking them to either allow or forbid their children to participate in my study. Letters and forms to both parents were written in such a way that the concerned parties would not by any means feel obliged to allow their children participate. For example, letters stated that participants were to feel free to withdraw at any stage of the study and would not be victimized in any ways, and that confidentiality, privacy and anonymity for all participants would be preserved whenever data collected in this classroom were to be used for other purposes such as conference presentations. On the other hand, issues of power are mainly about the relationship between the researcher and participants as the researched.

In a qualitative type of research, power relations exist between the researcher and the researched (e.g. teachers). In most cases a researcher is viewed as having more power than the researched due to the fact that they come to teachers with clear agenda (e.g. research questions and methodologies). Setati argues that in some instances some researchers have abused their power relations with teachers and school principals thereby failing to maintain and nurture good relationship with schools.

> Many schools have been victims of researchers, who drove in, collected data, drove out and never came back to share their findings or the insights from research. As a result some principals and teachers are very skeptical about anyone wanting to do research in their school. (Setati, 2005: 94).

The question is how best can researchers maintain good relations with teachers? Setati (2005) suggests a notion of working "with and on" teachers as opposed to either working “on” teachers or working “with” teachers. According to Setati this notion of working with and on teachers is a mutual exchange of service, obligations or privileges, and includes negotiation and choice. In this type of relationship both the researcher and teachers benefit. Like many researchers, I went into the school with a clear research agenda (research questions, methodology, and theoretical framework), which I discussed with the teacher so that he could have an idea of what I was looking for. However, I did not leave room for the teacher to change my agenda. The teacher and I had known each other for a year and five months by the date of data collection. We had done some courses together in the year prior to data collection at the university. Therefore coming to collect data in his class was not a threat at all. The teacher did not consider me as having more power than him, rather as a colleague. He also had his agenda, which was not directly related to my work in his class. During the week of data collection he asked me if he could discuss his course assignments with me before submission dates. This was for the first time this teacher asked me for this kind of service. I agreed because I also felt obliged to give back something to the school. It is interesting that this kind of relationship between the teacher and I continued way beyond the period of data collection.

Conclusion

In this chapter, I have described the methods I used to collect data and how I analyzed data. The methodology discussed in this chapter is appropriate for this study. Focusing on the selected case (the teacher) relevant data would be gathered that would possibly provide answers to critical questions raised in Chapter one. I explained how I categorized and coded my data. I finally discussed issues pertaining to rigour and ethics.

CHAPTER 4

DATA ANALYSIS

4.1 Introduction

In this chapter, I present an analysis of data that was collected through lesson observations and teacher interview. As mentioned in the previous chapter, lessons were observed over five consecutive days and the reflective interview with the teacher was conducted three months after the videoing of lessons. The time gap between the lesson videoing and teacher interview gave me an opportunity to transcribe all the five lessons and to study the lessons carefully in preparation for the reflective interview. I watched the video several times identifying instances across all five lessons from which an interview schedule was developed.

In the section that follows, I begin the analysis by providing an overview of those five lessons. The overview is followed by an in-depth analysis of the transcripts of all five lessons and the tasks that were used in those lessons. As explained in Chapter 3, the analysis was done by means of identifying situations in which the learners' home languages were used across the five lessons.

Throughout the extracts in this chapter, I use the following key:

( ) – Translation to English
… – Pauses or the speaker is interrupted
[ ] – My comments
R – Researcher
T – Teacher

4.2 Overview of the lessons

Table 4.1 provides an overview of what happened in all the five mathematics lessons observed. The first three lessons focused on equations and inequalities, and the last two lessons were mainly on Linear Programming. The teacher explained to me before the lessons that he planned to use the learners' home languages deliberately in his teaching. The table also serves to indicate the mathematical content covered and the activities carried out in each lesson.

Table 4.1: The descriptions of the five lessons

DAY	DURATION	LESSON TOPIC	CONTENT	DESCRIPTIONS
1	45 min	Linear Equations	Sketching linear graphs. $3x + 2y = 6$ $3x - 2y = 4$ $-2x + y = 0$ $y - 3x = 4$ $y = 3$ $x = 4$	The teacher began the lesson by grouping learners according to their home languages. There were 2 Sepedi groups, 2 Sesotho groups, 1 Xhosa group, and 1 Zulu group. In total, there were 6 groups in this class. Each group was given handouts and instructions to be followed when sketching the linear graphs. Learners worked in their respective groups. This was followed by the whole class discussion. This discussion was in various home languages
2	45 min	Inequalities	Sketching inequalities $2x + 5y \leq 10$ $2x + 5y \geq 10$ $2x + 5y < 10$ $2x + 5y > 10$	The lesson commenced with the teacher distributing worksheets to learners. Learners sketched lines but could not shade regions properly. The teacher went to the chalkboard and explained to learners the meanings of $\leq, \geq, <$ and $>$ and how the shading has to be done. The teacher asked learners to say what the term restriction means in their home languages. The Sesotho group said "ke molao" and the isiZulu group said "umthetho". The discussion went on into when to *shade* above *or below* the graph. Learners discussed this inequality $y \leq \frac{-2}{5}x + 2$ one learner said, "you

				shade below because in this graph it means that you look where the values of y are less. The teacher emphasized why learners should shade below.
3	45 min	Sketching feasible regions given constraints.	Coordinates, simultaneous equations, feasible region.	When the lesson began, the teacher gave learners a worksheet. The worksheet required learners to apply what they had learned in two previous lessons. For example, learners were to write down the equations of straight lines that served as constraints to the shown feasible regions. They also had to write and describe the inequalities shown in diagrams on the worksheet. Learners worked in their respective groups. They were able to recall that the solution for simultaneous equations is found at the point of intersection. They successfully described constraints and the resulting feasible regions. They were also able to draw required regions that were indicated by the overlap of colours. At the end of the lesson learners were given homework. The homework was based on what was taught in this lesson.
4	45 min	Gradient and equations of straight lines. Word problems	Use the formula $m = (y_2 - y_1)/(x_2 - x_1)$ to find gradient when given two points on a straight line. Refer to formula $y = mx + c$. Negotiating mathematical meaning of key concepts in linear programming	The teacher started the lesson by looking at the homework. He asked one learner to come to the board to show the class how they got the equations. The learner wrote the formula $m = (y_2 - y_1)/(x_2 - x_1)$ and substituted points (5,0) and (4,6) to get the equation, $y = \frac{1}{4}x + 5$. After discussing the homework the teacher gave learners a word problem task, which they were to do in 10 minutes in groups. The key words in the task were ‘at least’ and ‘minimum’. When learners were done in groups, the teacher asked one learner to come to the board to tell the class how they solved the problem.
5	45 min	Word problems	Model situations into inequalities and graphs. Mathematical	The lesson was divided into three sessions. In the first session, the teacher gave learners a task written in English to do in groups. He collected their responses to the task after 15 minutes.

			concepts (variables *x* and *y*, maximum, real values, feasible region).	Without discussing how learners worked out the task, he gave them another task, which happened to be the same task but this time written in learners' home languages. Again, after 15 minutes the responses were collected. In the last session, the teacher opened the whole class discussion in any language, about how learners felt about the two versions of the task.

Table 4.1 above provides a general picture of what happened in each lesson during the week of data collection. It is clear from the table that there is some form of mathematical progression from Lesson 1 to Lesson 5. Learners were first introduced to sketching linear graphs, which was followed by sketching inequalities, then shading feasible regions, and finally getting into the linear programming tasks. The linear programming tasks given on Lessons 4 and 5 required a thorough understanding of the concepts dealt with in the three preceding lessons. It follows then from this that the teacher made sure that prerequisite concepts are thoroughly dealt with before getting into linguistically demanding linear programming tasks (Lessons 4 & 5).

4.3 Counting situations emerging from data

As mentioned in Chapter 3, there were six (6) identified situations from data in which learners' home languages were used. In order to establish the number of occurrences each of the situations appeared either on the transcript or on the worksheet, I counted all such moments through the use of tally marks. However, the instances were not necessarily counted in a similar way. In what follows I describe how each of the situations was counted.

Counting tasks

All mathematical tasks that were given to learners during the week of data collection were carefully looked at, in order to identify the language used in setting up each task. The counting does not involve the languages used during the implementation phase of tasks. For instance, it is possible that in one task the use of learner's home language is counted [0] and yet the home languages were used during the implementation of the same task. It was found that some tasks were presented in English while others were written in learners' home languages. In situations where a task was written entirely in English, the use of English was counted [1] and the use of learners' home language was counted [0]. This can be seen in Table 4.2 below. When a task was entirely written in a home language, the use of home language was counted [1] and the use of English was counted [0]. For instance, in Lesson 4, learners were given two tasks. Both of them were presented in English, therefore in Table 4.2 below the number of occurrences of English usage was given [2] while the use of home language was given [0]. In situations where a task was written in both languages, the use of home languages was counted [1] and the use of English was also counted [1]. This happened in day 5 where one task was presented in English and home languages. Task 2(b) in Lesson 4 as will be shown later in this section demanded learners to rewrite the statement in their home languages. However, the use of home language was given [0] in Table 4.2 because the task was entirely written in English. In other words, I only focused on the language used when setting up the task and not on the language used during the implementation of the task in class.

Counting questions asked by the teacher

The teacher asked several questions during the lessons. The questions were either in the learners' home languages or in English. However, there were instances where the teacher used both the learners' home languages and English in one question. That posed a challenge to me when developing Table 4.2. The challenge was where to categorize such questions, i.e. under home language category or under English category. In a situation where more than 50% of words in a question were in home language, I took a decision to count such a question as a home language question. Similarly, where more than 50% of words in a question were in English, I counted such a question as an English question. Examples of such questions are: "*Can we classify u-at least with minimum or maximum? What if nina ni-decide ukusebenzisa uzero no-5?*" In the first question, more than 50% of words are in English therefore the question was counted as 'English', similarly in the second question more than 50% of words are in isiZulu and therefore it was counted as 'home language'. There were also some instances where there was more than one utterance in a question. That is, situations where the teacher asked two questions but made them one question by using connectives such as 'and'. An example of such situations is: "*Ukuthi igraph yakho izoba kuphi* (*as to where your graph will be*) *and why on this part?*" Even though, there are two questions in this example, I made a decision to count such questions as one question because they were in one utterance.

Learners' contributions during whole class discussion

It was not easy for the video recorder to capture the voices of learners while discussing in their respective groups. As a result such utterances that were made during group work were not transcribed. Learners' verbal contributions that were transcribed were those that occurred during the whole class interaction. Therefore, Table 4.2 below only reflects those utterances that were made during the whole class discussion. I actually counted all the audible statements made either in English or in home language by learners during whole class discussions. The utterances that learners made were mainly for the purposes of asking questions, explaining a procedure or a concept to the whole class, affirming what the teacher or another learner has said, and for greeting the class (e.g. *dumelang, sanibonani*). I counted all such utterances and recorded them in Table 4.2.

Re-voicing learners' ideas

I looked through all the transcripts for sentences where the teacher re-voiced learner's contributions and counted all of them. The scores that show the occurrences where the teacher re-voiced learners' expressions either in English or in home languages, are recorded in Table 4.2 below.

Counting teacher's instructions

The teacher gave instructions to learners both in English and in learners' home languages across all five lessons. I counted all instructions that were in English in every lesson and recorded them in Table 4.2. Similarly, I counted all those instructions that were in home languages and recorded them per lesson.

Learners' discussion in groups

Grouping learners according to their home languages was a deliberate strategy that the teacher used in this study to encourage learners to interact through such languages. Learners used home languages in discussing tasks and solutions. The teacher encouraged learners to discuss tasks in their home languages. However, I decided to exclude this situation because it was not well recorded by the video recorder. It was not practical to record what was happening in every group at the same time. Secondly, the focus was on how the teacher used learners' home languages. Therefore this incident (*Learners' discussion in groups*) is excluded so that there are only five incidences shown in Table 4.2.

Below is Table 4.2, which shows the number of occurrences at which languages were used for each situation across the five lessons that were video recorded. It also indicates that the frequencies, at which learners' home languages were used across the five lessons, vary with respect to situations.

Table 4.2: The frequency of the use of languages across the five lessons

Lesson 1	Situations	Language used	Number of occurrences
	Mathematical tasks	Home language	0
		English	1
	Questions asked by the teacher	Home language	34
		English	28
	Learners' discussion	Home language	58
		English	31
	Re-voicing learners' ideas	Home language	8
		English	3
	Giving instructions	Home language	4
		English	1
Lesson 2	Mathematical tasks	Home language	0
		English	1
	Questions asked by the teacher	Home language	5
		English	31
	Learners' discussion	Home language	13
		English	33
	Re-voicing learners' ideas	Home language	1
		English	7
	Giving instructions	Home language	0
		English	4
Lesson 3	Mathematical tasks	Home language	0

		English	1
	Questions asked by the teacher	Home language	2
		English	36
	Learners’ discussion	Home language	3
		English	30
	Re-voicing learners’ ideas	Home language	2
		English	8
	Giving instructions	Home language	2
		English	5
Lesson 4	Mathematical tasks	Home language	0
		English	2
	Questions asked by the teacher	Home language	36
		English	37
	Learners’ discussion	Home language	34
		English	26
	Re-voicing learners’ ideas	Home language	5
		English	4
	Giving instructions	Home language	0
		English	0
Lesson 5	Mathematical tasks	Home language	1
		English	1
	Questions asked by the teacher	Home language	54
		English	10

	Learners' discussion	Home language	43
		English	12
	Re-voicing learners' ideas	Home language	3
		English	0
	Giving instructions	Home language	0
		English	6

The use of the above-identified situations helped me to concentrate on how the teacher used learners' home languages in lessons instead of focusing on any other classroom activities irrelevant to this study.

4.4 Data representation and discussion

In this section I present the results recorded in Table 4.2 above graphically in order to show the frequency at which each situation was observed. I also draw from both the lesson and teacher interview transcripts in providing answers to the following research questions:

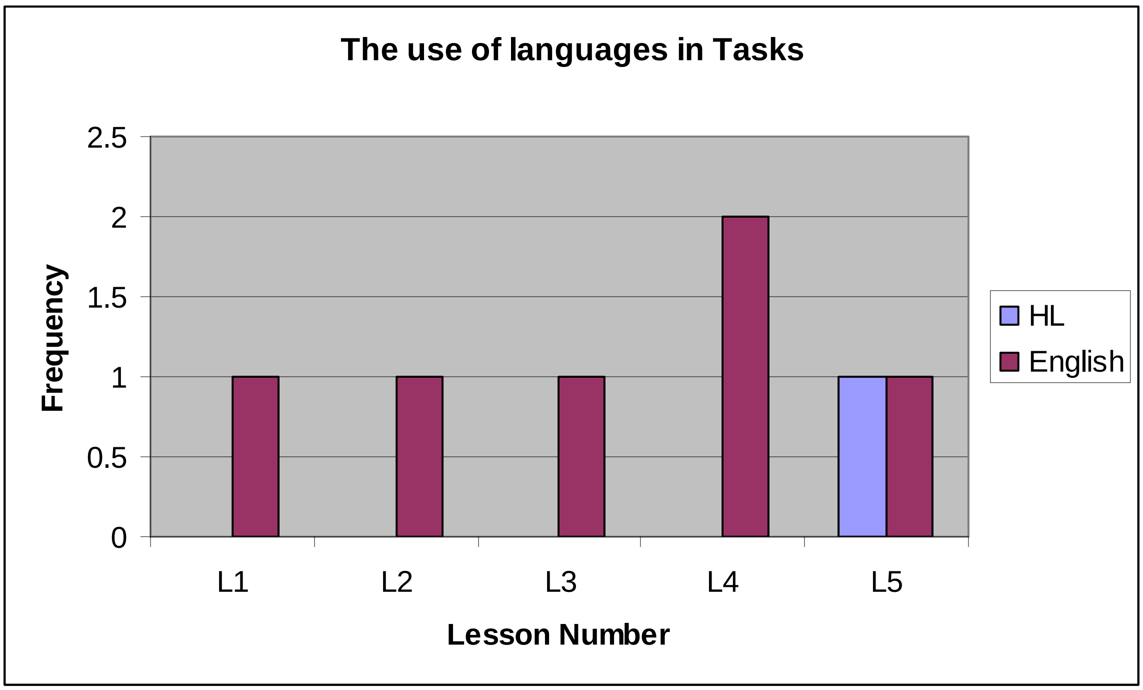
> *How does a Grade 11 mathematics teacher in a multilingual classroom use learners' home languages when teaching Linear Programming?*
>
> *How does the way in which the teacher uses learners' home languages support learners' understanding of key concepts in Linear Programming?*

Answers to the third research question (Why does the teacher use learners' home languages in the way in which he does?) are only drawn from the reflective teacher – interview's transcript.

Focusing on tasks

Chart 4.1 below shows the frequency at which home languages and English were used in tasks across the five lessons.

Chart 4.1



According to Chart 4.1 above, lessons 1 – 3 have similar task scores. That is, in each of the three lessons **home language** is awarded a score of 0 while **English** is given a score of 1. This means the teacher used one task in each lesson, which was entirely presented in English. In Lesson 4, English is given the score of 2 and home language is given the score of 0. As mentioned earlier in this chapter, the teacher gave learners two tasks in Lesson 4 and both tasks were written in English. In Lesson 5, English is given a score of 1 and home language is also given a score of 1. It is worth noting that in Lesson 5 learners were given a task in English to do in the first part of the lesson. They were then given the same task translated into Sesotho, Sepedi, isiXhosa and isiZulu to do in the second part of the lesson. I counted the translated version into home languages as single use of home language, which is why in Chart 4.1 the use of **home language** has a frequency of 1. During the interview the teacher was asked to reflect on the nature of tasks he used during the week of data collection. The following extract reflects that conversation.

R: Thank you. Now tell me about the tasks that you gave to learners during the lessons.

T: The tasks that I gave to my learners, I can say, they were all thought through carefully because I didn't eh… use a textbook as it is, but what I did was, I took tasks from the textbook and modified them according to the situations that would suit my learners. For example, task 1 on day 4, I actually came up with a task which said: If Mandla's Cinema can accommodate a maximum of … eh my aim there was to check if I used the word maximum rather than going to the textbook and take tasks as they are. But then it was clear that the way they were phrased there was no ambiguity, they were clear and learners were able to see that the word maximum means something cannot go above that level.

…Right on day 5, that is when I gave them a task that was written in different home languages. So now what happened there…? I gave them a first task that was written in English. Different home languages were isiZulu, isiXhosa, Sepedi and Sesotho. Then after 15 minutes, I collected that task and gave learners the very same task this time written in home languages.

…A number of problems arose around the word ezingadalulwanga from the Zulu group. So what I actually did on that day I translated everything into their home languages forgetting that they don't have a register in their home languages that address those technical terms like inequalities, like unknown so instead of using x as it is from the textbook, I used the word ezingadalulwanga, which simply means the unknown but learners found it very difficult to engage with the task because of that word which was translated into their … and it was for the first time for them to come across that word ezingadalulwanga.

…There was only one group the Sepedi group … because maybe their translating was well done, I don't know how, but they said they find it very easy to learn Maths in Sepedi because they understand everything in Sepedi. Everything was clearly understood by those learners.

There are a number of issues raised by the teacher in the above extract. According to the teacher's explanation, he selected tasks carefully from textbooks and modified them in such a way that they suit his learners. Modifying tasks is an important role played by experienced mathematics teachers. It is a demanding role in that it requires a teacher to know learners' mathematical needs well. That may involve knowledge of what they have learned already, what they are likely to learn on their own or with the minimal assistance from the teacher, and what their mathematical strengths and weaknesses are. According to the teacher in this study, part of the process of modifying tasks involved translating some tasks from English to learners' home languages. It is obvious from teacher's account that the manner in which such translation is made could play a role in giving learners access to mathematics or on the other hand deny them such access. For instance, in his case the isiZulu group experienced some difficulties in understanding the isiZulu task because of the manner in which it was translated. The complexities of translating mathematics tasks will be dealt with later on in this chapter.

The teacher also raised the issue of implementing the two versions of tasks (i.e. English and home language) in Lesson 5. The teacher implemented the two tasks separately under test-like conditions. He gave learners the English version to work on for a specified time frame (15 minutes). He asked learners to write their answers on the examination-pad and NOT in their exercise books. During the first four days learners were writing answers in their exercise books. After collecting the scripts, the teacher gave learners a task written in their home languages to do for another 15 minutes. Given the fact that the learners were seeing mathematics tasks translated into their home languages for the first time, these test-like conditions may have increased the pressure on them.

R: This clip is part of day 5's lesson when learners were working on a task that was written in their home languages. I find it interesting that in this particular incident you did not go from group to group. Can you tell me more about it?

T: Am… on day 5, like I said earlier on when we started… day 5 was a day that was totally different from the four previous days and yet it was not supposed to be like that. What happened on day 5… even when those

> learners from isiZulu group complained about the word 'ezingadalulwanga', I did not intervene and help them with the meaning of the word. But I actually wanted to… to… it was like an assessment. It was totally different it was like an assessment.

A common practice in schools is that when learners are given a test in class, they do not get any assistance from a teacher and that is exactly what happened in this case. The teacher in the above extract argues, "it was like an assessment", which suggests it was not really a test even though it appeared as such. It is interesting however that the teacher argues that he was not intending to assess learners. It can be argued here that given the manner in which the teacher implemented the two tasks the use of home languages did not support learners' understanding of mathematical concepts.

Questions asked by the teacher

Chart 4.2 below shows the frequency at which home languages and English were used in asking questions across the five lessons.

Chart 4.2

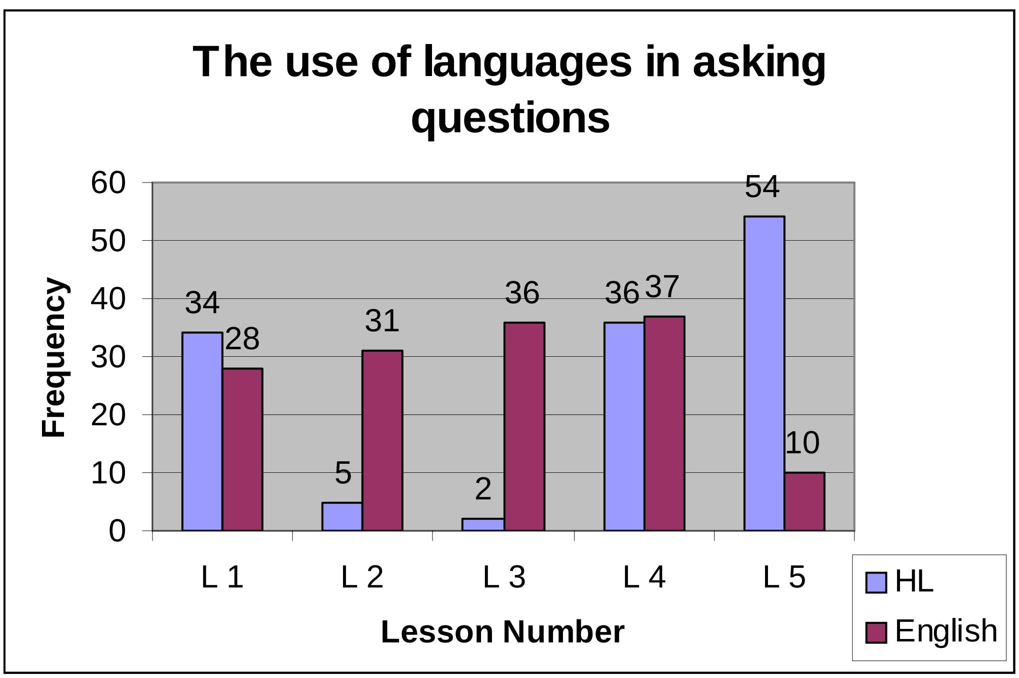


Chart 4.2 shows that the teacher asked questions using languages at different frequencies in each lesson. That is, in some lessons most questions were asked in home language while in other lessons most questions were asked in English. For example, in Lesson 1, the teacher asked sixty-two (62) questions in total. Thirty-four (34) of them were asked in learners' home languages. That means 55% of questions asked were in home languages. In Lesson 2, five (5) questions out of thirty-six (36) questions were asked in learners' home languages. In Lesson 3, the teacher asked thirty-eight (38) questions, and only two (2) of them were in home languages. The teacher asked seventy-three (73) questions in Lesson 4, and thirty-six (36) of them were in home language. In Lesson 5, the teacher asked sixty-four (64) questions and fifty-four (54) of them were in home languages. Since questions in home languages were asked at different frequencies across the five lessons, it was crucial to focus on those lessons where the teacher asked most questions in learners' home languages and those happened to be lessons 1 and 5 (*34 questions out of 62 and 54 questions out of 64 respectively*). However, Lesson 4 is interesting in that about 50% of the questions were in home languages. Looking closely into the transcript of Lesson 5, I realized that most questions were about learners' opinions about learning mathematics in their home languages or English and not about content (linear programming concepts). Therefore, I decided to focus on the transcripts of lessons 1 and 4. When comparing the types of questions the teacher asked in both lessons, I realized that he used learners' home languages to ask questions that required learners to elaborate more on what is being discussed. The extract below shows the type of questions the teacher asked.

1.	Teacher	NgesiXhosa kutheni u-at least? (*What does at least mean in Xhosa?*)
2.	Thabo[2]	Okungenani (*at least*)
3.	Teacher	NgeSesotho ethini? (*What does it mean in Sesotho?*)

[2] All names in this transcript are not learners' real names.

4.Mofokeng	Bonyane, e ea tshoana le ka Sepedi. (*At least, it is the same even in Sepedi*.)
5. Teacher	It means R10 or more.
6. Teacher	So can I use minimum and at least as one thing?
7.Caroline	Sipho o itse ten rantanyana, o n'a lokela hore a re bokagone, eseng ten rantanyana, o bua Sepeli se samoo. (*Sipho said ten 'rantanyana', he was suppose to have said at least, not 'ten rantanyana', he talks local Sepedi*.)
8. Teacher	Sepedi saseloction? (*The location Sepedi*?)
9. Teacher	NgeSesotho? (*What about in Sesotho*?)
10. Ntsoaki	Bonyane R10 or more. R10 is the minimum. (*At least R10 or more*.)
11. Teacher	Now, at least and minimum is it one and the same thing?
12. Thandi	Ha li tshoane, minimum e kafatse, maximum e kaholimo. (*They are different, minimum is below, and maximum is above*.) [Gesturing to show something on the ground and something above her head].
13. Teacher	What is different? Can we classify at least with minimum or maximum? If I say borrow me at least R10, is R10 minimum or maximum?

The teacher deliberately asked questions that encouraged learners to provide explanation of mathematical concepts in their home languages (*utterances* 1 *and* 3). The teacher here asked learners to express their understanding of at least in isiXhosa and in Sesotho. The transcript also shows that learners developed some understanding of at least by using appropriate words like "bonyane" in Sesotho, and "okungenani" in isiXhosa. Asking learners to think about the terminology in their own languages created an opportunity for them to think about the different ways in which they could be expressed in their languages, hence the variety of words in different languages. Learners also demonstrated their understanding of concepts through the use of metaphors drawn from their home languages. Although Thandi misunderstood the teacher's question that was on whether at least and minimum mean the same thing she said (*utterance* 12) they are different. By means of her hand, Thandi showed that minimum is on the ground and maximum is high above her head. Moschkovich (2002) argues that such metaphors, gestures, learners' home languages and everyday meanings are resources that learners utilize to communicate their understanding of concepts. The teacher used learners' home languages in asking questions. The use of home languages in this manner supported learners' understanding of mathematics concepts as shown in the above discussion.

The teacher also asked questions in the lessons when learners worked on tasks in their respective groups. During the interview I asked the teacher to tell me what he does when he gets into a group of students in class.

> R: In this particular video clip, I see you moving from one group to another, and this is typical of all your lessons. That is from lesson 1 to lesson 5. I'm therefore interested in knowing this, what do you do when you get into a group?
>
> T: When I get into each group I try to find out what they do… Sometimes I pose a question and move to the next group so that they can just start debating about that particular question I gave them. When I get into another group, even if I am not good in that particular home language I try to listen and try to behave in the way they talk. But my aim is just to get to what they are doing, and if they do that which they are suppose to do at that particular moment then I provide help where necessary.

The teacher listens carefully to what learners are discussing in groups and poses questions to stimulate and challenge the way they think and reason about the task under discussion. He also ensures that learners' discussion focuses on the task. I asked the teacher during the interview about the language(s) he uses as he moves from one group to another.

> R: What language(s) do you use in each group?
>
> T: In isiZulu group I actually use Zulu and English. In Sepedi group I try to use Sepedi and sometimes they laugh at me. That is, the Sepedi and Sesotho groups when I try to pronounce words that I'm not familiar with, they simply laugh at me but because I want to push my point I don't have a problem with that... In isiXhosa group I definitely use isiZulu and English because those who speak isiXhosa, isiZulu and Ndebele we fall… I mean in

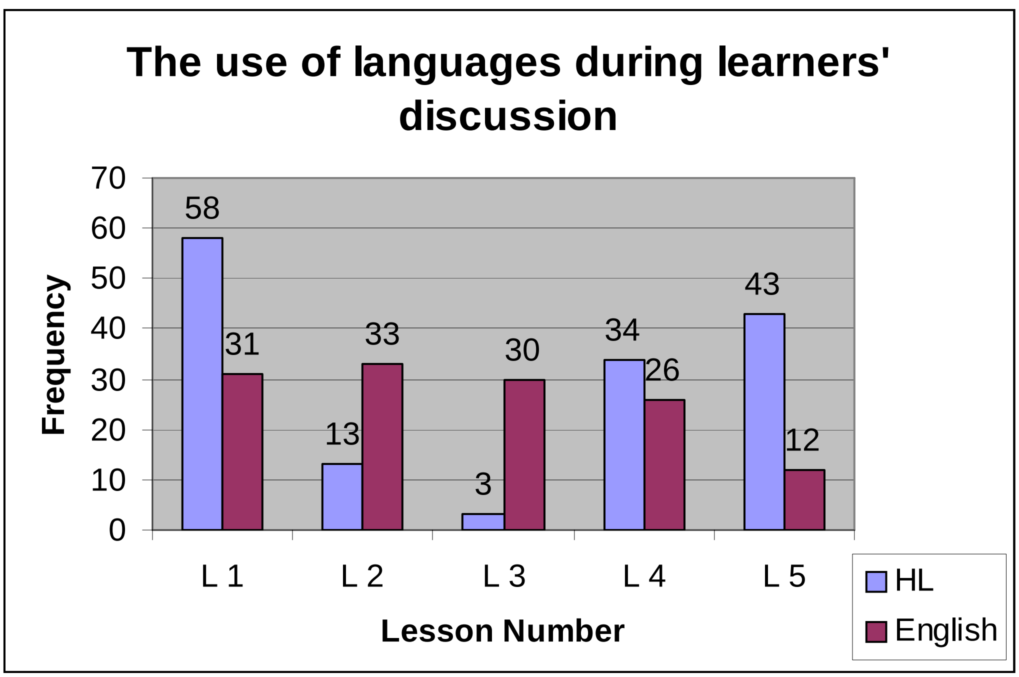
one category and we understand each other very well. There's no problem at all.

The teacher code switches between learners' home languages and English in order to ask questions in each group. According to the research done in multilingual classrooms (Adler 2001, Moschkovich 2002, & Setati 2002), code switching between learners' home languages and the language of learning and teaching (LoLT) benefits bi/multilingual learners. In what follows I focus on the use of languages during the whole class discussion.

Participating in whole class discussion

Chart 4.3 below shows the frequency at which home languages and English were used during the whole class discussion across the five lessons.

Chart 4.3



The chart above shows that in Lesson 1, fifty-eight (58) utterances were made in home languages and thirty-one (31) utterances were in English. Forty-six (46) utterances were counted in Lesson 2. Thirteen (13) of them were made through the use of home languages and thirty-three (33) were made in English. In Lesson 3, learners made thirty-three utterances. Thirty (30) utterances were in English and only three (3) were in home languages. In Lesson 4, learners made thirty-four (34) utterances in home languages and twenty-six (26) in English. In Lesson 5, a total of fifty-five (55) utterances were made and out of that forty-three (43) were in home languages.

It is worth noting that more than 50% of learners' contributions were in home languages in lessons 1, 4 and 5. The transcripts of these three lessons show that these contributions were either in the form of questions or in the form of explanation and/or descriptions. Therefore home languages were used in a similar fashion throughout all five lessons. It is interesting to note too that in lessons where the teacher asked many questions in learners' home languages (**Chart 4.2**), learners too made most of their contributions in their home languages (**Chart 4.3**), and in lessons 2 and 3 where the teacher used home languages minimally learners made most of their verbal contributions in English.

In the following extract taken from Lesson 1, learners were caught up in the discussion about the nature of straight lines that are parallel to the y-axis [i.e. lines that are in the form of x = a number]. The discussion was in both home languages and English.

14. Marvin	Thisha mina ngifuna ukwazi why iso? (*Teacher I want to know why is it like this*?) Why singayibeki so? (*Why don't we put it this way*?)
15. Abel	If besizoyibeka ka so besozoyihlanganise no y-axis. (*If we put it that way it will meet the y-axis*). Kusho uthi akusosiyiyo lento abasiphe yona. (*That would mean it is no longer what they originally gave us*).
16. Ntsoaki	Why do we have x = 4? We can't have a gradient therefore we don't have a slope. Thabo if you write y = mx + c what do we have? We don't have a y-intercept and we only have x = 4.
17. Teacher	What were you saying Mofokeng? What is the value of y? Do we have x-intercept?

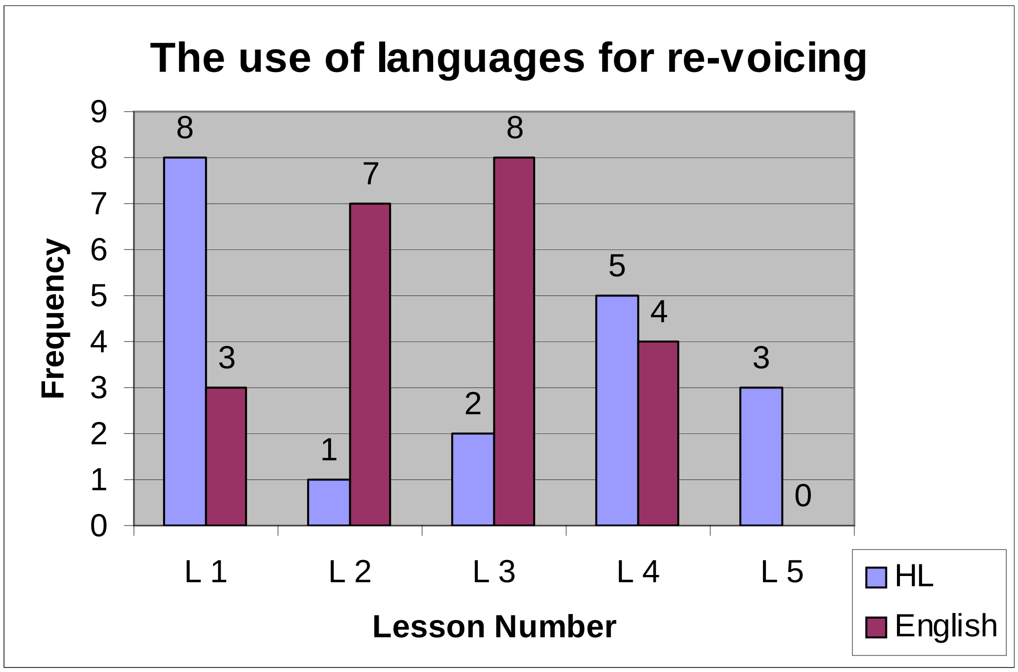
In this instance, Marvin posed a question directly to the teacher in isiZulu. Instead of being answered by the teacher, Abel responds to that question also in isiZulu and argues that the line should not meet the y-axis because otherwise it would be a different line (*utterance* 15). It is interesting that while the teacher was still listening to the discussion, Ntsoaki intervened and asked the same question as Marvin's but in a more specific way by making reference to the equation of the line, $x = 4$. Based on her contribution, it can be argued that Ntsoaki is raising two important mathematical questions – What is the gradient of all straight lines that are parallel to the y-axis? If the general formula for straight lines is $y = \mathrm{m}x + \mathrm{c}$, do lines that are parallel to y-axis fit in this formula? In my judgment the teacher did not pick up these concerns and address them fully. Ntsoaki's contribution is mathematically interesting in that she argues that the line whose equation is $x = 4$ has no gradient and hence no slope. She argues, "we can't have a gradient therefore we don't have a slope" (*utterance* 16). There are two things to note from Ntsoaki's contribution. Firstly, according to her understanding gradient and slope are two entities that depend on each other (i.e. if no gradient, then no slope) whereas the two words (gradient & slope) mean the same thing. Secondly, according to her the line $x = 4$ has no gradient. What she says is mathematically incorrect because all lines that are parallel to the y-axis such as line $x = 4$ have undefined gradients. In other words, the line $x = 4$ has a gradient which is undefined. It is also interesting that Ntsoaki made the contribution entirely in English despite the fact that the other two students who spoke before had made their arguments in isiZulu. The use of English by Ntsoaki probably influenced the teacher to respond in English as well (*utterance* 17).

The teacher and learners used home languages during the whole class discussion across the five lessons. The use of home languages in this way assisted learners to communicate mathematically as indicated in the above discussion. Another situation where the teacher used learners' home languages was when he re-voiced learners' utterances.

Re-voicing learners' utterances

Chart 4.4 below shows the frequency at which the teacher used home languages and English for re-voicing learners' utterances across the five lessons. As mentioned in chapter three, the focus was only on the languages the teacher used for re-voicing and not on the languages used by learners in their utterances.

Chart 4.4



According to Chart 4.4 above, in Lesson 1 there were eleven (11) occurrences of re-voicing and out of that, eight (8) of them were done in learners' home languages. In Lesson 2, there was only one occurrence where re-voicing was done in the learners' home languages. The other seven (7) occurrences of re-voicing were done in English. In Lesson 3, re-voicing was done ten (10) times, and out of that only two (2) were done in home languages while the other eight (8) were in English. Out of nine (9) occurrences of re-voicing in Lesson 4, five (5) of them were in the learners' home languages. It is interesting that in Lesson 5, there were only three (3) occurrences of re-voicing which all happened in learners' home languages. The following extract shows an incident where the teacher re-voiced learners' contribution.

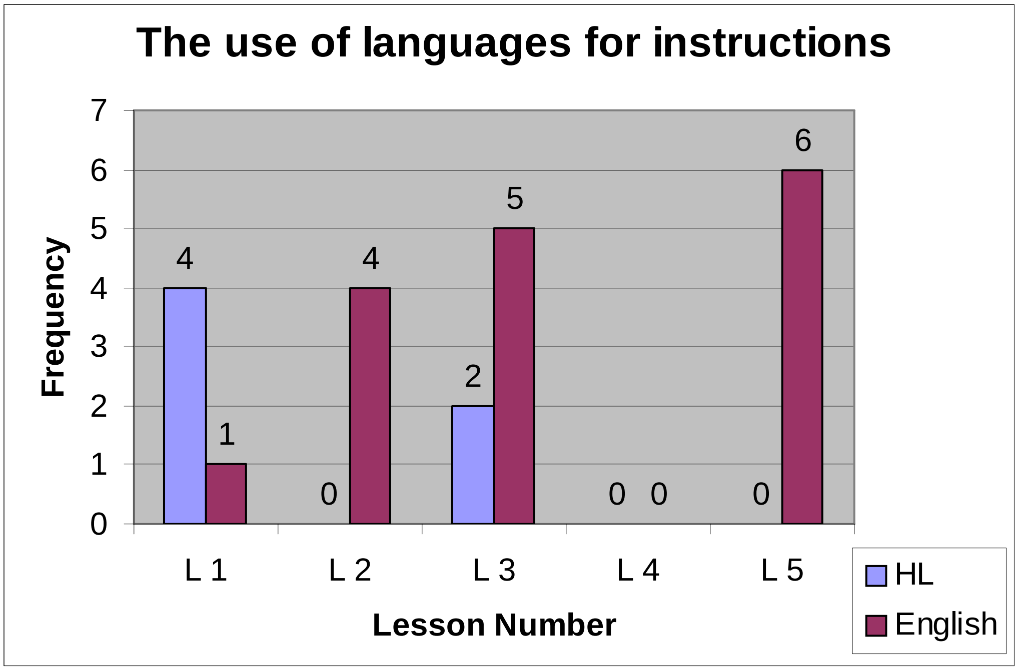
18. Tshidiso	Why ashadile kamofatsi asashade holimo? (*Why did he shade below and not above?*)
19. Teacher	Kamofatse ga eng? (*Below what?*) Be specific kamofatsi ya eng? (*Be specific, below what?*)
20. Tshidiso	Kamofatsi ga graph ya hae. (*Below his graph*.)
21. Teacher	Kamofatsi ga graph ya hae. (*Below his graph*.) Ha kere? (*Isn't it?*) Why u shaida kamoo fatsi ho graph ya hau? (*Why do you shade below your graph?*)

In above extract one of the learners (Tshidiso) asked a question (*utterance* 18). The teacher pushed Tshidiso to ask a specific question. He then re-voiced Tshidiso's question in utterance 21 (*why u shaida kamoo fatsi ho graph ya hau*?) The use of home languages in this manner helped learners to give precise contributions. It is a valued practice in mathematics classrooms to encourage learners to be precise whenever they make contributions. In what follows I focus on the use of languages when giving instructions to learners.

Giving instructions

Chart 4.5 below shows the frequency at which home languages and English were used for giving learners instructions across all five lessons.

Chart 4.5



The chart above shows that in Lesson 1, the teacher gave learners five (5) instructions. Four (4) were in home languages and one (1) in English. In Lesson 2, all four (4) instructions were given in English. There were seven (7) instructions given in Lesson 3. Two (2) were in home languages and five (5) in English. There were no instructions given in Lesson 4. In Lesson 5, all six (6) instructions were given in English. The types of instructions that the teacher gave in learners' home languages were disciplinary in nature. That is, they had nothing to do with the mathematical concepts. This was the case across all five lessons. As Chart 4.5 shows most of instructions in home languages were given in Lesson 1 comparatively speaking. While these instructions are helpful in class, the use of learners' home languages in this manner was irrelevant to this study, which sought answers for questions like how does the use of home languages in this manner supports learners' understanding of key concepts in linear programming. Therefore the following examples of such instructions are drawn from Lesson 1:

Teacher Sheshisani… (*Be quick…*)

Teacher Asilaleleni. (*Let us listen*.)

Teacher Ungasuli leyo. (*Don't erase that one*.)

The use of home languages in this manner clearly did not directly support learners' understanding of linear programming concepts. In the next section I analyze linear programming tasks that were given to learners during the week of data collection.

4.5 Analysis of Tasks

In this section I provide an analysis of tasks that the teacher used in lessons 4 and 5. My choice of tasks for analysis in this section is based on the fact that it is in lessons 4 and 5 where the teacher focused on linear programming. In lessons 1, 2 and 3 the teacher had focused mainly on establishing the following concepts: sketching linear graphs, shading feasible regions, and the use of symbols for inequalities, which are the prerequisite to linear programming. The tasks used in lessons 4 and 5 dealt with key concepts in linear programming such as *at least, at most*, *minimum and maximum*. Below are two tasks that the teacher gave to learners in Lesson 4.

Lesson 4 tasks

TASK 1

a. If I say to you borrow me at least *R10* how much money do I need?
   i) What is the key word or words that give(s) the clue to the answer to question (a) above?
   ii) Write an algebraic representation of the amount of money I need as indicated in (a) above.
b. The minimum salary of each worker at Ingqayizivele Secondary School is R1 500,00 per month. John, one of the workers at the school, told his girlfriend that he earns a salary of R1 800,00 per month. Is John telling the truth?

TASK 2

Mandla cinema hall can accommodate at most 150 people for one show.

a. Rewrite the sentence above without using the words "at most".
b. Rewrite the sentence in your home language.
c. If there were 39 people who bought tickets for the first show, will the show go on?
d. If Mary was number 151 in the queue to buy a ticket for the show, will they accommodate her in the show? Explain your answer.

The teacher used a well-known practice of ‘borrowing money’ within the communities where his learners live when setting up Task 1. The use of such relevant context in tasks allowed learners to freely engage with the task. Focusing on the use of language in Task 1, it can be argued that at the set up stage there is no indication that the teacher had intended to make use of learners’ home languages during the implementation stage in class. The task focused on developing vocabulary such as “at least” and “minimum”. Mathematical terms such as at most, at least, more than, less than, etc. are extensively used in linear programming and pose challenges for many learners because they have situated meanings. In commenting on the complexity of such words, Moschkovich (2002: 194) argues that “in a classroom situation, *more* is usually understood to be the opposite of *less*; at home the opposite of *more* is usually associated with *no more*”. However, using a situated-sociocultural perspective, it can be argued that Task 1 does not only deal with vocabulary but also requires learners to get involved in an important aspect of mathematical Discourse practice (Moschkovich, 2002), which is writing algebraic representations.

In Task 2 the teacher once more used relevant context for learners. Unlike in Task 1, the teacher in Task 2 deliberately asks learners to rewrite the statement in their home languages. Learners are also requested to rewrite the statement without using the words ‘at most’. Rewriting the sentence without the phrase *at most* and in one’s home language would provide an opportunity to unpack learners’ understanding of such phrases with multiple meanings in various situations. While this task has little ambiguity with regard to what is expected of learners, it is cognitively and linguistically demanding.

The task is linguistically challenging in that part (a) does not simply require learners to omit the expression “at most” it rather demands another word, which has the same meaning as “at most”. It is again linguistically demanding in that in part (b) learners are asked to translate the given statement from English into their home languages.

Such a translation is not a smooth process because it requires a thorough understanding of the meaning not only of individual words but also of the whole statement. The task is also cognitively challenging in that, learners have to make reasoned decision based on the given information. For example, in part (c) learners had to decide whether the show could still go on if only 39 people bought the tickets. Again in part (d) learners had to think and reason around the issue of Mary who happened to be the 151st person to buy the ticket. According to Stein, Smith, Henningsen, and Silver (2000) the processes of thinking and reasoning are characteristics of high-level cognitively demanding tasks. This suggests that the teacher designed the tasks carefully to cater for both cognitive and linguistic demands.

In the following section I focus on lesson 5 tasks.

Lesson 5 tasks

In lesson 5, the teacher gave learners the following task to work on in the first part of the lesson.

TASK

(a)

i. A farmer buys *x* diary cows at R1 250 each and *y* beef cows at R1000 each. He can spend up to a maximum of R5 000. State this information as an inequality in *x* and *y*.

ii. Write down any other inequalities implicit in the situation.

iii. Can *x* and *y* take on any real values? Explain

(b) Graph the inequalities to show the feasible region

The task required learners to construct inequalities from the given farming context. The farming context is common to many learners in South Africa. However, given that the school is located in a township there's a possibility that some learners might not be fully acquainted with the context of cattle. But no student raised concern about the unfamiliarity of the context of the task. The challenge for learners would be to formulate correct inequalities and to sketch them properly so that the correct feasible region is produced. However, given the fact that in lessons 2 and 3 learners were taught how to produce inequalities from any given text and to sketch feasible regions, this task is a low level cognitively demanding task (Stein et al, 2000) for these particular learners. According to Stein et al, (2000: 16) cognitively low level tasks have the following characteristics:

> Involve reproducing previously learned facts, rules, formulae, or definitions. Are algorithmic. Use of the procedure is either specifically called for or its use is evident based on prior instruction, experience, or placement of the task. Require limited cognitive demand for successful completion. There is little ambiguity about what needs to be done and how to do it.

The linguistic demands of this task could be challenging to learners. In part (i) question (a), learners had to understand expressions "up to" and "maximum" in order for them to be able to use the correct inequality sign (≤ 5000). Failing to understand such expressions would result in learners producing a wrong inequality. Again in part (iii) in question (a) where learners are asked whether x and y can take on *real values*? In mathematics, the expression (*real values*) is hardly used. What are commonly used in mathematics are *real roots* as opposed to imaginary-roots and the expression *real numbers*. It seems like embedded in this question is the question: Can x and y take on any integer? That being the case, it would then be clear to learners as to what is required of them. The anticipated answer to that question was: x and y can only take on a set of whole numbers because x and y represent a number of cows of each type (dairy or beef) as a result x and y cannot take on negative numbers.

In what follows, I address the question of why the teacher used learners' home languages in the way in which he did.

4.6 Why does the teacher use learners' home languages in the way in which he does?

As mentioned earlier in this chapter, the answers to this question are drawn from teacher-interview data. I posed several questions to the teacher in order to address this question (*Why does the teacher use learners' home languages in the way in which he does?*) even though I did not put my research question explicitly to him.

> R: Now my first question is: having observed your five lessons, what is it in your view would you say went well?
>
> T: I can say what went well is when I grouped learners according to their home languages, because their participation was good unlike in the past days like last year. So participation for this lesson was really good because they were actually expressing themselves the way they liked.

The teacher used learners' home languages in order to group learners so that they could fully participate in the learning of linear programming. It follows from the teacher's account above that he was successful in doing that because learners were able to freely express their views in either their home languages or English. In other words, learners were able to code switch between languages and that increased their participation in lessons. It follows then that when teachers afford learners a chance to use their home languages in learning mathematics then their participation in learning increases.

> R: Ok, thank you. You said you were doing an action research in which you were transforming your teaching; tell me, what is it that you were transforming about your teaching?
>
> T: I can start by saying that before I came to Wits; I was actually bored with the way of teaching. I was using one style of teaching, using the same textbook method, using the same approach I was taught at the College. I was actually bored not knowing what to do, but when I arrived at Wits University that's when I learned a number of things like giving learners chance to express their views in their home languages, not to look for only one right answer and to probe learners, and that's when I started changing even my teaching, but then I said maybe it will even be better for Linear Programming if they can use their home languages. The use of home languages I learned in last year's course called Expressing Mathematics.

The teacher in this study used the learners' home languages the way he used them because he was inspired by one of the courses (Expressing Mathematics) he did in his further training. The course emphasized the importance of using learners' languages in teaching mathematics. The teacher used learners' home languages in teaching linear programming concepts as a result of his further university training.

The teacher in this study made a remarkable attempt to use learners' home languages in mathematics tasks in order help learners to understand concepts. In a situation (day 4 task, part (b)) where learners were asked to translate the given statement from English into home languages, they successfully managed to do so. The teacher confirmed this during the interview:

T: I wanted to find out … maybe could they use the word maximum, do they understand the word maximum. So because if I remember it very well it said Mandla cinema can accommodate a maximum of 150 people for each show, so write that sentence in your home language. So what I picked up from that: learners quickly identified that oh the word maximum means … because those from isiZulu group, because I can side with isiZulu I'm also talking Zulu; they said: imandla cinema enganelwa abantu abangevele kwaba ikhulu namashomi amahlano, which means, a Mandla cinema can only accommodate 150 people because the word maximum means it cannot go beyond that point. So I even took other sentences that were translated into Sepedi, Sesotho to … ah to Sesotho educators and they also said to me it was well translated so on that particular day I achieved what I wanted to achieve because my aim was …

According to the teacher's account above all language groups managed to translate the given statement correctly. The teacher consulted with his colleagues who teach languages such as Sesotho and Sepedi to confirm that learners' translations were correct. It is important for teachers from different departments (mathematics & language) to interact and begin to speak to each other. The teacher in this study seems to be doing that well.

In the following section I discuss the complexity of translating mathematics tasks from English into learners' home languages.

4.7 Complexities of translating tasks

I begin this section by presenting Lesson 5 task in Table 4.3 together with its translated versions into learners' home languages. I then point to the complexity in the translation, which shed light into the discussion on the experiences of learners as they worked on the translated versions.

Table 4.3 below presents the task that was given to learners in Lesson 5 and the versions of the same task in learners' home languages. Learners were given the task in one language at a time, first in English and then in their home languages. This way of using the learners' home languages is deliberate because it is included in the task where learners have to read the task, discuss and write their responses in their home languages.

Table 4.3: Lesson 5 task and its translated versions in learners' home languages

Task in English	Task in isiZulu	Task in isiXhosa	Task in Sepedi	Task in Sesotho
(a) (i) A farmer buys x diary cows at R1250 each and y beef cows at R1000 each. He can spend up to a maximum of R5000. State this information as an **inequality** in x and y.	**(a)** (i) Umlimi othize uthenga izinkomo zobisi **esingazazi** ukuthizingaki, iyinye ibiza inkulungwane namakhulu amabili anamashumi amahlanu amarandi (R1250) kanye nezenyama **ezingadalulwanga** ukuthi zingaki kodwa iyinye ibiza *inkulungwane yamarandi*. Imali angayisebenzisa ukuthenga izinkomo zobisi nezenyama iyizinkulungwane ezinhlanu zamarandi (R5 000). Sicela	**(a)** (i) Umlimi uthenge iinkomo zobisi **ezinga**, inye ixabisa iwaka elinamakhulu amabini aneshumi elinesihlanu (R1250) waze wathenga iinkomo zenyama **ezinga**, inye ixabisa iwaka leerandi (R1000). Angachitha kangangamawaka amahlanu (R5000) Yenza **umlinganiselo** weenkomo zobisi nowenkomo zenyama.	**(a)** (i) Molemi o reka dikgomo tša maswi **tše sa tsebjego** gore ke tše kae, fela e tee ke R1250 le tša nama **tše sa tsebjego**, e tee e lego R1000. A ka šomiša tšhelete ye lekanego R5000. Ngwala **tekatekanyetšo** ka dikgomo **tše sa tsebjego** tša lebese le tša nama.	**(a)** (i) Rapolasi o reka dikgomo tsa lebese ka R1 250 e le nngwe le dikgomo tsa nama ka R1000. Tjhelete e kahodimo eo a ka e sebedisang ke R5000. Beha ditaba tsena jwaloka **kgaello** ya dikgomo tsa lebese le tsa nama.

	usibhalele ama "**inequalities**" mayelana nezinkomo zobisi nezenyama.			
(ii) Write down any other **inequalities** implicit in the situation.	(ii) Singajabula uma ungasibhalela amanye ama "inequalities" maqondana ne ngxoxo ingenhla ekubeni futhi layo ma "**inequalities**" ebeka imigomo ethize.	(ii) Yenza omnye **womlinganiselo** ngalengxelo ingentla.	(ii) Ngwala **ditšhitišo** tše dingwe mabapi le polelo ye ka godimo.	(ii) Ngola di **kgaello** tse ding tse ka hlahellang maemong ana a ditaba tse ka ho dimo.
(iii) Can *x* and *y* take on any real values? Explain.	(iii) Kungabe izinkomo **ezidaluliwe** zingabalelwa ezintweni ezikhona noma ezingekho? Kungani chaza.	(iii) Ingaba iinkomo zobisi nezenyama zingasinika owuphi **umlinganiselo**? Chaza.	(iii) Go a kgonagala gore **tše sa tsebjego** go tša maswi le tša nama di gona ka nnete? Hlaloša karabo ya gago.	(iii) Na dikgomo tsa lebese le dikgomo tsa nama e ka ba manane a nnete? Hlalosa.
(b) Graph the **inequalities** to show the feasible region.	**(b)** Bonisa umdwebo omuhle lapho, lama "**inequalities**" ehlangana khona enze isithombe esisibiza ngokuthi I "feasible region".	**(b)** Zoba lengxelo phantsi ubonakalise ukuba isonjululwa njani ukubonisa "feasible region".	**(b)** Laetša ka sethalwa gore **mo di kopanago** di dira "feasible region".	**(b)** Bontsa **dikgaello** tse ka hodimo ka graph; o bontshe le di "feasible region".

The process of translating mathematics tasks from English to learners' home languages is demanding and complex. In what follows I discuss complexities reflected in each translated version. By discussing the manner in which the teacher translated the task into learners' home languages is by no means a way of exposing his weaknesses, rather it is done to show the complexities embedded in the translation of mathematics tasks.

Task in isiZulu

In part (a) (i) the English task mentions *x* diary cows and *y* beef cows. Mathematically speaking, *x* and *y* are symbols that are used as representations for different unknowns. The symbol *x* stands for the unknown number of diary cows. On the other hand *y* stands for the unknown number of beef cows. However, in all the translated tasks, the teacher avoided the use of *x* and *y*. He used the word **esingazazi** (unknown) for *x* and the word **ezingadalulwanga** (anonymous) for *y* in isiZulu version. By doing that the teacher made these symbols appear as if they were words that had to be translated. Later on in part (a) (iii) he used one word for both *x* and *y* **ezidaluliwe** (anonymous). Such an inconsistency has a potential of complicating the task and confusing learners. Again, the teacher did not write the amount R1000 in figures. It is written in words only as **inkulungwane yamarandi** (one thousand Rands). Other prices in the same isiZulu task have been presented both in words and numerals. This is another inconsistency that could have confused learners. However, it is interesting to note that in the isiZulu version the teacher did not translate the word **inequality**. He used it as it is throughout the isiZulu task, which in a way gave learners from isiZulu group an idea that they have to write and draw inequalities. The use of the word inequality could have lowered the complexity of task and make it easy to understand.

It is also interesting to note that the style of translating in isiZulu task is more personal than it is in the English version. For instance, in part (a) (ii) the task reads: “Singajabula uma ungasibhalela amanye ama inequalities…” (*We can be happy if you can write other inequalities…*). The English version for the same part reads: “Write down any other inequalities…” This example shows the complexity of translating tasks from English to learners’ home languages. How does this personal style of translating tasks supports or constrains learners’ understanding of mathematics concepts? This personal style reflects the manner in which the teacher who shares the same language with this particular group (isiZulu) of learners interacts with them. This style of translating is rooted within the isiZulu language practices, which do not exist in English language. In general, it is a polite way of giving instructions to people who you respect. The personal style of translating therefore has an element of encouragement (and solidarity) to engage with the task. However, the disadvantage of this style is that it adds more words into a task and as a result some learners might lose track of what is required of them in the process of reading a long passage.

Task in isiXhosa

In isiXhosa version the teacher used the word **ezinga** (unknown) for both *x* and *y* in (a) (i) but avoided to use the word (ezinga) for *x* and *y* in part (a) (iii). When comparing the clarity of the two parts ((a) i. & (a) iii.), it seems that part (a) (iii) is clearer than part (a) (i). For example, part (a) i. reads:

> Umlimi uthenge iinkomo zobisi **ezinga**, inye ixabisa iwaka elinamakhulu amabini aneshumi elinesihlanu (R1250) waze wathenga iinkomo zenyama **ezinga**, inye ixabisa iwaka leerandi (R1000). Angachitha kangangamawaka amahlanu (R5000) Yenza **umlinganiselo** weenkomo zobisi nowenkomo zenyama.

On the other hand, part (a) iii. reads:

> Ingaba iinkomo zobisi nezenyama zingasinika owuphi **umlinganiselo**? Chaza.

It appears therefore that there was no need to use the word *ezinga* in part (i). The other challenge in part (a) (i) involved the translation of a mathematical term – inequality. The teacher translated the word inequality as **umlinganiselo** (unequal things) in isiXhosa. While the word umlinganiselo has an element of inequality, it does not give the same meaning as inequality in mathematics. As a result, it could be extremely difficult for any mathematics learner whose home language is isiXhosa to read that question and understand that they have to write an inequality. It is worth noting that while the teacher used the word umlinganiselo consistently for inequalities in parts (a) (i) and (a) (ii), he used it again in part (a) (iii). The English version does not make use of the word *inequality* in part (a) (iii) (*Can* x *and* y *take on any real values? Explain*). Therefore the isiXhosa version in this particular incident is a totally different task to the original English version. This is the extreme level of complexity in translating mathematics tasks. Again in part (b), the English version requires learners to graph the inequalities but the isiXhosa version on the other hand does not make reference to the word umlinganiselo, which then suggests that, the two versions require different things. How best can such inconsistencies and discrepancies be avoided when translating mathematics tasks from English to learners' home languages?

It is important that the mathematics teacher makes the translation or at least be part of the translating panel of teachers. When a task has been translated from English into learners' home languages, and has been thoroughly edited, the teacher should give it to another mathematics teacher to solve. Such an exercise would enable the teacher to identify the complexities before using such a task in a classroom. The teacher should also avoid translating technical terms such as *inequality*.

Task in Sepedi

In Sepedi version the teacher consistently used the expression **tše sa tsebjego** (unknown) for both *x* and *y* in parts (a) (i) and (a) (iii). This makes sense because *x* and *y* are both the unknowns. The teacher used the word **tekatekanyetšo** (*measurement*) for the word *inequality* in part (a) (i), which refers to the notion of measurement when used in everyday situation. The use of this word (*tekatekanyetšo*) for an inequality is problematic because it not a correct translation of the word inequality. The teacher has also been very inconsistent in translating the word inequality in Sepedi version. Reference is made here to Table 4.3 where in (a) (i) the word inequality is translated as **tekatekanyetšo**, in (a) (ii) the word inequalities is translated as **ditšhitišo** (*obstacles*), and in (b) the word inequalities is translated as **mo di kopanago** (*where they meet*). Such inconsistency in the use of words complicates the meaning of the task for learners. The three mentioned words for inequality are not even related to one another. That is, each word has a different meaning to the other two. The words also have totally different meaning to that of an inequality in mathematics. Perhaps it would have been better for the teacher not to translate the word inequality into Sepedi.

Task in Sesotho

It is surprising that in Sesotho version the teacher did not use any word for *x* and *y* in both parts (a) (i) and (a) (iii) and yet I find the task making sense and meaningful. In (a) (i), the teacher simply said: Rapolasi o reka dikgomo tsa lebese…le likgomo tsa nama… (*A farmer buys diary cows…and beef cows…*) without the use of the two unknowns *x* and *y*. It is worth noting however that when solving this task, learners would still have to make use of any two letters (not necessarily *x* and *y*); one for an unknown number of diary cows and another for the unknown number of beef cows. The teacher used the word **kgaello** (*shortage*) for inequality consistently throughout the task in Sesotho version. The word **kgaello** in Sesotho means lack of, or shortage of something hence does not share the same meaning with the word *inequality*. The use of this word for inequality complicated the task for learners from the Sesotho group. Therefore, it would have been better not to translate the word inequality into Sesotho.

The discussion in this section has shown that the process of translating mathematical tasks from English into learners' home language is complex. In this study, the process of translating was complicated by the fact that the teacher translated mathematical technical terms such as *inequality* and translating letters used as unknowns in an English version such as *x* and *y* into words in learners' home languages, also by involving teachers who do not teach mathematics in the translating panel. This complexity raises a critical question: How did such confusing translation affect the learners' engagement with the tasks?

In the next section, I present the learners' reflections on their experiences with the translated tasks.

4.8 <u>Learners' reflections on the home language versions of the task</u>

During the implementation of the translated versions of the task (Day 5's task) in the second part of the lesson, learners from isiZulu, isiXhosa, and Sesotho groups complained that the task in their home languages was ambiguous. The following extract shows how learners from these groups felt about the task in their respective home languages.

22.Ntsoaki	Rona tichere, hane re tlolietsa ka vernacular there were most terms, some of the terms ne re sa di utloisisi, ne resa di utloisisi, nere qala hodibona, nere prefera ho dietsa ka English. (*Teacher, when we did the task in vernacular, we did not understand many terms, we did not understand them, we saw them for the first time, we therefore prefer to do it in English*).
23.Teacher	Le ne le prefera ho dietsa ka? (*You prefer to do them in?*)
24. Learners	English.

In the above extract Ntsoaki argues that they found the Sesotho version difficult to understand because of many words that they were seeing for the first time. Which words were they? How could the teacher have avoided the use of such words when translating the task?

25.Sabelo	Siyibone ngesiXhosa ukuba inzima. (*We found it difficult in isiXhosa*). Nge English is much easier ngoba amanye amagama esiXhoseni athanda ukuba nzima, siqala ukuwafumana. (*It is much easier in English because some terms are difficult in isiXhosa; we see them for the first time*).

When talking on behalf of the isiXhosa group, Sabelo presents the same argument to Ntsoaki's that some words were unfamiliar to them in isiXhosa.

26. Teacher — Ok so it's only one group ethi yona ithole kulula kakhulu uma yenza… asikezwa kahle kuleyagroup. (*Ok so it's only one group that says they found it easier when they do it in… let's get it clear from that group*).

27. Ntsoaki — Re itse rona re prefera ho etsa ka English. (*We said we prefer to do it in English*). If neba refile ya Sesotho pele ne re ka setsebe hore tswantse re etseng. (*If they gave us the Sesotho version first we wouldn't know what to do*).

28. Teacher — IsiSotho anisasazi manje? (*So you don't know Sesotho anymore?*) [*Learners laugh*].

Ntsoaki argues further that they prefer the English version of the task because it was better to understand and if they were given the Sesotho one first they would not know how to work it out. As mentioned earlier, learners were given the English task to do in the first fifteen minutes of the lesson and then after collecting the scripts where learners wrote their answers, the teacher gave learners the same task translated in home languages to do for the other fifteen minutes. It follows then that if the tasks were given in reversed order, learners would have encountered problems in understanding what was required of them. This is not surprising because these learners were never exposed to mathematics tasks in their home languages in any given time before, and probably throughout their entire schooling. Again because of translating mathematical register. Therefore the complexity goes far beyond the teacher's question (*utterance* 28). In other words the issue is not only about whether learners know their home language (Sesotho) well or not, it rather encompasses issues of whether historically these learners have been socialized in this practice of doing tasks in their home languages. The quality of translation also matters a lot.

29. Teacher — Yes, that thing is simple and straightforward. Into ekhona noma engekho? (*Does it mean something is there or not?*) Yini eningayi zwizisanga lapho? (*What is it you don't understand there?*)

30. Hlengiwe — Igama esingalizwisisanga ezidaluliwe. (*The word we don't understand is "ezidaluliwe"*).

31. Teacher	Woo! Izinkomo lezi ezidaluliwe. Ngiyabona ke, ukuthi inkinga yenu ikuphi. (*Woo! The cows that we talked about. I now see where your problem is*).

In the above extract, Hlengiwe from the isiZulu group argues that they too encountered problems with the isiZulu version of the task. She mentions that words like "ezidaluliwe" were problematic to understand. On the other hand, the Sepedi group argued that they found the translated task into Sepedi easy to understand. Why was the Sepedi version easier to understand than the other versions? The following extract shows how learners from the Sepedi group felt about their task.

32. Sipho	Ka Sepedi e ne e le easier than English. (*In Sepedi, it was easier than in English*)
33. Teacher	In Sepedi was easier than in English?
34. Learners	yes.
35. Teacher	Niye nathola ukuthi niyi understand kahle when you do it in English or you understand it better in Sepedi? (*Did you understand it better when you do it in English or you did in Sepedi?*)
36. Thandi	Ka Sepedi … (*In Sepedi…*)
37. Teacher	Ok. Let's keep quiet, yes!
38. Thandi	Ka Sepedi because ka ya English hane re qala ho e etsa e ne e le more difficult, but ha ne re latela kaya Sepedi, re kgonne ho ngola a page. (*In Sepedi because when we first did it in English it was more difficult, but when we do it in Sepedi we managed to write a page*).

According to Thandi (*utterance* 38), the Sepedi group found it easier to work on the Sepedi version so much that they managed to "write a page" which they had failed to write when they were working on an English task. As indicated earlier, in Sepedi version the teacher consistently used the expression **tše sa tsebjego** (unknown) for both x and y in parts (a) (i) and (a) (iii). Perhaps that consistency played an important role in making the task better to understand for the Sepedi group.

Conclusion

In this chapter, I have provided an overview of the five lessons observed. This was followed by the discussion regarding the counting of situations (incidents) that emerged from data during the analysis. The analysis of tasks that were used in class reveals that the teacher deliberately used learners' home languages in tasks in order to enhance their understanding of concepts. It also came out clearly in this chapter that the inappropriate way in which tasks were translated from English into learners' home languages let to learners having undesired experiences when working on such versions of the task. The manner in which tasks were implemented on Day 5 did not make home languages to act as a support to English in order to enhance learners' understanding of key concepts in linear programming.

In the next chapter, I pay attention to the conclusions and implications drawn from the analysis done in this chapter.

CHAPTER 5

CONCLUSIONS AND IMPLICATIONS FOR PRACTICE

5.1 Introduction

The aim of this study was to explore the ways in which a mathematics teacher in a multilingual classroom used learners' home languages as a support in learning and teaching of linear programming concepts. Through a detailed analysis of five consecutive mathematics lessons in which the teacher deliberately used learners' home languages in his teaching of linear programming concepts, this study has shown that while there are situations where the use of learners' home languages supported learners' understanding of concepts there is also an instance (implementing day 5 task) where the use of learners' home languages could not help. This study has also shown that translating mathematics tasks from English into learners' home languages is a complex professional task for mathematics teachers.

In this chapter, I use the research questions stated in the first chapter as headings in order to guide my presentation of the summary of the findings. The chapter also presents the implications for curriculum development and teacher education. I finally highlight the limitations of the study.

5.2 Summary of the findings

How does a Grade 11 mathematics teacher in a multilingual classroom use learners' home languages when teaching linear programming?

The teacher in this study deliberately grouped learners according to their home languages in order to afford them opportunities to communicate mathematically through the use of various languages. In every lesson he reminded learners that they were at liberty to use their home languages in their respective groups to discuss the demands and solutions of given mathematical tasks. The teacher also used learners' home languages in mathematics tasks. For instance, in one of the Day 4's tasks (part (b)) he asked learners to translate a statement from English into their home languages (*Mandla cinema hall can accommodate at most 150 people for one show.*

a. Rewrite the sentence above without using the words "at most".
b. Rewrite the sentence in your home language)

According to the account given by the teacher during the reflective interview, this was done in order to assist learners to acquire better understanding of the task. Through the learners' writing the teacher would be able to sense whether they understood the question or not. Again in one incident (Day 5) the teacher translated a task from English into learners' home languages and asked learners to work it out.

Learners' home languages were used persistently during the five lessons for asking learners questions. The teacher posed questions to learners during the whole class discussion in home languages. Such questions encouraged learners to think and talk in home languages. As a result, many contributions that learners made during the whole class discussion were in home languages. I found it interesting that learners were able to understand and speak all the languages available in the class (isiZulu, isiXhosa, Sesotho, & Sepedi). For instance, during the whole class discussion, one learner would talk before the class how they worked out the solution to a task in isiXhosa and another learner would ask a question in Sepedi or add to what the isiXhosa presenter says in Sesotho. During the interview, the teacher confirmed that his learners were fluent in all those languages even though he is only fully fluent in two (isiZulu and isiXhosa) and can understand Sesotho and Sepedi. The use of home languages in this manner kept the discussion alive across all the five lessons. I therefore conclude that the use of learners' home languages in these lessons enhanced their participation in class discussions.

The teacher also used learners' home languages to re-voice learners' contributions in all five lessons. The teacher rephrased learners' utterances so that they could be more mathematically focused. This kind of use of home languages helped learners to think of what they said and helped them to correct themselves. However, re-voicing is not always an easy practice for teachers because:

> It is not always easy to understand what a student means. Sometimes a teacher and a student speak from very different points of view about a mathematical situation.
> (Moschkovich, 1999: 15)

What is being highlighted by the above quotation was evident in some situations where the teacher re-voiced learners' contributions made in English. The teacher also used learners' home languages for giving instructions to learners. As mentioned earlier, such instructions were regulatory in nature necessary for maintaining order in class, but did not have a direct relation to learners' understanding of linear programming concepts. Even though learners' utterances were not properly recorded when working in their respective groups, it was assumed that learners discussed tasks in their groups in home languages. This assumption is based on the fact that the groups were formed according to the four existing home languages in the class. The following section speaks to the question of whether the manner in which the teacher used learners' home languages supported learners' understandings of key concepts in linear programming or not.

How does the way in which the teacher uses learners' home languages support learners' understanding of key concepts in linear programming?

The teacher deliberately asked questions that encouraged learners to provide explanation of mathematical concepts in their home languages. For instance, he asked learners to express their understanding of concepts such as *at least* and *at most* in their home languages. The analysis of lessons' transcript shows that learners demonstrated some understanding of the word *at least* by using appropriate words like "bonyane" in Sesotho, and "okungenani" in isiZulu. Asking learners to think and talk such concepts in their own languages provided an opportunity for them to think of the different ways in which concepts could be expressed in their languages, hence variety of words in different home languages were used.

Through the use of learners' home languages, the teacher managed to actively engage learners in mathematics conversations throughout the five lessons. As mentioned in the early chapters, the mathematics curriculum in South Africa encourages teaching strategies that promote active participation in communicating mathematically. The teacher in this study employed a teaching strategy, which involved grouping learners according to their home languages to enable them to communicate mathematically in their own home languages. This proved to be working well in this particular class. The teacher argued during the interview, that the level of learner participation in mathematics practices was comparatively higher than it used to be in other lessons where home languages were not used. What came out clearly from the data gathered from the five lessons where home languages were used is that learners actively participated in mathematical talk through the use of multiple home languages.

The teacher in this study made a remarkable attempt to use learners' home languages in mathematics tasks. On Day 4's task, part (b) he asked learners to translate the given statement from English into home languages. He also made an effort to translate Day 5's task into learners' home languages. As shown in the previous chapter, learners successfully managed to translate the given statement from English into their home languages. On the other hand, the analysis also shows that the teacher's endeavor to translate mathematics tasks into learners' home languages proved to be problematic in some instances. Some of the translations were not properly done and as a result of that some translated versions such as the isiXhosa one distorted the original meaning of the English version. Therefore the use of home languages in this manner did not support learners' understanding of mathematical concepts. This particular finding highlights the complexity of the process of translation.

The analysis has shown that the way (test-like style) in which the teacher implemented the English version and the translated versions of the task in class on Day 5, did not make the use of learners' home languages to function as a support to English for learners' understanding of key concepts in linear programming. This was due to the fact that learners could not use, for example, the Sesotho version alongside the English one to enhance their understanding of the demands of the task. Learners failed to make any connections between the two versions (English and Home Languages) because the teacher handed them to learners at different intervals. The issue here is that failing to give learners the English version simultaneously with the home language versions obviously defeated the purpose of using such learners' home languages in the teaching and learning of mathematics.

The analysis has also shown that learners were comfortable to discuss key concepts in linear programming through the use of home languages. During the whole class discussion, learners naturally switched between languages. They used both English and their home languages to explain their solutions to the whole class.

The following section focuses on the third critical question in this study.

Why does the teacher use learners' home languages in the way in which he does?

The teacher used learners' home languages as a base for forming groups (Sesotho group, isiZulu group, etc) of learners so that they could fully participate in the learning of linear programming. During the interview, the teacher claimed that he was successful in doing this because according to his account learners were able to freely express their views in either their home languages or in English. However, this strategy of grouping learners according to their home languages may be criticized for having a potential of taking learners back to the apartheid time where people were segregated according to ethnic groups. I raised this issue with the teacher during the interview, and he reacted as follows:

T …at the back of my mind there was also that thing of tribalism, which says if we group learners according to their languages I would be promoting that and yet it wasn't my intention. My aim was not to promote tribalism but make sure that there was some understanding of one another. So what I normally do is to say, if you can't answer or say it in English, use your home language …

Looking closely at the teacher's account, it appears that the teacher was fully aware of issues relating to ethnicity. It is this awareness that I believe would help him to be cautious of actions and utterances that would promote divisions among learners. It would be scary if the teacher was ignorant of this issue. He set a clear aim, which was to create conducive learning environment where learners could use their home languages freely with understanding as they discuss mathematical concepts. As indicated in Chapter 4, he encouraged learners to use their home languages throughout the five lessons. That helped learners to focus on the discussions rather than on their differences. From a situated perspective, this strategy would be interpreted as the teacher's attempt to form communities of practice with learners who share similar identity (language).

The teacher used learners' home languages the way he used them because he was inspired by the university course he studied in his further training. The teacher's account shows that the course emphasized the importance of using learners' languages in teaching mathematics. So the teacher wanted to put into practice the use of learners' home languages in teaching mathematics. He used learners' home languages in teaching linear programming concepts as a consequence of his further university training.

He also used learners' home languages in the way he did in all five lessons because he was undertaking a research project in which he aimed at improving on his practice (teaching of mathematics).

The teacher reflected on his practice of marking Grade 12 mathematics learners at the end of every academic year and recalled that many learners do not do well in linear programming, and assumed that one of the factors is the language barrier. This assumption motivated him to undertake a study in which he could deliberately use learners' home languages in teaching linear programming concepts. The teacher used learners' home languages to pose questions to learners in order to get more feedback from them. He re-voiced learners' contributions using home languages in order to push learners to think carefully about their contributions (questions, comments, etc).

The teacher used learners' home languages in setting up tasks in order to detect the level of understanding learners had regarding the demands of the tasks. In the next section I pay attention to implications for teaching.

5.3 Implications for curriculum development and teaching

The teacher in this study has initiated an important role of modifying textbook tasks and translating some of them from English to learners' home languages. I would like to recommend that it could help teachers who teach multilingual learners if textbook publishers could produce bilingual textbooks (i.e. a book written in both English and home language). This study revealed that translating mathematics technical terms such as inequality and variables into home languages does not only make the task ambiguous but also alters its demands. I therefore recommend that when teachers translate tasks, they should avoid translating mathematics technical terms.

Given that the curriculum calls for the use of learners' home languages in teaching, and based on the results of this study, I would like to recommend that even though in general African parents, learners and teachers may prefer English due to its power to give access to social goods (Setati, 2003) mathematics teachers should make an effort to use home languages together with English in learning and teaching of mathematics right from grade R up to Grade 12. In this way learners can have access to mathematical knowledge while they are developing fluency in the English language.

It is well known that a majority of African teachers in South Africa have fluency in at least three languages. In my view for strategy that the teacher in this study used to work it is important that the teacher has fluency in the home languages of the learners in his class. Given the multilingual nature of South African classrooms, it is advisable that all teachers be required to take an additional African language as a special subject while in pre-service training.

The manner in which the tasks (English & Home Language) on Lesson 5 were implemented did not create opportunities for home languages to support learners' understanding of key concepts in linear programming. I therefore recommend that teachers give tasks to learners in two languages (English and the home languages) on one page with one language on side of the page so that learners can refer to the versions as and when they need to. In that way the home language can serve as a support for learning English and the use of home languages would benefit engagement with the mathematics task.

The teacher in this study employed a strategy that shed light on how learners' home languages could be used in multilingual classrooms. The strategy involved grouping learners according to their home languages and translating mathematics tasks from English into home languages that exist in class. Based on this initiative by this teacher, I would like to recommend that further studies be conducted in other multilingual classrooms in order to investigate other strategies that mathematics teachers make use of when teaching mathematics concepts through learners' home languages.

5.4 Limitations of the study

The limitations of this study specifically lie on its nature. This is a case study that focused on one mathematics teacher in one Grade 11 multilingual class, focusing only on five lessons therefore the results cannot be generalized to other lessons, other mathematics topics and even other multilingual classrooms. The study had a limited scope of focusing on the teacher only once when he for the first time in his career deliberately used learners' home languages. This calls for further research which would focus on how this teacher would do things different in the second and third rounds of deliberate use of learners' home languages in his teaching.

The following section addresses the conclusions reached in this study.

5.5 Conclusion

This study explored the ways in which the teacher used learners' home languages in order to support learners' understanding of key concepts in linear programming. Through a thorough analysis of transcripts of five consecutive lessons, and transcripts of the reflective interview with the teacher it is clear that the use of learners' home languages in multilingual classrooms helps learners to develop in-depth understanding of mathematical concepts such as "at least, at most, etc. When learners are grouped according to their home languages they were encouraged to communicate mathematically in those languages. However, the focus should not be on the use of home languages only but also in helping learners to develop conceptual understanding.

Improving the level of learners’ participation in mathematics classrooms is demanded by the new curriculum in South Africa. One of the ways in which this requirement could be achieved is by permitting multilingual learners to discuss mathematics in their languages as shown in this study. This study has shown that translating mathematics tasks from English to learners’ home languages is a complex task. Given that the aim of this strategy that the teacher was using is not to develop the mathematics register in the learners’ home languages but to make mathematics accessible to the learners while they are still learning English, I recommend that teachers should avoid translating mathematics technical terms such as inequality, variables (e.g. x & y), equation, etc. The findings of this study suggest possibilities of a multilingual mathematics teaching strategy that can benefit learners’ engagement with mathematical tasks and thus gains in their learning of mathematics. More research into the strategy needs to be done.

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APPENDIX

Lessons' Transcripts

Day 1

Teacher	Right, ok now listen very careful, Kulawo magraphs esesiwadwebile. You consider those graphs esiqeda ukuwa sketcher ne…
Learners	Yes!
Teacher	Consider these two restrictions $x \geq 0$ and $y \geq 0$. Do you know what a restriction is?
Learners	Yes!
Teacher	Awungitshele ngesiSotho. Yini irestriction? Stand up. What is a restriction?
Ntsoaki	Ke hore ntho yahao ntswantse itsamaisane lentho eo eseke yafeta. Tswantse ebe… ehh within esekeyafeta.
Teacher	Ibe within?
Ntsoaki	Yes
Teacher	I-restriction in sotho?
Ntsoaki	Ke molao, umthetho.
Teacher	Ke molao. Ya u sketcher the graphs maar o lebelela molao o?
Ntsoaki	Yes
Teacher	And then? Yes!
Lebohang	Ke molao ka Sepedi.
Teacher	In Zulu?
Mfana	Umthetho, sir.
Teacher	Asizwa kahle.
Thabo	Imithetho.
Teacher	Now ngicela ukuthi in those graphs esiqeda ukuwa sketcher, just for 10 minutes. I will give you only 10 minutes kulawo magraphs enizowa sketcher. Let's say igraph yakho i cutter y-axis and i cutter x-axis. Now you must use these restrictions $x \geq 0$ and $y \geq 0$ Ukuthi igraph yakho izoba kuphi and why on this part? Angazi noma siyazwana?
Learners	Yebo, siyezwana.
Teacher	You are only following a restriction. This is our y-axis and our x-axis. Isn't it?
Learners	Yes, siyabona.
Teacher	You take anything that is greater or equals to 0 in that graph. You look for the values of x. where are the values of x here? Isn't it? Now you must look for where this graph is greater or equals to 0. If all these values on that side are greater or equal to 0, so kusho ukuthi this means that this is the part you are going to consider and you cancel the rest. Isn't it?
Learners	Yes
Teacher	But if your x is greater or equal to 0 is on that part, you will cancel that and consider almost everything that side. When you do that please use a blue pen and a red pen just to cancel to show ukuthi lokhu-okunya akusebenzi. Yes on those same graphs, you use those graphs.

Teacher	Yes, you just sketch, angithi, let's say this is your graph. So you fill ukuthi iportion ongayifuni kulegraph is this one. You still take this …… from here to here I don't want that portion and again maybe from there to there I don't like this portion igraph esalayo is one that satisfy the restriction.
GROUP DISCUSSIONS	
Teacher	Ok, now what we are going to do, igroup negroup izosipha ifeedback, ngalama graphs lanka ebisiwenza. Ngisoinikeza I problem No.1. 1, 2, 3, 4, 5, 6 amagraphs ebesiwenza. This group ngizoyinikeza u no. 1 and 2. No. 3. How many are they? 7?
Teacher	1, 2, 3, 4, 5, 6 and 1 nisikhombise ukuthi nisketche kanjani and then that will be groups 2, 3, 4. Both nizositshengisa ukuthi nisketche kanjani. After unqede uku sketcher bese ni considera lawa ma conditions nithole ukuthi igraph yakho ime kanjani eboardini. Sheshisani. Others must listen. Right uma ufuna ukubuze amaquestions you can ask questions. I question uganyibuza ngesiZulu, ngesiPedi noma ngesiVenda akekho umuntu ozothi ke lokho okushoyo is wrong.
Ntsoaki	Dumelang. Lamathomo reqadile kahongola equation in the form y = mx + c and then, rathola hore y = mx + 6. (3x + 2y = 6, $\Rightarrow y = \frac{-3}{2}$ x + 3) Ke y-intercept and x = 0 and therefore y = 3 x intersect i y – yarona y = 0 and x =2
Teacher	Is that correct?
Learners	Yes.
Ntsoaki	Ha re qeda kadi points and then (0, 3) and then this one (2, 0) and then you join the 2 points. And then when we considered the two restrictions ok, ahh x ≥ 0, on our graph ok, x ≥ 0 here but then, y$\leq$0. When it comes to this y$\geq$0 but here x$\leq$0 therefore ntho, only place whereby the graph, the two restrictions are on this graph therefore …………
Teacher	Kukhona into engingayizwisisi kahle. Aah kukhona iquestion kuNtswaki. Ntswaki uthi why do you cancel that part? Let's start with this one le eye part yangaphakwa left.
Ntsoaki	This one?
Teacher	Yes. Le yakwa left. Angithi uqale ngokucancella leya portion.
Ntsoaki	Yes.
Ntsoaki	x is less than zero.
Teacher	How do you know that x is less than zero?
Ntsoaki	Because the value of x is negative.
Teacher	So if something is negative, does it mean that it is less than zero?
Ntsoaki	Yes, it is less than zero.
Teacher	You mean to say ahh, yiphi inumber enkulu u 0 no -30.
Learners	Zero.
Teacher	Right any question. So thanks very much let's go to another group. Akusheshwe!
Hlengiwe	Sanibonani
Learners	Yebo.
Teacher	Asilaleleni.

Hlengiwe	Siqala ngokubhala 2x bese….
Teacher	That was task No. 1. Isn't it?
Learners	Yes.
Hlengiwe	Task number 2 sizoyenza u = x abe uzero. If u x angu 0, I sub yaka 1. Sizo substitute la ku-x sifake u 0. Uma si solve la z any nnumber multiplied by 0 = 0 and bese senza the same thing njengoba sense a i. bese 0 ÷ 2 = 0.
Teacher	0 ÷ 2 is 0?
Learners	Yes
Hlengiwe	0 ÷ -2 = 0
Teacher	No, asiyisulu sizobhala ngale, sketch igraph.
Hlengiwe	Angithi niyavumelana nami ukuthi imid-point u o?
Learners	Yes.
Hlengiwe	Ya so u y u-0 no x futhi u-0. We are just going to draw a line ezocutter through the, and then base siyabona ukuthi uma, uzobheka irestriction esinikezwe yona. Angithi any no. if u x ebelow ku-ntive no., u-0 mukhulu negative No. So size cancella this side. Uma u-x u greater than 0 and then this side u less than 0, and u y u greater than 0.
Teacher	Right, any question, uma une question uphakamise isandla. Yes.
Johannes	Why le line ungayi draw 'so'?
Hlengiwe	YuyaFana
Teacher	Yes, ithi iquestion why le line ungayidraw la? 'Cause kuyafana na la wuzero is to zero.
Hlengiwe	If unganyenza ibe kanye kuyapana 'cause awuzobheka uzocuttela, uyabona this side i…u…
Teacher	Chishe igroup izokuhelper. Akusiyo iproblem ka Gumede eyi one. Because azisafani sisenamagraph. Ayafana igraph eso neso?
Hlengiwe	If inje, ngizo cancella because una ubheka u-y lapho kule side u, u – u zero u less than u.
Teacher	Is less than zero?
Hlengiwe	Ya, and then uma uzobheka ku-x lapa is less than zero. So ngapha u y-uzo cutter la x a less than zero.
Teacher	Ake sithathe omunye. Are you satisfied nge explanation kaGumede?
Teacher	Is one and the same thing, YikuPhi ozoducancella Gumede?
Hlengiwe	Zoyi-2
Teacher	But then now kusesekhona igraph. Bathini abanye ake siswe. Ake siswe le group. Iyafana uma iphume nge so noma nge so is it one and the same thing? According to you.
Thabo	No.
Teacher	Why not?
Hlengiwe	A'ah ashs, uma sicancella la ku x no y iya cancella. Uma engayijika futhi eyenze the way uJohannes esho ngakhona, u y uzoba u positive u x abe unegative. Azisafani.
Teacher	So uthini ngalokho? Uthi akwenziwe njani? Unawo umbono? Because thina sesifocuse kakhulu enolabeni yokucancella asisekho endabeni yokusketcher I graph. Our aim here is to sketch a graph. Indaba yoku cancella nendaba yonkwenzani, leyo iza after ukuthi sesi follower the second part of the problem.

	Ake sibheke I part 1. Siyeke indaba yokucancella. Let's look at Part 1. Yes.
Caroline	Teacher nna ho ya kanna hadi tswane, because the other way like Johannes ane a dira ka hona is the y-axis is negative and the x-axis is still negative. So if we cancel ka moka both x & y…………
Hlengiwe	Bekungeke kube negraph.
Teacher	Bekungeke kuba negraph?
Hlengiwe	If besi draw kanje, besizo cutter kanje.
Teacher	So siyavumelana ukuthi igraph ibingeke ize ibe khona.
Learners	Yes.
Teacher	Ngoba igraph ngeke ibekhona sekufuneka senze into e wrong ngoba igraph ingeke ibe khona? Si follower ama procedure la? Or sesi interested endabeni ye graph?
Gumede	Ahh!
Teacher	Ok, ake sizwe la, maybe uzosinceda.
Sipho	U batla side e lekane le zero or e be greater than zero? Or if u etsa so, ho tlotswana hore, you must do it for side e ngwe.
Teacher	Kwangazathi asizwani grade 11. Iquestion ka Johannes iyi-1. Uthi uJohannes yini ungayidrawanga le graph yaba so? Wayi drawer yaba so? Johannes is saying why our graph is rising and not falling?
Gumede	Into efike enqondweni yami ukuthi ngiyi draye ngiyibhekise le. I have just decided to draw it like that.
Teacher	Ok, Engifuna ukukwazi ukuthi kwa grade 10 ubuyenza kanjani caue heniyenza nakwa grade 10. Ngifuna ukwazi ukuthi beniyenza kanjani because akusiwo amagraphs ka grade 11. Umsebenzi wakwa grade 9 nomsebenzi wakwa grade 10. Ukuthi niwadrawer kanjani, ukuthi uma uyidrawer yiziphi izinto obuthi uma uzidrawer uzibheke? Yes!
Gumede	Ama-points…
Teacher	Ake sizwe Mosia
Mosia	Ngiphendula umbuzo wokuthi why igraph ibheke le. It is because of the gradient.
Teacher	Ohh i-gradient?
Mosia	Yes. Our gradient is +2
Teacher	Iphi leyo equation? Awayibhale
Mosia	Nayi
Teacher	This one?
Mosia	Yes.
Teacher	So -2x+1=0. Right!
Ntsoaki	Our gradient is going to be positive.
Teacher	Izoba yi, y=2x. So then our gradient is positive 2.
Ntsoaki	Our grarient is positive
Teacher	Awusikhombise ukuthi ihamba kanjani le ethi igradient is positive.
Ntsoaki	Kule side leli, u x, u x ngapha yi negative and u y ngapha y positive.
Teacher	Sula kahle lapha azoyidrawer, sizama uku answera iquestion ka Johannes. Right!
Ntsoaki	This side u x wethu is negative, therefore ngapha.
Teacher	Ake siyeke uku-cancela. Sike sithole ukuthi igraph yethu nqala. Sithole ukuthi igraph yethu ime kanjani. Sizama ikuanswera u Johannes.

Ntsoaki	Uzoma kaso.
Teacher	**Right why siyidraya kanjalo?**
Ntsoaki	Our gradient is positive and this side …
Teacher	Ake siyeke ngaleside sike sianswere the first question.
Learner	I gradient yethu is positive.
Teacher	Is that true?
Sibanyoni	Yes.
Teacher	Ubani lo ovumayo? Asizwe yes, why?
Sibanyoni	Aah!
Teacher	Siyavumelana na ukuthi igraph yethu uma ime kanje i-gradient yetho i-positive?
Thabo	I am not sure.
Teacher	You are not sure?
Thabo	Yes.
Teacher	Ubani ovumelana naye ukuthi legraph ime ka so? yes!
Ntsoaki	I do agree. That's the way it should be.
Teacher	So libezoma kanjani?
Ntsoaki	Ibe zoba y = -2x
Teacher	Ohh ibezoma ibheke le?
Ntsoaki	Yes
Teacher	So you understand ukuthi uma igradient is positive ibheka kule direction and uma in (-) ibheka kule direction.
Teacher	Ok sit down. Gumede uthe uzocansella this part or that part?
Hlengiwe	This part
Teacher	Right! Number 3
Thandi	Ok, e ya number 3, which is 3x - 2y = 4 re chositse hore resubstitute 0 ho x. Re itse let x = 0. So itloba … meaning y is going to be (-2) therefore dipoints tsa rona itloba (0, -2) kamorago re re let y = 0, then ra re… be re re dipoints tsa renna ($^4/_3$, 0) graph ya rona ke e…
Teacher	Ungasuli leyo. Right this one.
Thandi	Ena ke (0, 4/3) & (0, -2). Then ra ethalla so harefeditse ra sheba melao ya rena. Ra re $x \geq 0$ therefore rasheba hore, which side, is greater than 0 and less than hona mong. Then this side etloba less than this side then ra cancella this side. Why this thing eltoba kokayi then ra checka hore itloba less than mona.
Teacher	Right question? Yes ahh ok.
Thabo	Angi understand!
Teacher	Kuphi? i number 1
Thabo	Le part yama graphs
Teacher	Ukuthi ba cansella kanjani? If uthandi engakuqhazela noma anyone. Ubani ongaqhaze indaba yokucancella? Awunayo iproblem yokuskech igraph.
Thabo	La okucancella khona.
Teacher	This one ezohamba la and this one ezohamba la? Because this is your 1.
Lebohang	Tishere e right ke e yabo 2. Ee yabo 2 re e simplifyle.
Teacher	Yini into ezoyenza ukuthi uplote between 3 and 4. Because there is a reason ukuthi uzoplotter between 4 and 3. Why you have divided to plot between 4 and 3? Maybe you have a reason for that. You are not answering the question.

	My question is straightforward why you have decided to put it between 4 and 3? Do you have a reason for that? Yini enkewenze uchose u 2 no 4? Because maningi amapoints ubungachose u 1 and 2.
Thandi	Tishere e re ke answere question ya hao.
Teacher	Yes.
Thandi	Why bayi simplify ile?
Teacher	Why you simplified it? Do you have an answer for that?
Thabo	Tisha ukuyangami babone u 3 no 4 bacabanga ukuthi kumele ibe between 3 and 4.
Teacher	Ohh! That is not a reason, why?
Thandi	For your case azange kakhetha between 4 and 3. Re kgethile between 3 and 4 le Caroline.
Caroline	Tishere ke kgopela ho araba. Ne re ka sekhone ho kgetha ho 3 or 4 that is why regethile between 3 and 4.
Teacher	Awuvesi udecide sisebenzisa amarules $^{4}/_{3,}$ is it proper or improper?
Learners	Improper
Teacher	Nasenithola ubani i answer?
Learners	$1^{1}/_{3}$
Teacher	Never ever assume…
Teacher	Which graph is correct?
Caroline	Ee yabo 2, cause yabo 2 ree simplifyle.
Ntsoaki	Tishere rona re e shebile.
Teacher	Yini into eyenza ukuthi uplote between 4 and 3 because they have a reason ukuthi $1^{1}/_{3}$.
Thabo	Thandi uyazi i $1^{1}/_{2}$ ibhalwa njani?
Thandi	Yes.
Thabo	Ibhale ke
Thabo	$1^{1}/_{2}$ iso infana ne $1^{1}/_{2}$. So lena eyakho yi $1^{1}/_{3}$ izoba lapha.
Teacher	Right now the last group. This group. Quickly you have 2 minutes.
Thabo	Siyenze so ke, sithi 1,2,3,4. then sizopholela la ka so. Then sizoyenza ngapha ama negative sign. Then sa cancella this part.
Teacher	Ok any question! Yes!
Lerato	(0, 4) e ne e tlo ba tlase ha yona?
Caroline	Tishere waitsi ke eng ana ke x-axis and ena ke y-axis. Re e drawer ka x-axis x = 4 kee. So reetsa ka x-axis not y-axis.
Thabo	Wena ufuna ukuthi khona la? Anyeke uyikhone la.
Teacher	One at the time. Are you answered?
Thabo	No.
Teacher	Thabo, a simple question. How do you know ukuthi igraph lakho kufuneka lime this side or that side?
Thabo	Because 'lieme' so.
Hlengiwe	So if senza into e sa ngeke ubone uzochabangu ukuthi yinto eyi-1.
Teacher	x = 4 so why mo lining ya hae acansetsi all posite?
Hlengiwe	Angithi lapa ama negative. Um aux (-) not (+) uthola u(-). Asifuni u negative sifuna u positive kuphela.
Teacher	I don't think iquestion yakhe siphendulekile ukuthi why this graph ithatha idirection le not leya.

Hlengiwe	Nojicabanga ukuthi izohamba phezu kwenye noma ungasebenzisa enye number.
Teacher	She is not convinced and I am not conviced.
Sipho	Thina sifuna u 4 kuphela.
Teacher	Sifuna i procedure. Out of the sudden I simple straight.
Marvin	Tisha mina ngifuna nkwazi why iso? Why singayibeki so?
Abel	If besizoyibeka ka so besozoyihlanganise no y-axis. Kusho uthi akusosiyiyo len to abasiphe yona.
Ntsoaki	Why do we have x = 4? We can't have a gradient therefore we don't have a slope. Thabo if you write y = mx + c what do we have …, we don't have a y-intercept and we only have x = 4.
Teacher	What were you saying Mofokeng? What is the value y? Do we have x-intercept?
Sipho	Uthishela azange asitshele ukuthi why.
Teacher	You were told ukuthi yenciwa kanje. Go home and find out ukuthi yenziwa kanjani. This is your homework… If x = 0 y = 0 x = 1 y = 3 x = 2 y = 3 x = -1 y = 3 x = -2 y = 3 Lets see x = 0, y = 3, x = 2, y = 3, x = 3, y = 3, x = 4, y = 3! Do you see that? Not that you were told. If the value of x is the same the value of y the value of y will remain what?
Learners	The same
Teacher	Now tomorrow you show us why this graph is parallel to the y-axis, see you tomorrow.

END OF DAY 1

Day 2

Teacher	All you need to do just read the instruction and do the work.
Teacher	Right group 1 ake sizwe ukuthi ubani ozo presenta. You must be ready group 2, 3. Quickly. Yes. Question is already there $2x+5y\leq 10$. You talk to us such that we all understand what you are saying.
Mofokeng	Re qala kaho ngola equation ya y = mx+c.
Teacher	Ok!
Mofokeng	Then … (*Writing on the board*)
Teacher	Do you understand what he is saying?
Learners	No.
Mofokeng	We solve by x, we solve for nthwena for y. Divide by 2. To solve for y. x = 0. any no. multiply by 0 = 0 y-intercept 2. $\frac{2}{5}y \leq 2$ (multiply through by 5) $2x \leq 10$ (divide by 2) then $x \leq 5$.
Teacher	Right just before that he is saying what is that, what is that? You said we must multiply by what?
Ntsoaki	5.
Teacher	Are we allowed to multiply inequality sign by 5?
Ntsoaki	If we multiply by negative sign is going to change.
Teacher	But are we allowed to multiply?
Ntsoaki	Yes.
Mofokeng	This is our graph. Re tlo sheida part eka tlase because kamo $y\leq 0$ and lekamo $x\leq 0$.
Teacher	Right Ok. Do you all understand? Yes! What is your problem?
Mofokeng	Ahh…
Teacher	Bathi u cancelle everything. Did you cancel anything? Uya sheida. One at a time. Yes!
Tshidiso	Why ashadile kamofatsi asashade holimo?
Teacher	Kamofatse ya eng? Be specific kamo fatsi ya eng?
Tshidiso	Kamofatsi ya graph yahae.
Teacher	Kamofatsi ya graph yahae. Ha kere? Why u shaida kamoo fatsi ho graph ya hau?
Teacher	The question is why ushedile the below part? Yes!
Christopher	Because if our equation is $y \leq mx + c$.
Teacher	Yes $y \leq mx + c$, did you say the same thing. Lets get this when you shade, do you refer to this graph or that graph?
Ntsoaki	We refer to the one that is written in standard form.
Teacher	The one in standard form.
Ntsoaki	$y \leq \frac{2}{5}x + 2$
Teacher	Can you explain thoroughly why do you shade below? Not above.
Ntsoaki	Above as you can see. If you shade above our line, our values are greater.

Caroline	My question is why besheda below, all the line hayi above?
Teacher	Caroline you are not listening.
Thandi	Question yabona kehore why ba sheida ba sa etse method wamaobane tishere abobontsitseng wona?
Teacher	Ake sithole u Caroline uzoyi explainer kahle.
Caroline	Ok, why basashada on the line, or on top of the line?
Teacher	Maybe they will answer that question. Iquestion ithi why now you shade instead of cancelling? Yes!
Ntsoaki	Akeri yesterday we where given straight line graph and a restrictions that ($x \geq 0$ and $y \geq 0$)
Teacher	The way uNtswaki esho ngakhona we were given restrictions. Sketch a graph and consider this restriction. Are we given a restriction today? Are you answered?
Teacher	Second group. Your graph is $2x+5y \geq 10$ that's your graph.
Sipho	Let $x = 0$
Teacher	While you are still there group. Are you group 2? Now you have seen how this graph is sketched. Your group is going to present this one. You have started by saying … OK. Anyone who want to say something because we were given this. And now we are given something that is totally different from that. Isn't it?
Learners	Yes.
Teacher	Is it totally different?
Sipho	I think the values will be the same.
Teacher	You see that, now they are trying to help you because everything is the same. That group, yes! Who can help them? Sit down. But you said to me this is one and the same thing. Let's get this one. You said to me this is one and the same thing. Thabang?
Teacher	Now the shading is … Do you want to say something?
Mfanafuthi	Why a shada this side?
Teacher	Thabang, why are you shading this part? Stop here.
Thabang	Angithi lapha sir, lana ucabanga ukuthi lena yi greater than akusi less than. Manje umaku greater than zihamba kanje.
Teacher	We want the full equation ukuze sizo understanda kahle. Asifuni I > or <.
Thabang	(*Writes equation*)
Teacher	Continue Thabang. Is that correct?
Marvin	No
Teacher	One at a time, if you want to say something raise up your hand. Is that correct?
Thabang	Yes.
Teacher	Sit down. At this one we look at what you said, that we must shade below because that is where the values of y are less. Now we shade above because the values of y are greater. Let's quickly get to number 3.
Caroline	$2x+5y \leq 10$ (*on the board*)
Teacher	Right let us look at number 3. $2x+5y \leq 10$, let us compare No. 1, 2 and 3. Is there any difference? OK, between No. 1 and 3. Raise up your hands.
Sipho	No. 1 the values of y are greater.
Teacher	Ahh is it greater or equals to?

Sipho	It is less and equals to.
Teacher	Yes.
Sipho	And the No. 3 di…
Learners	Less
Sipho	Yes less.
Teacher	This is our first solution and second solution they look the same. What is the difference between the two? No. 1 $2x+5y \leq 10$ This graph cuts y-axis a 2 and x-axis at 5 and the shading is the same. Does it mean that the solutions are the same? Because I am looking at the sign. Do you want to tell me 1 and 3 is one and the same thing? Yes!
Thandi	They are not the same because the sign is not same that one is less equal and that one is less only.
Teacher	Yes.
Caroline	The graphs are not the same; the shadings are not the same.
Teacher	It does not matter whether you shade or draw line it does matter
Caroline	I shade up to point 5
Teacher	Why do you shade up to point 5? You are the one who asked first question why do we shade below the graph. But now you have decided to shade below.
Gumede	Ngicela ukubuza why ashade, kugcina ku 5? Lapha ku 2?
Teacher	Anyone who can help us. Are this graph and this one the same thing? Yes!
Ntsoaki	The difference should be …
Teacher	Come and show us, I do not hear you.
Ntsoaki	When we come to this, we have an equal sign, we can say this one we can do it so. And that one.
Teacher	Go to that one.
Ntsoaki	Therefore the line to show that this is not a solid line.
Teacher	Is this line not a solid line?
Learner	Yes, this is not a solid line.
Teacher	I said you might use your home language if you do not have a terminology.
Ntsoaki	A ke re line e robehileng.
Teacher	Use your home language.
Learner	Ho graph ya less than ha re sebelise a straight line re user ena …
Teacher	Right, thanks. When you are asked to sketch $y < \frac{2}{5}x + 2$ you must know that the line is a broken line. But Ntsoaki struggled to get a broken line ngoba uthanda iEnglish. Do you see that? In this case everything is the same except that in this is less than. What does that mean? For less or equals to we get a solid line, we shade because our line is solid. What does that mean?
Ntsoaki	Hare na le equal sign, it means dintho tsa rona li included.
Teacher	Everything is included all the points on this line are included. Alikho eli. If you look at this points on the line are excluded. You only count below the line. But in this case you start exactly right on that line. But you start from the line you go down. But if it is broken, it means all the points on

	the lines are not included. For example on the last graph 2x+5y > 10 this is one. The difference will be on what? On the line. Is it a broken line or a solid line? When do we find a broken line if it is less than only or greater than only? Or if it is greater or equals to, then you shade below. But if there is no greater or equals to. Lets say y = 2x + 5y. Where do we shade in this I mean 2x + 5y = 0 where do we shade?
Thandi	Re tlo shade siding ekamo …
Teacher	I do not understand by the opposite side. When you say opposite side what do you mean?
Thabo	Vertically.
Teacher	What is vertically? Say it in your mother tongue ake usiqhaze le kahle ngesiZulu. Yes. Where do we shade here?
Thabo	Asi shade
Teacher	Why? It means all the points on the line are included together with those that are below.
Thabo	All the points on the line are included together with the points above the line. Is that clear?
Learners	Yes.
Teacher	Our time is over, tomorrow we continue

END OF DAY 2

Day 3

Teacher	Right now you are going to sketch these two graphs $3x - 6y \leq 12$ and $2x + 3y \leq 18$ on the same set of axes and then consider these restrictions $x \geq 0$ and $y \geq 0$.
Learners work in groups	
Teacher	I will call upon this group to do one problem on the board, then after we will share with the whole class.
Teacher	Let me draw axes for you.
Teacher	Just sketch those 2 graphs.
Teacher	Are you struggling to sketch straight-line graph? You did straight line graphs in Grade 9.
Teacher	Ok, extend that graph, the yellow one.
Teacher	Ok, thank you very much. Now is that correct?
Teacher	Does that graph cut the x-intercept where is supposed to and the y-axis?
Mosia	No.
Teacher	I don't know which is which. Which graph is $3x - 6y \leq 12$ and $2x + 3y \leq 18$? (*Goes to board and labels graphs*)
Teacher	Ok.
Teacher	Now, I hope you are following the restrictions, it says $x \geq 0$ and $y \geq 0$
Teacher	Focus on the first restriction so that you can delete what is not needed.
Mosia	(*Goes to the board*).
Teacher	Lalela wena… sifanele siqale nga ma-restrictions, $x \geq 0$ and cancel what is not needed there. It seems now you don't understand what you are doing. Why do you cancel that side?
Mosia	Because … ehh … x is greater than zero.
Teacher	Because i-x is greater than zero, i-restriction ithi $x \geq 0$. So those values of x that are less than zero should be removed.
Mosia	x this side …
Teacher	The side you have cancelled, you have cancelled that side. Isn't it?
Mosia	Yes
Teacher	Why have you cancelled this side?
Dineo	x is negative.
Teacher	So we don't want where x is negative.
Teacher	Sebenzisa udusta uku cancella, yes, good!
Teacher	Right for the first graph, now you are saying this part is not?
Learners	Needed.
Teacher	And that part is not?
Learners	Included.
Teacher	What about that part?
Teacher	Right, is that correct?
Learners	Yes.
Teacher	Now, let's look at the first one. What is needed? Look at the first condition. We are looking at these two graphs. Were they supposed to be sketched the way they are sketched here?
Julia	Yes, it is right.

Teacher	So there is nothing wrong with that graph?
Teacher	Yes (*pointing to a learner*)
Julia	Tishere … we shade …
Teacher	Is this perfect?
Learners	(*Laugh*).
Teacher	What we are saying is, are they both perfect?
Julia	Tishere that one $2x + 3y \leq 18$ is not right.
Teacher	Oza uzosikhombisa.
Julia	(*Goes to the board and shades below the line* $2x + 3y \leq 18$)
Teacher	What about the other one?
Julia	I-right.
Teacher	So how many graphs were we suppose to shade there?
Learners	2
Teacher	Khulumani into eyodwa.
Mnisi	(*Goes to the board and shades below line* $3x - 6y \leq 12$)
Teacher	Is that correct?
Teacher	How do you know ukuthi ishading yakhe is correct? Let's look at this graph, how do you know that we have to shade below or above? You are saying he is correct. My question is why?
Ntsoaki	The shading is incorrect. Ha uqeta ho …
Teacher	Come and show us. The shading is incorrect but you all said it's correct. But I'm looking at this graph only.
Ntsoaki	(*Writes* $3x - 6y \leq 12$ *on the board*). Re qalile ka ho engola in standard form, because we should do that before sketching it. (*Writes* $3x - 6y \leq 12$ *in standard form and shade it above*).
Teacher	Use a different colour.
Teacher	Then tell us why you are shading above.
Ntsoaki	After writing it in standard form re bone hore y is greater, so ra e esheita ka holimo.
Teacher	She explained that even yesterday. You must first write this equation in standard form. ($y \geq \frac{1}{2}x - 2$). We are looking at where the values of y are greater $\frac{1}{2}x - 2$. We said solutions that lie on the line and … Yes!
Ntsoaki	…
Teacher	For greater or equal to, what does that mean? Yes!
Teacher	Where do we get our solution? We said yesterday for greater or equal to, solution is on the line and … Yes!
Learner	Above.
Teacher	Above, now you have answered my question. You shade on the line and above for when you shade greater or equal to, you shade on the line and ………
Learners	Above.
Teacher	What about greater only? Where do we shade? Yes!
Gumede	Sisosketch iline, and then bese sisheda above.
Teacher	When you shade above, where is our solution set? Where do we find our solutions?
Learners	Above.
Teacher	Above, isn't it?

Learners	Yes!
Teacher	If you sketch y = 2x + 3, your solution is on the line. But if you have $y \geq 2x + 3$ your solution is on the line and above.
Teacher	If I write $y \geq 2x + 3$ where do you shade?
Teacher	Just above, and the solution is not on the line.
Teacher	Right! When you look at these two graphs ($2x + 3y \leq 18$ and $3x - 6y \leq 12$). I want you to show me where there is an overlap of shading. What colour is this?
Learners	Orange.
Teacher	And?
Learners	Yellow.
Teacher	Where they have shaded at the same time.
Teacher	Delete anything that does not have yellow and orange at the same time.
Teacher	Yes! Just go and do it anything that is not double shaded.
Caroline	(*Goes to the board and erases*).
Teacher	I said erase anything that does not have yellow and orange colour at the same time.
Teacher	Uzosule yonke into manje, akusana igraph manje. We don't have graph. You should only concentrate where there's no overlap of yellow and orange. We also want to see where it cuts the x-axis and y-axis.
Caroline	(*Sits down, and gives the chalk to another learner*).
Gumede	(*Draws lines and leaves the region*).
Teacher	Is this correct?
Learners	Yes.
Teacher	Let's call this point A, B, and C (labels them on the region).
Teacher	What is in here (*pointing at the feasible region*)? This is where we get our solution.
Teacher	So we call this region our feasible region, where a yellow colour overlaps with an orange colour. What about points A, B and C?
Teacher	We call them feasible solutions. We have two things feasible region and solution. The lines where colours overlap and the edges of the feasible region bound, we call them feasible solutions. Is that clear?
Learners	Yes.
Teacher	Right, now can we find values of x and y B (x, y). I know the coordinates of points A (0,6) and C (4,0), what about coordinates of B?
Learners	It is easy.
Teacher	So you are saying the value of x is…7 and value of y is …2, is it correct? So x=7 and y=2, but we need to prove this, to check if this is correct. Because initially we had a graph going that way and another going in that direction. Now what is taking place at point B?
Teacher	I am not saying this (7, 2) is not correct, understand me well. If we were using a graph I would say maybe it is correct but now I am not sure. Yes Gumede!
Gumede	That is the point where they meet. It is the point of intersection.
Teacher	That is our point of intersection.
Teacher	If they meet at the point of intersection, what do you think is happening at the point of intersection?
Teacher	Kwenzakalani kwipoint of intersection?

Teacher	What is taking place at the point of intersection?
Gumede	Lines are going in different directions.
Teacher	Akesiyiyeke indaba yamadirection. What is happening at the point of intersection? Where they intersect, what do you think?
Teacher	Omunye, nomunye kufanele asho ukuthi ucabangani … yes!
Ntsoaki	Both graphs have the same coordinates.
Teacher	They have the same coordinates, usho ukhuthi they are sharing the same coordinates. That is they have the same value of x and the same value of y. this is where our graphs are equal. This is where the graphs are …
Learners	Equal.
Teacher	Because they are sharing the same values of
Learners	x and y.
Teacher	That means, what was the equation of that graph? It was $2x + 3y = 18$ and $3x - 6y = 12$. These 2 graphs are equal at that point (7, 2). So what we want to find is that the x value is equal to another x value and y value is equal to another y value at that point of intersection. So what do you think we should do?
Teacher	Yes! Katleho!
Katleho	Substitute…
Teacher	But we don't know what is the x value and they y value. We want to find out what are the x and the y values. What we know is that at that point of intersection, they share the same value of x and the same value of y.
Teacher	Now these are the graphs, what do you think we should do in order to these 2 graphs to share the same values of x and y?
Ntsoaki	The two graphs are … Let me come and do it. (*Walks to the board and write* $y = \frac{1}{2}x - 2$ *and* $y = \frac{-2}{3}x + 6$ *and solves them simultaneously*).
Teacher	Do you now understand that things that are the same to one thing are also equal? That this is equal to y and that is equal to y, therefore they are equal ($\frac{1}{2}x - 2 = \frac{-2}{3}x + 6$).
Teacher	So the value of x is $6\frac{6}{7}$. How can we find the value of y? Yes!
Teacher	Yes, Bafana!
Bafana	Make y subject of the formula.
Teacher	Niyamuzwa ukuthi uthini, we must make y the subject of the formula.
Teacher	In both equations? Come and do it. Woza.

END OF DAY 3

Day 4

The teacher starts the lesson by drawing a feasible region on the board

Teacher	I gave you three problems yesterday problem 1,2 and 3. I just want us to look at the last one, the one drawn on the board. The instructions were very clear. (*Reads instruction of the task*).
Teacher	How did you find the inequalities? Nisebenzise which method? And how many inequalities did you discover?
Teacher	I'm not going to point to any group, any one who feels like coming to the board please do so and share with us, what did you discuss in your group? Niwathole kanjani ama-inequality?
Teacher	Remember this is a feasible region found after the overlapping of inequalities. So yesterday you were given this for you to discover the inequalities.
Teacher	Right, anyone can come and tell us ukuthi bona bayathole kanjani. Yes! This group, tell us, niwathole kanjani ama-equations?
Teacher	Yes, akesithole ukuthi nenze njani?
Thabo	(*Walks to the board*)
Teacher	You must use the same method.
Thabo	(*Writes on the board*)
Teacher	$Y_2 - y_1$ where does that come from? Over $x_2 – x_1$.
Thabo	U - y_2, u - 6 and u - y_1 U - 2. i-gradient i-$\frac{1}{4}$, then we can find the value of c by substituting. C is 5. Then i-equation etho is y = $\frac{1}{4}$ x + 5.
Teacher	Right any question for Thabo? Do you have any question as far as that is concerned?
Lebohang	Why u sebelisitse formula eo?
Teacher	Which formula?
Lebohang	Eona eo, hobane hase yona ea straight line?
Thabo	Ngiqale ngafumana i-gradient, then c and then i-equation.
Teacher	Are you answered?
Lebohang	Yes.
Teacher	i-question yakho ena indaba yakuthe ayoyona i-straight line.
Lebohang	Taba ke hore why u sa cancela on the line?
Teacher	So iproblem ukuthi ubungaboni ukuthi this is also a straight line? This is a straight line and that is also a straight line.
Teacher	Abawiswe ukuthe utheni.
Learners	Asewuswe kahle
Teacher	Do you all agree that for this line the inequality is y $\leq \frac{1}{4}x$ + 5?
Learners	Yes
Teacher	Another group.
Dimakatso	Ok nna ke tlo etsa this line (*pointing to the graph*)

Teacher	Aa-e, it seems if you are copying from the book.
Learner	(*Uses the formula* y_2-y_1/x_2-x_1*, to calculate the gradient*) so gradient ke $\frac{-3}{2}$. Then re usa formula e tshoanang leya Thabo.
Teacher	Awuyeke indaba yaka Thabo.
Learners	(*Laugh*).
Dimakatso	Then re tlo usa y = mx + c then 6 = $^{-3}/_{2}$(4) + c.
Teacher	What is that? ($^{-3}/_{2}$x 4)
Dimakatso	-6
Dimakatso	Equation ya rona ke y = $^{-3}/_{2}$x + c.
Teacher	I-value ya c ubani?
Dimakatso	Sorry, y = $^{-3}/_{2}$x + 12, then e tsoana le ya Thabo.
Learners	(*Laugh*)
Dimakatso	(*Writes y =* $\leq$) $^{-3}/_{2}$x + 12.
Teacher	How many signs are there?
Dimakatso	Sorry (*Writes y* $\leq$ $^{-3}/_{2}$ *+ 12*)
Teacher	Where is x?
Dimakatso	(*Writes y* $\leq ^{-3}/_{2}x + 12$)
Teacher	So these are the only 2 graphs. Any question before we move on? Any question?
Teacher	What if… because Thabo in this one decided to use this point, although he doesn't indicate which one is x_1 and x_2, y_1 and y_2. What if I decided to use (0,5) not this one? I don't think I would get it correct. Yes Katleho! No, I'm asking ukuthe what if I decided to use (0,5) not (4,6) because uThabo usubstitute esebenzisa ubani Katleho? u 6 no-5. What if nina ni-decide ukusebenzisa uzero no-5? What is going to happen?
Katleho	Ho ea tsoana.
Teacher	Why ho tsoana?
Katleho	Ha ke re u itse re ka nka e 'ngoe le e 'ngoe feela.
Teacher	Ho ntso tsoana?
Katleho	Yes.
Teacher	Ao! Ushonjalo uKatleho uthi as long as, why kufana?
Learner	Because they lie on the same line.
Teacher	Because…
Learners	They lie on the same line.
Teacher	Now do you want to tell me that these are the only constraints for this function?
Teacher	Yes, Sipho!
Sipho	(*Mentions the 2 constraints*)
Teacher	Remember, we said a feasible region is where there is overlapping of lines. Isn't it?
Learners	Yes.
Teacher	Good.
Teacher	But now, according to this information you are saying these are the only constraints. But if that is the case why is it that this graph is not going in that direction? (*Extending lines on the feasible region*).
Teacher	Is there anything wrong here? If I decide to extent these lines? Yes!

Sipho	Re sheba livalue tsa moo li hakanang teng.
Teacher	Asoba ubani amavalue?
Teacher	Li teng ee wena Sipho? I'm looking at, what if I extent this line, I extent that one, and I also extent that one.
Sipho	e…e…e
Teacher	That's why I was asking, are these only restrictions?
Teacher	Yes, icorneng!
Mofokeng	A…
Teacher	Asikuzwa, khulumela phezulu.
Mofokeng	Ena ha ena restriction.
Teacher	E ha ena restriction? What is the restriction by the way? What is restriction?
Mofokeng	Ke molao
Teacher	Ke molao.
Teacher	Ke?
Learners	Ke molao.
Teacher	Ke efe e senang molao? Mofokeng!
Mofokeng	Ke yona eo.
Teacher	Ha ena molao?
Mofokeng	Yes.
Teacher	Joale bua ka molao oo.
Mofokeng	Ke $x \geq 0$ and $y \geq 0$.
Teacher	I don't understand, come and show us.
Mofokeng	(*Walks to the board*)
Teacher	Keep quiet! Yes!
Mofokeng	(*Writes $x \geq 0$ and $y \geq 0$*)
Teacher	You can write even here.
Teacher	U batla ho erestriction ($y \geq 0$)
Mofokeng	Yes.
Teacher	Why?
Mofokeng	Because, this part is wher y is less.
Teacher	Ubani usomnceta?
Marvin	(*Points to another graph*)
Teacher	Which one?
Marvin	I don't understand.
Teacher	Which one, kukhulunywa ngamagraph lapha. Itheni iquestion? You don't understand what?
Teacher	(*Takes the worksheet and shows it to learners*) le graph le leyajana nilograph le. Awowabheka amagraph wetho awafana. Look at the above one, is it the same as this one below.
Learners	Anjani?
Teacher	Lines on this one were not cut just like in this one.
Teacher	This means this one inamarestriction, you can't just write only these two inequalities. We must also put these other inequalities ($x \geq 0$ and $y \geq 0$) because of these other lines.
Teacher	So do you understand that?

Katleho	Yes.
Teacher	Amagraph ayizolo, we drew a number of graphs yesterday. Isn't it?
Learners	Yes
Teacher	Uma siqeda senzenjani?
Leaners	Sawasheda.
Teacher	Sasheda amagraph wayezolo. Sasheda kanjani?
Teacher	Aphelele lapho Katleho? Ok, what happened yesterday? Kwenzakaleni?
Teacher	What was the question izolo? Ibithi $2x + 3y \leq 18$ and $3x - 6y \leq 12$. Ama-equation siwathole kanjani Katleho? What else were we given yesterday Katleho?
Teacher	What else?
Katleho	Restrictions.
Teacher	Besinikwe amarestrictions. Abetheni amarestrictions?
Teacher	Abethini amarestrictions Katleho?
Katleho	A ne a re …
Teacher	Ukhulumela phansi …
Katleho	Molao …
Teacher	No, what were the restrictions?
Teacher	Yes! Abethini amarestriction ayizolo?
Katleho	They were …
Teacher	Angizwa!
Katleho	$x \geq 0$ and $y \geq 0$
Teacher	y is greater or equal to zero.
Teacher	And the second one?
Learners	x is greater or equal to zero.
Teacher	That is why sebesheshada, secancela and that graph initially was like this but we ended up having this. We cancelled everything; we ended up having something like this if I'm not mistaken, where you apply all the restrictions.
Teacher	Right. Ey! I have these sentences here, which are written … I just want us to discuss these sentences. I have got one…
Teacher	(*Distributes worksheets to learners*) Right now you read those stories.
Learners	(*Discuss the worksheet in groups*).
Teacher	(*Moves from group to group*)
Teacher	Ok: let's discuss the questions. What group is that?
Learners	Sepedi.
Teacher	Itheni iquestion ingeSepedi?
Sipho	(*Reads the question*)
Teacher	Yah
Sipho	Ansara ea rona ke, o nyaka more than R10.
Teacher	Shhh. Keep quiet.
Sipho	O nyaka ten rantanyana. Ho tsoana le ha a re kopa ten rantanyane ke khone ho tsamaea.
Teacher	What if he was given R5.00?
Sipho	R5 e nyane
Teacher	So he needs R10 or more?
Teacher	Shhh. Listen. Yes.

Learner	(*Reads the question in Xhosa*).
Teacher	Ushokutheni, ukungenani? NgesiXhosa?
Thabo	R10 or more.
Teacher	So kuyafana nekgesiPeli?
Thabo	Yes.
Teacher	Unangithi abanto ba at least 5 balimele at car accidents are they more than 5 or exactly 5 or less than 5? Ikhona into ngifuna ukuzithola kahle, ukuthi are they more than 5 or exatly equal to 5 or less than 5?
Teacher	Or mhlambe singathi more than 5, equal to 5 or less than 5? I shouldn't write this I might give you an answer. I'm afraid I will give you the answer. Yes!
Zola	Mina Tishere, ngicabanga ukuthe kulimele bayi- 5.
Teacher	Kalimele bayi-5 ukuphela?
Zola	Yes
Teacher	Which means i-answer yesinawo abanto ba limele bawo-5.
Learner	Tishere!
Teacher	Yes!
Learner	O re Zola, ukuconywani, ha ke re ban e ba le 20 abalimele bawo 5, ukunconywani bawo 5 b alemetseng ayi kaofela ha bona.
Teacher	That is helpful ngoba seemingly indaba yasi R10 yiyasilahla. Abanye bathe uR10…. Mona ngazi ukuthi ngithatha ephi i-answer, ngoba, half of the class, abanye 2 groups bathe greater or equal to R10 or minus R10, abanye bathe 10 or mor than R10, manje mina angazi ukuthe sithathe which answer. Usho ukuthe sesihlolwa ngesiPedi, ngesiZulu, sehlolwa ngesiXhosa because if we understand all that we would have a problem. Umonye ubengenge asho loko, umonye asho loko ngoba iproblem is one and yet 2 groups are saying R10 and more while others are saying R10 and less. It means lapho there is a problem. Yes!
Gumede	Iquestion ithi (*reads the question in Zulu*). Usho ukuthi that or more.
Teacher	So you mean to say ukungenani ukuba yini?
Gumede	Ukungenani ukaba uR10.
Teacher	Akesewuswe ngesiPedi, niyibone kangani ukuthe iR10 or more? Ngoba ngesiZulu name ngiyayithola ukuthe injalo kodwa angi too sure ngoba uthe ukungenani…
Sipho	Re na re itse at leastnyana …
Teacher	NgesiXhosa kutheni u-at least.
Thabo	Ukunenani
Teacher	NgeSesotho ethini?
Mofokeng	Bonyane. E ea tshoana le ka Sepedi?
Teacher	It means R10 or more.
Teacher	So can I use minimum and at least as one thing?
Caroline	Sipho o itse ten rantanyana, o na lokela hore a re bokao, eseng tenrantanyana, o bua Sepeli se samoo.
Teacher	Sepedi saseloction
Teacher	NgeSesotho?
Ntsoaki	Bonyane R10 or more. R10 is the minimum.
Teacher	Now u at least and minimum is it one and the samething.
Thandi	Ha litsoani, minimum e kafatse, maximum e kaholimo.

Teacher	What is different? Can we classify u-*at least* with minimum or maximum? If I say borrow me at least R10, is R10 minimum or maximum?
Learners	Minimum.
Teacher	Ok, let's start with this group. Yes!
Learners	R10 or more.
Teacher	That group!
Learners	R10 or more.
Teacher	That group!
Learners	R10 or more.
Teacher	Awo siniya shinya into yino manje?
Learners	(*Laugh*)
Teacher	So minimum goes together with …
Learners	At least.
Teacher	At least.
Teacher	Ok! The last one says (*reads question 3 from the worksheet*).

END OF DAY 4

Day 5

Teacher	Right, ok, I want …
Teacher	Right shhh. Ake sihleleni so, after you have sketched your graphs. I gave you two tasks. That was the first one, which was written in English. The second one was written in Home Language (HL). I want to hear from you. What can you say about these two versions? Anything that you would like to tell us about these two versions. I gave you a version in Sesotho, Pedi, Xhosa, and isiZulu, and the other one in English. Say anything that you would like to say. Yes!
Mfanafuthi	Ubunzima …
Teacher	Shhh. Keep quiet and listen. Yes!
Mfanafuthi	Uma ngibhala ngesiZulu kubanobunzimanyana obubakhona, but kodwa uma besibhala ngesilungu kukhona ukuzwisisa kahle imibuzo.
Teacher	Ok. That is from isiZulu group. Ethi yona ibe nobunzima, nithi niyenathola ubunzima kuphi?
Learners	NgesiZulu.
Teacher	Ok fine, that's this group (*pointing at Zulu group*)
Teacher	Yes, that group!
Ntsoaki	Rona tichere, hane re tlolietsa ka vernacular there were most terms, some of the terms ne re sa di utloisisi, ne resa di utloisisi, nere qala hodibona, nere prefera ho dietsa ka English.
Teacher	Le ne le prefera ho dietsa ka?
Learners	Ka English.
Teacher	Right. Ok. Let's find out from this group (*pointing to another group*). What have you discovered?
Sipho	We have discovered that …
Teacher	Shhh, keep quiet.
Sipho	Ka Sepedi e ne e le easier than English.
Teacher	In Sepedi was easier than in English?
Learners	Yes.
Teacher	Yes, that group (*pointing to another group*).
Thandi	Rona kurupung ea rena, re nahana hore ka English was more easier because mabitso amantji were more familiar than aSepedi, hobane rena re thoma ho a bona and ha re a undastante.
Teacher	Ok, uThandi una something different, eyakhe ithi isiPedi kuye sibenzima kakhulu ngoba some of the words ubeqala ukuwabona for the first time.
Teacher	Wena uyithole injani ngeSepedi, uma uyifunda ngeSepedi, uyi analyze ngeSepedi, because that group this side, bayibone ngeSepedi much easier, and you are saying ngeSepedi kunamagama amaningi ongazange uwazwisise kahle. So, but generally ibi njani?
Thandi	At time …

Teacher	Shhh! Keep quiet just listen to Thandi please.
Thandi	Ha re e bala bere analyze, ke hona re undastantang teng, because if ra e bala re sa discasa, ke hona moo resa e undastenting teng, cuz, rena le di opinions tse different sentense e feletseng.
Teacher	Into engiyinotisaya ukuthi, you are not used to doing mathematics in isiZulu. Anijwayele ukwenza imaths ngeSepedi…
Learners	NgeSepedi.
Teacher	That is what you are saying but, ngifuna ukuthola ukuthi iproblem yenu ikuphi. Niye nathola ukuthi niyi understand kahle when you do it in English or you understand it better in Sepedi. That is, what I want because that group made it clear that ngeSepedi was easy. La angitholisisi kahle.
Thandi	Ka Sepedi …
Teacher	Ok. Let’s keep quiet, yes!
Thandi	Ka Sepedi because ka ya English hane re qala ho e etsa e ne e le more difficult, but ha ne re latela kaya Sepedi, re kgonne ho ngola a page.
Teacher	Now you come with something else.
Caroline	Aaa! Tishere…
Teacher	No, I am not saying Thandi is wrong get me clear… alright just keep quiet, Grade 11E, keep quiet.
Teacher	UThandi uthi according to yena one other thing eyenze ukuthi a understand kahle, it was because bese niyiyenze nge English. That is what Thandi is saying. But mina ngifuna ukuthola ukuthi, was it easy nge English, … ok, let’s move to that group (*pointing to isiXhosa group*).
Sabelo	Thina sir, siyibone inzima ngesiXhosa …
Teacher	Ok keep quiet please, yes!
Sabelo	Siyibone ngesiXhosa ukuba inzima. Nge English is much easier ngoba amanye amagama esiXhoseni athanda ukuba nzima, siqala ukuwafumana.
Teacher	Ake ngenze i-example esimple because sengiyabona ukuthi uThandi uthini. Ok, I understand ukuthi uThandi uthi ukuba bebengaqalanga nge English bebeqale ngeSipedi, ebengeke ayi understanda kahle. Le ubeyi understand because uthe uma beyibheka laphaya wabona ukuthi they have already done it in English. Ake ngithathe iproblem ye linear programming. What would you prefer, Sepedi or in English? Just for the first time ukuze unikezwe i option ukuthi uyenze nge English uphinde uyenze ngeSepedi.this group, yes.
Cathrine	Nge English
Teacher	Why English?
Thandi	Seretlwaetsi yona…
Teacher	Please keep quiet.
Thandi	Mantwse amang retlabe resawatholi.
Teacher	Now you are with Thandi that mantswe amang haliwatholi in

	Sotho.
Learners	Yes.
Bafana	Tishere hobala statement kase Sotho hasebothata but potso.
Teacher	Oh wena uthi i-story lesi ubusi understand. Istory lesi benisi understand before.
Bafana	No.
Marvin	Uma siqala thisha besinga understandi.
Teacher	Yes!
Marvin	Ngabe azange siqale ngale English besingeke si understand lestory leso. Kungcono siqale nge english
Teacher	Ok, you mean to say uma niqale ngestory sesiSotho beningeke ni understand altogether ngesiSotho?
Learners	Hayi
Teacher	Ake sibheke nayi iquestion, sengizwile. Ithi ahh, whereis that question? I want it in English ithi (*reads the task in English*) awuyifunde ngesiZulu.
Learner	(*Reads the task in Zulu*)
Teacher	(*Reads the task in English*)
Learner	(*Reads the task in Zulu*)
Teacher	Ok fine ake siyithole ngesiZulu sakini ukthi (*reads the task in Zulu*)
Teacher	So ubani obenga understand that statement in Zulu?
Hlengiwe	Lesisokuqala sisizwisisile.
Teacher	Oh, good ake size la eSepedini

Learner	(*Reads the task in Sepedi*)
Teacher	Ubatla hore awu understand ka ufela? You understand better uma ifundwa kasikgowa?
Ntsoaki	Yes
Teacher	Oh kulesitatement engukunikeze sono, yikuphi ongakuzwa ofuna ukutolikelwa kona? Hey? Ake sizwe ngesiXhosa yini into eningayizwa? IsiPedi? IsiSotho? Yes.
Learner	(*Reads the task in Xhosa*)
Teacher	Awu understand ini? Amawaka inkomoixabisa… imalini? Azangenginixelele?
Teacher	Yikuphi ongaku understand? Ngifuna ukuthola lokhu ongaku understand uthi kunzima. I want to know ukuthi yikuphi lokhu ongaku understande? Ngiyezwa but this one nithi ni… you find it much easier uma nenza ngani? NgesiPedi. That’s the only group ethi yona ithole kunzima. Well akengibuze, ake sikhiphe lokhu eningaku understand. Ake siqalengalaba besi Xhosa, sizozama maybe ukuthi si modify.
Mnisi	Lokhu esingaku understand nga…
Teacher	Yiphi iquestion? Ithini iquestion?
Mnisi	Yenza omunye ngalo ngxela tishela.
Teacher	Ungxela yini? Akusi statement osinikiwe esithi ngalengxela engenhla. Beninga understand isi statement? Ok fine ake size kule group yeSipedi. Yikuphi eningaku understandanga kahle?
Mnisi	Isisho…
Teacher	Ini?
Ntsoaki	Itsho tsa teng…
Teacher	Ok so it’s only one group ethi yona ithole kulula kakhulu uma yenza… asikezwa kahlekuleyagroup.
Ntsoaki	Re itse rona re prefera ho etsa kaenglish. If ne ba refile ya Sesotho pele ne re ka setsebe hore tswantse re etseng.
Teacher	IsiSotho anisasazi manje? (*Learners laugh*).
Ntsoaki	Tishere English re e badile, dipotso tsa teng dine di utloahala hore di batlang. For example, khaello, hare tsebe hore ke eng, e re qakile. Hare tsebe re qale kae.
Teacher	Kgaello?
Ntsoaki	Yes.
Teacher	Ikgaello angithi yi inequality?
Learners	(*Laugh*)
Teacher	Ok, let’s hear!
Caroline	A kere if as Ntsoaki a tjholo, ekebe esa tla ka English mathomong ha ne re thomile ka Sepedi. Ho tshoana le rena ka Sepedi lentsoe le la “tekatekanyetšo” ha re tsebe le bolelang.
Learners	(*Laugh*)
Julia	Eya tishere ha ene e se ka English e kabe re sa tsebe hore ba itseng.
Teacher	Ake ngithole emaPedini aphuma le ekhaya kwangathi sesiphelelwe amaPedi la ekhaya.

Learners	(*Laugh*)
Teacher	EsiZulwini yikuphi into eningayi understande?
Hlengiwe	Uyabona sikuzwisisile lokhu
Teacher	Yikuphi eningakuzwisisanga?
Hlengiwe	Funani izinkomo ezibhaliwe ezintweni eziphuma kwezingekho
Teacher	Ake siphenduleni lowo mbuzo, unamba bani lowo? Roman figure?
Hlengiwe	Three
Teacher	Three, yes ungayibalela kuphi leyo nkomo? Ezintweni ezikhona noma ezingekho? Ithini iquestion?
Learner	(*Reads the question*)
Teacher	Yes, that thing is simple and straightforward, into ekhona noma engekho? Yini eningayi zwizisanga lapho?
Hlengiwe	Igama esingalizwisisanga ezidaluliwe.
Teacher	Wooo! Izinkoma lezi ezidaluliwe, nyabona ke, ukuthi inkinga yenu ikuphi.
Hlengiwe	Inkinga ukuthi onke ama learning areas sijwayele ukusebenzisa iEnglish, and then uma sisebenzisa isiZulu sijwayele ukusebenzisa awo…nje
Teacher	Inkinga la eyokuthi sinamaZulu ase Johannesburg namaZulu ase Natal, nabeSotho base Johannesburg. Into edaluliwe isho ukuthini leyonto leyo? Awulazi lelogama? Ithini awufunde lapho.
Hlengiwe	(*Reads the task in Zulu*)
Teacher	Yes, ezidaluliwe, ingabe lezinto okukhulunywe ngazo ngaphezulu zidaluliwe. Ake sizwe ngeSepedi.
Teacher	Aniyi understandanga nani the very same question, aniyi understandanga leyo question? Ithini?
Caroline	(*Reads* kgaello)
Teacher	Kgaello?
Learners	Yes.
Teacher	Kgaello eno e ngotsoe ke Mrs… Mrs…
Teacher	All right, all right, all right!
Teacher	Ok asenzeni so; let’s do amacorrections on the board. Nizosenzela sibone ukuthi niyi understande kanjani. Let’s quickly do correction. Sengitholile iproblem ikuphi. Mina sengiphangise ngabona ukuthi asisasazi isiPedi. Uma umuntu eqala nje, awubheke lapho esiZulwini bahlulwa yigama elithi okudaluliwe. Angeke ngichaze kakhulu ngesiPedi. Asisekho manje…into ebanga ukuthi…nampa abange ngapha, asisekho ngapha. Sibhalele iproblem sense amacorrections. Number 1 does everything. No! Sengiyayibona inkinga yenu ukuthi yini. Uzosiqhazela Sipho, uma ungayenza from where you have started.
Sipho	Sir NO.1?
Teacher	Yes number 1.
Teacher	Uma ufuna Sipho, uzositshela ukuthi lokhu okubhalile uqhaze

	kahle ngesiPedi. Now listen very carefully please.
Sipho	Like…
Teacher	Shhh, listen!
Sipho	Hona le mantsoe eres'a tsebeng hore a makae, but ngemaths, ka maths. Feela e tii ke sekete sa diranta makgolo amabedi le mashome a mahlano (R1 250). Aka shumisa tshelete e lekanang dikete tse hlano.
Teacher	Right, what about sizothola, awusibhale leso statement.
Teacher	All right, let's start with that one - is that one correct? Yilokho enikubhalile? Nina is that correct? Isho khona lento ayibhalile, because nina nithe ni understanda better nge English. Yes this group! (*Pointing to anather group*)
Hlengiwe	Yebo thisha.
Teacher	Yes
Hlengiwe	Ngibona ngathi isuita uma ina 2…
Teacher	Isuita unumber 2 kanjani kanti sithini istatement?
Hlengiwe	Angithi kumele siyibhale kuyinto eyi – 1
Teacher	Kwangathi sibanenkinga. Uma ufunda into kuthiwa umuntu ungukuthi kanye nokuthi. NangesiSotho nangesiPedi
Hlengiwe	U "and" masesimenza ngo multiply …
Teacher	But I don't see plus, and you are saying this is one
Hlengiwe	Azange ngisho kanjalo!
Teacher	Utheni?
Teacher	Uthe icorrect inumber 2? Which number 2 okhuluma ngayo?
Hlengiwe	Yo (a) uma sifaka ne restriction.
Teacher	Ne?
Teacher	Yikuphi uNo.2? Awufunde lelo sentence nge English, awuyifunde kahle leyo sentence ukuthi icorrect kuphi nge English. Ithini nge English elapho Kunene? Angithi uthi ungayivumela nge statement sesi – 2? Awuyifunde lapho esho khona ukuthi singayivumela.
Hlengiwe	(*Reads statement 2 in English*) Angithi thisha uma sizothi x can be less than or equal to 5000. Angithi thisha le 5000 le imaximum kusho ukuthi …
Teacher	Kusho ukuthi istory asisizwa. Both English and Sesotho or Sepedi. Kusho ukuthi you don't understand. Now the issue is that you don't understand mathematics. Istatement selo, in English it says the farmer buys a cow …. (*reads the statement in English*) full stop. Kusho ukuthini lokho?
Teacher	Yes, asizwe kule group, ngesiXhosa bathini?
Untombomzi	(*Reads the task in Xhosa*)
Teacher	Waze wathenga. Yini lokho? Waze wa thenga? Uthini? Wazewathenga kuchaza ukuthi lokho? Ukusho ukuthini lokho in Xhosa? Kusho ukuthini lokho?
Untombomzi	Waze wathenga …
Teacher	Mathematically, this is not English, wazewathenga
Untombomzi	Plus

Teacher	Do you see plus there?
Teacher	You don't understand even in Xhosa. Because I have asked you, all of you. I said is this statement 1 correct? You said, yes it is correct. Yes!
Ntsoaki	We said no!
Teacher	Oh, you said no? Yes asizwe lapho. Oh, niyaphika azange nikhulume nina lapho.
Learners	(*Laugh*)
Teacher	Ngingamvumela uMofokeng ngoba isandla sakhe besilokhu siphakeme.

END OF DAY 5

Teacher's interview transcript

R: Thank you very much Bheki for allowing me to observe your lessons and learn from your teaching, I really enjoyed the lessons and appreciate the opportunity to do this study with you. I have a few questions to ask about the lessons that I observed. I might stop at one stage during the interview to show you some video clips and then ask you some questions from there as well. Remember, there are no wrong or right answers, just feel free to say whatever you want to say, and you can stop me where you don't understand so that I can rephrase the questions.

Now my first question is: having observed your five lessons, what is it in your view would you say went well?

T: I can say what went well is when I grouped learners according to their home languages, because their participation was good unlike in the past days like last year. So participation for these lessons was really good because they were actually expressing themselves the way they liked. I think thus the most important part that I felt went well in my lessons when they were grouped in their home languages.

R: Ok, thank you, now you said you were doing an action research in which you were transforming your teaching, tell me what is it that you were transforming about your teaching?

T: I can start by saying that before I came to Wits; I was actually bored with the way I was teaching. I was using one style of teaching, using the same textbook method, using the same approach I was taught at the College. I was actually bored not knowing what to do, but when I arrived at Wits University that's when I learned a number of things like giving learners chance to express their views, not to look for only one right answer and to probe learners, and that's when I started changing even my teaching, but then I said maybe it will even be better for Linear Programming if they can use their home languages. The use of home languages I learned in last year's course called Expressing Mathematics. We were told that one should not only use English for learners to understand, you can use any language learners would still understand. So I said in my mind, how about if I can just go and try to check or investigate if it could work in this section, because it has been a big problem. When we mark we find that learners' performance is very poor under Linear Programming, and my assumption was that it was because of language. So in my study I wanted to check if it would work, and it did work well because learners were able to say the word 'at least' is okungenani in Zulu, and the Sepedi group said 'bokagone' and bonyane. This shows the depth of understanding when it is done in their home languages. This is now the strategy I'm using, I don't just pose questions to learners and give them answers. But when I pose a question, I try to probe them to find out. In the past I used to say oh! You don't know the answer, this is an answer, and this is an answer. But by doing that, I wasn't even aware that I was making them inactive in mathematics.

R: Thank you. Now tell me about the tasks that you gave to learners during the lessons.

T: The tasks that I gave to my learners, I can say, they were all thought through carefully because I didn't eh, use a textbook as it is, but what I did was, I took tasks from the textbook and modified them according to the situations that would suit my learners. For example, task 1 on day 4, I actually came up with a task which said: If Mandla's Cinema can accommodate a maximum of … eh my aim there was to check if I used the word maximum rather than going to the textbook and take tasks as they are. But then it was clear that the way they were phrased there was no ambiguity, they were clear and learners were able to see that the word maximum means something cannot go above that level. So I can look at task 1 if I remember it well, it was on Mandla Cinema, as I have indicated it can accommodate 150 people. Then I said to my learners, there comes a person who was number 151 in a queue, would they accommodate that person? They quickly said no because he will be out of space because this hall can only accommodate a maximum of 150 people. This means they understood the meaning of maximum.

I gave them another task, which said a worker from Ingqayizivele school earns at least R1500.00 a month and it happens that this month they gave him R1800.00 did they rob him or not? Then the learner said no because it is stated that he earns at least R1500.00 which means he can … anything above R1500.00 even R10 000.00. It shows that they understood it very well if I design my own tasks and try to modify those from the textbook and not take them as they are.

Right on day 5, that is when I gave them a task that was written in different home languages. So now what happened there, I gave them a first task that was written in different home languages? It was in isizulu, isixhosa, Sepedi and Sesotho. Then after 15 minutes, I collected that task and gave learners the very same task this time written in home languages. What I realized on that day, because it was totally different from the previous 4 days, because in those days what we normally used to do was to give learners a task and then come together to discuss about the task. But on day 5 it different and learners were a bit shiffering asking what is happening is Mr. Duma now trying to give us an assessment of all what we have been doing, learners were so shiffering they didn't know what to do because in the 4 passed days I used to say, after doing the task we would come and discuss that task, to check if they gained. But on that day 5, I didn't do that. A number of problems arose around the word ezingadalulwanga from the Zulu group. So what I actually did on that day I translated everything into their home languages forgetting that they don't have a register in their home languages that address those technical terms like inequalities, like unknown so instead of using *x* as it is from the textbook, I used the word ezingadalulwanga, which simply means the unknown but learners found it very difficult to engage with the task because of that word which was translated into their … and it was for the first time for them to come across that word ezingadalulwanga. Even if I tried to probe them and say you know Zulu and Zulu is your home language, so what is it that is difficult? They said, yes we understand isiZulu but we don't understand this word, we were never taught this word that in isiZulu it means that … so that is where … but I thought it was only isizulu group that had that problem and only to find that other groups too, the Sesotho group had a problem with the word kgaello, and that word, which simply means inequality. The learner said … I even said to them, those: the one who translated this to your home language is your vernacular teacher. They said no: it does not matter but we have not dealt with this in mathematics. That is when I realized that I made a mistake by translating those technical terms. I wasn't supposed to have translated those technical terms. I wasn't supposed to have translated that technical terminology. After that I went to isixhosa group, but didn't have that much problems except that they just prefer English. There was only one group the Sepedi group … because maybe their translating was well done, I don't know how, but they said they find it very easy to learn Maths in Sepedi because they understand everything in Sepedi. Everything was clearly understood by those learners. But after everything I realized that in future if maybe I would conduct the very same research I would not actually translate technical terms like inequality, linear programming, unknown which simply means *x*, but that was everything went well except for those few mistakes, because actually in English version they managed to get all solutions correctly. So that is where I discovered that translating everything into their home languages was a problem, because they couldn't even realize that it was the very same problem they did in English. Otherwise I wouldn't have much problem if learners realized initially that, oh this is the same problem. But now, because they were not memorizing, they were trying to engage with a task that was in front of them, that is why they found it difficult to say oh this word we don't understand, ezingadalulwanga, what does it mean. I said to them ok, find this won't be a problem and since I promised them even before we started this research that I'm not going to allocate marks for them, that is why everything went well.

R: Ok, thank you very much. I'm going to ask you some questions based on day 4 tasks. The one on Mandla cinema …

T: Yes.

R: I remember on that task there was somewhere where it read, "write this sentence in your home languages …"

T: Yes.

R: Yah, tell me about that, of what importance was it for them to translate that question into their home languages?

T: I wanted to find out … maybe could they use the word maximum, do they understand the word maximum. So because if I remember it very well it said Mandla cinema can accommodate a maximum of 150 people for each show, so write that sentence in your home language. So what I picked up from that: learners quickly identified that oh the word maximum means … because those from a isizulu group, because I can side with isizulu I'm also talking Zulu; they said: imandla cinema enganelwa abantu abangevele kwaba ikholo namashomi amahlano, which means, a Mandla cinema can only accommodate 150 people because the word maximum means it cannot go beyond that point. So I even took other sentences that were translated into Sepedi, Sesotho to … ah to Sesotho educators and they also said to me it was well translated so on that particular day I achieved what I wanted to achieve because my aim was … one of my research question was; will this Linear Programming work because I always assume it becomes a problem to learners to translate. So my aim was to find out whether it is English, which is a barrier to my learners or is it mathematics. But on that day it became clear that it is English because learners were able to translate the word maximum correctly when they were rewriting that sentence.

R: Ok, thank you. About this issue of translating technical terms, I am interested in knowing who helped you with the translation.

T: For Sesotho, I went to their subject teachers Mrs. [3]Lebona, and mam Sefako. They helped to translate Sesotho into English. For Sepedi I went to Mr. Maila. For isiXhosa, I went to another educator Mr. Dube who teaches isiXhosa and madam Mayikiso. The isiZulu translation was done by three of us. It was Mr. Bhani the deputy principal; Mrs. Mkhize the cluster leader in isiZulu and myself because I speak isiZulu as my home language. The main problem I did on that particular day like I have indicated is that I didn't tell them that we shouldn't translate everything into home languages. That is the

[3] All names in this transcript are not real names

mistake I acknowledge to have made, so these are my colleagues that helped me with translation.

R: That's quite interesting. Thank you. Now I would like us to watch the video clips and then as I mentioned earlier, I'm going to ask questions based on these video clips. Let us watch the first one:

R: I find this conversation very interesting. Can you tell me more about it? What was going on?

T: In that conversation, like I said earlier that those lessons were thought through carefully. I didn't just take examples from the textbook as they were. In constructing these questions I was also helped by my supervisor. We looked through those questions very carefully. We were trying to eliminate a lot of ambiguities whereby learners would not understand what you were trying to say. That is why we need to go to the level of learners by just asking them a very simple question like "if I say to you borrow me at least R10, how much money do I want?" Lend me at least R10, if that is the correct word to use in English. Lend me or borrow me… but the key word there was 'at least' because normally in our daily English learners refer to *at least* as meaning something very small. If I say to you borrow me at least R5, I mean to say I just want R5 or more than that. Before giving this problem to my learners, I actually took it to English educators, and it was interesting to find out that even English teachers were actually debating about that. Some were saying it could be R5 or more and others said it was R5 and less. I even went to my principal because my principal is very good in English. I was with another English teacher after we had debated. I said to the principal "if I say to you borrow me at least R10, how much do I want? To be honest I was also nervous that my principal would say 'at least' would be R10 0r less. But he explained it very well and said when you say borrow me at least R10, you mean the lowest amount I want is R10. That was when the English teacher said, oh, at least means… That is when I realize that the English used in linear programming has a problem because now there comes an English teacher who cannot explain even to the learners to say if the radio said at least 5 people have been injured in an accident 'how many people were injured? Are they 5, less than 5, or more than 5?' So I wanted to find out if my learners would engage with the word 'at least' and understand the word 'at least'. Mathematically what does the word *at least* mean? So that is why from… am… isiZulu group, one learner said at least, teacher, it means that okungenani. So in Zulu when you say okungenani you are saying you can give me whatever you want to but it should not be… okungenani should be R15… should be R10. That is why a learner cited a very good example when we were looking at that. She said let's say at home they used to give you R10 for your bus fare and money for lunch. That learner said to me on that day maybe your parents don't have enough money that they usually give you. Then you will say to your parents, mum okungenani give me R10. So which means the least amount that you can give me should be R10. Right, I went to other groups like Sepedi group because they showed me that they enjoyed when it is done in Sepedi. They said bonyane, bonyane it should be R10 and not less than R10. It should be something that starts from R10 and above. My aim on that day was to draw to the learner… so that we could debate about it so that when examinations come, they can have a better picture in might that at least means… and in that lesson, they even introduced a number of terminology. They said minimum and I quickly said, what does the word minimum mean? To my surprise they understood the word minimum very well. But for *at least* they did not understand. For minimum there were no debates. They know that minimum is the lowest amount you can get, but for the word *at least* it was actually tricky for them. But on that lesson I actually looked at different terminology: it was minimum, at least, at most, maximum, must not exceed, should not exceed, so that all these terminologies were addressed by simply one word *at least*.

R: So would you say learners got these concepts?

T: Very well, very well, because when they expressed it in their home languages, they were able to talk to each other to say no, okungenani in Zulu means… in Sepedi bonyane so they understood it very well.

R: Thank you. Let us now watch another video clip:

R: In this particular video clip, I see you moving from one group to another, and this is typical of all your lessons. That is from lesson 1 to lesson 5. I'm therefore interested in knowing this, what do you do when you get into a group?

T: When I get into each group I try to find out what they do. Are they actually engaging themselves with the task, and how best are they solving that task, what is the discussion all about, is there someone in the group coming up with something good, what is the response of other learners, do they listen to each other or is the group chaotic? If there is somewhere I can get in to help… but I don't just give answers. Sometimes I pose the question and move to the next group so that they can just start debating about that particular question I gave them. When I get into another group, even if I am not good in that particular home language I try to listen and try to behave in the way they talk. But my aim is just to get to what they are doing, and if they do that which they are suppose to do at that particular moment then I provide help where necessary.

R: What language(s) do you use in each group?

T: In isiZulu group I actually use Zulu and English. In Sepedi group I try to use Sepedi and sometimes they laugh at me. That is, the Sepedi and Sesotho groups when I try to pronounce words that I'm not familiar with, they simply laugh at me but because I want to push my point I don't have a problem with that. But basically in Sepedi and Sesotho groups I mostly use English because they end up laughing at me instead of concentrating on what we are doing. But I try to accommodate everybody. Even when I teach in class, I used to say 'u reng', 'u reng'? Something like that only to find that they laugh at me and then I pass to the other item and we continue like that. In isiXhosa group I definitely use isiZulu and English because those who speak isiXhosa, isiZulu and Ntebele we fall… I mean in one category and we understand each other very well. There's no problem at all.

R: I would like us to watch the last video clip:

R: This clip is part of day 5's lesson when learners were working on a task that was written in their home languages. I find it interesting that in this particular incident you did not go from group to group. Can you tell me more about it?

T: Am… on day 5, like I said earlier on when we started… day 5 was a day that was totally different from the four previous days and yet it was not supposed to be like that. What happened on day 5… even when those learners from isiZulu group complained about the word 'ezingadalulwanga', I did not intervene and help them with the meaning of the word. But I actually wanted to… to… it was like an assessment. It was totally different it was like an assessment. I was like assessing them to say I'm not going to give you an answer even if I see that they were struggling. They indicated earlier that they don't understand the word 'ezingadalulwanga' right from the beginning but I didn't even go to their group to listen further to say 'what is it that you don't understand?' but I simply ignored them. I didn't visit any group on that day. So to be honest I don't know what was happening on that day. I cannot tell you exactly why I was doing that because I was supposed to be visiting every group to support them. My aim for doing this action research was… I said in one of my research questions: to support learners' understanding… but on that day I didn't at all. I simply looked at them. So I actually said ok if you are done… I even looked at that lesson even before you could tell me that it was on day 5 because I know that this was exactly what happened on day 5. I didn't visit even a single group on day 5. There after, I hope you still remember because you were there. After that I went to the chalkboard and asked them about eh… which version they preferred. That is, between English and their home languages. Even before they could answer, I already knew what they were going to say, because I did not support them at all on that day. It came as a shock to them because for the other 4 days I helped them, we talked together. So on day 5 that's where things went wrong…

R: Yes, especially when they were doing that task on their home languages. That was the time when you did not go to them, but earlier on when they were doing it in English you moved from one group to another. You went to groups, but when they did it in their home languages you didn't go to them…

T: Yes

R: That is why I say it would be of interest for me to find out why you didn't go to groups?

T: Yes, like I have said earlier on that maybe I was hurrying up to finish everything. I don't know, but definitely, I don't know what was happening because even when I got home on that day I recalled and said I should have intervened when my learners said 'we don't understand the word 'ezingadalulwanga'. I could have intervened even when the Sesotho group said to me 'what does the word kgaello mean?' I could have done maybe something better like just going to the board, write it and say the word kgaello means inequality but now I acted like I was actually trapping them and yet it was not my intension. My intension was not to trap my learners rather my intension was to support them. I don't know what went wrong on that day.

R: Thank you. What have you learned from the action research you carried out?

T: I have learned a lot. Number 1, like I have indicated, before this study I thought that English was… learners could not cope without English but then it was clear after this action research that mathematics like Pimm used to say it has its own language. It does not necessarily depend on English, which means that even a learner can use whatever language not that it can only be understood in English. Another thing that I learned was that seeing that mathematics is difficult, they used to say mathematics is difficult and yet it is not difficult. I learned that doing it in their home languages… because what I noticed on day 4 and day 5 when one of my colleagues gave them questionnaire to whether they did benefit when the task was written in their home languages. What came up clearly in that, was that learners find it easy when the teacher does not only use English from the beginning of the period till the end of the period. This means as educators when we teach mathematics we should keep on code switching between languages to say to learners this is what it means in English. If you can just present your lesson in English throughout you might find that you are just going alone. So I have learned a lot. One other thing, I even thought my learners were slow learners before but to my surprise when they were grouped according to their home languages, there was a high level of participation. They asked questions maybe because it was done in their home languages. They were actually free to ask questions knowing that if I use my language no one will laugh at me. I'm Zulu, I'm talking to Pedi people, I'm talking to Sesotho people and they are not good in Zulu. But for them they can actually communicate in all these languages so I find it very much benefiting to use their home languages when teaching. So these are the things I have learned. Since then I have been trying to use this strategy of using home languages. I even tell them that one is at liberty to use whatever language. Mathematics just like science and other subjects… ah… if you know mathematics you know mathematics irrespective of whether you know English. In fact, if you are good mathematics student you can be employed and not that you can't be employed because you don't know English. But some of the learners, they even came to me after this and said to me why do you want to teach us in isiZulu, isiPedi because isiZulu and isiPedi are sometimes boring. So I said to them… because some of them approached me and asked me some questions about that… I said to them remember that you are living in a world of democracy where now we must promote everything. I even told them that, years ago Latin was a language of power so it was also phased out and now English is the language of power. We never know maybe in the future it will be Chinese. Our learners will be learning in Chinese. So things keep on changing. So our home languages should also be developed just like English was developed after Latin. Everything should be developed.

R: That's interesting. You said after your action research, you continued practicing this strategy. Part of the strategy was to group learners according to their home languages…

T: Yes

R: Do you still teach like that?

T: I don't actually do that everyday. I only do that if maybe there is a particular work we have to do. But what I normally do now I try to promote… eh…that even if you are Zulu and grouped with Sotho, you must still be able to communicate. At the back of my mind there was also that thing of tribalism, which says if we group learners according to their languages I would be promoting that and yet it wasn't my intention. My aim was not to promote tribalism but make sure that there was some understanding of one another. So what I normally do is to say, if you can't answer or say it in English, use your home language. If learners say a word I don't understand, I then use other learners to help me understand that just like Pirie pointed out that you can also use learners to teach one another. Since I'm not good in Sesotho, I use another learner to explain to us the meaning of that word. In short, I don't usually group them but there's that atmosphere to say; use your home language.

R: Thank you very much for mentioning that point on tribalism because the new curriculum encourages integration of all sorts. It encourages people to integrate irrespective of their race, tribe, sex, etc. However, I think you have addressed that well. Once again thank you for your time and participation.

END

Ethical clearance documents

UMnyango WezeMfundo
Department of Education

Lefapha la Thuto
Departement van Onderwys

Date:	**06 September 2006**
Name of Researcher:	**Mpalami Nkosinathi**
Address of Researcher:	**FA 2 International House**
	Wits University
	Johannesburg 2050
Telephone Number:	**0725212216**
Fax Number:	**(011) 7173259**
Research Topic:	**Teaching and Learning Linear Programming in a Grade 11 Multilingual Mathematics Class**
Number and type of schools:	**1 Secondary School**
District/s/HO	**Johannesburg East**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

Permission has been granted to proceed with the above study subject to the conditions listed below being met, and may be withdrawn should any of these conditions be flouted:

1. ***The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.***
2. ***The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.***
3. ***A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.***

4. ***A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.***
5. ***The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.***
6. ***Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Senior Manager (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.***
7. ***Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year.***
8. ***Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.***
9. ***It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.***
10. ***The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.***
11. ***The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.***
12. ***On completion of the study the researcher must supply the Senior Manager: Strategic Policy Development, Management & Research Coordination with one Hard Cover bound and one Ring bound copy of the final, approved research report. The researcher would also provide the said manager with an electronic copy of the research abstract/summary and/or annotation.***
13. ***The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.***
14. ***Should the researcher have been involved with research at a school and/or a district/head office level, the Senior Manager concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.***

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

ALBERT CHANEE
ACTING DIVISIONAL MANAGER: OFSTED

The contents of this letter has been read and understood by the researcher.	
Signature of Researcher:	
Date:	03/10/2006

Faculty of Humanities: Education Campus

Room 208/9, Administration Block, 27 St. Andrews Road, Parktown • Tel: +27 11 717-3021/18 • Fax: +27 11 717-3219
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UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

Mr N Mpalami
Room FA2
International House
Wits
2050

STUDENT NUMBER 0507612Y
Protocol 2006ECE17

11 October 2006

Dear Mr Mpalami

Application for Ethics Clearance for Master of Science (Science Education)

I have pleasure in advising you that the Ethics Committee in Education of the Faculty of Humanities, acting on behalf of Senate has agreed to approve your application for ethics clearance submitted for the degree of Master of Science (Science Education) for your proposal entitled: **Teaching and learning linear programming in a Grade 11 multilingual mathematics classroom.**

The Committee has agreed that you may proceed with your research project subject to the following recommendations:

- Although you indicate that in the event video recordings of classroom interactions being used the anonymity of the learners will be protected. It is not clear though, how this will be done;
- It is not clear how the video recording can still be used if learners' parents do not want their children' identities to be revealed.

You need to clarify how the anonymity of learners will be ensured in the video recording. Also, you need to indicate how identities of learners will be protected in the video recordings. Once such clarification is obtained, to the satisfaction of your supervisor, you may proceed with your research.

Yours sincerely

Mathoto Senamela
Faculty Officer for Faculty Registrar
Faculty of Humanities

cc GSEC file
Supervisor
Ethics File
HDethics clearance

UNIVERSITY OF THE WITWATERSRAND: MATHEMATICS RESEARCH PROJECT

Dear Principal

My name is Nkosinathi Mpalami. I am currently doing MSc degree in Mathematics Education. As part of the fulfillment of my degree, I am doing a research project in which I investigate how Grade 11 mathematics teachers in a multilingual classrooms use learners' home languages to promote learners' proficiency in Linear Programming. The focus of my study is on a Grade 11 mathematics teacher. I therefore request your permission to involve one Grade 11 mathematics teacher in your school.

With your permission, I will video-record 5 lessons on Linear Programming and I will interview the teacher as part of the reflections on his teaching through learners' home languages. The interview will be tape-recorded in order to ensure accurate recording of what the teacher says. When video and tape recording have been transcribed, you will be provided with copies of the transcripts. Once the research is complete, the video and tape records will be destroyed in fire.

I intend to protect the anonymity of your school, the teacher and learners to the fullest possible extent. In any publication emerging from this research, the school and participants will be referred to by a pseudonym. I will remove any references to information that might allow someone to guess the identity of the participants and the school. However, it is still possible that despite all my efforts to preserve the anonymity of the school and participants there might be someone who will be able to identify them. Please note that if however you would like the real name of the school to be used in the publications you will have to make a written request to me. The research may be reported at conferences, in journals and to research sponsors.

Once the research has been completed, a brief summary of the findings will be available to you.

Please be advised that your school's participation in this research project is voluntary. Should you wish to withdraw at any stage, or withdraw any unprocessed data collected in your school, you are free to do so without any prejudice. Your decision to participate or not, or withdraw, will be completely independent of your dealings with the University of the Witwatersrand.

Should you require any further information, do not hesitate to contact me. My contacts are given below.

Mr. Nkosinathi Mpalami 011 717 5413 (h)
mpalamin@science.wits.ac.za.

UNIVERSITY OF THE WITWATERSRAND: MATHEMATICS RESEARCH PROJECT

Dear Teacher

My name is Nkosinathi Mpalami. I am currently doing MSc degree in Mathematics Education. As part of the fulfillment of my degree, I am doing a research project in which I investigate how Grade 11 mathematics teachers in a multilingual classrooms use learners' home languages to promote learners' proficiency in Linear Programming. The focus of my study is on a Grade 11 mathematics teacher. I therefore request you to be a participant in this research project.

If you agree to participate in my research project, I will video-record your 5 lessons when you teach Linear Programming to Grade 11 learners. I am interested in a class where you will be using learners' home languages. I would like you and me to watch the video together and engage in a reflective interview about teaching Linear Programming through learners' home languages. The interview will be tape-recorded in order to ensure accurate recording of what you say. When video and tape recording have been transcribed, you will be provided with copies of the transcripts. Once the research is complete, the video and tape records will be destroyed in fire.

I intend to protect the anonymity of you, the school, and learners to the fullest possible extent. In any publication emerging from this research, the school and you will be referred to by a pseudonym. I will remove any references to information that might allow someone to guess your identity and that of school. However, it is still possible that despite all my efforts to preserve the anonymity of you and that of school there might be someone who will be able to identify you and your school. Please note that if however you would like your real name to be used in the publications you will have to make a written request to me. The research may be reported at conferences, in journals and to research sponsors.

Once the research has been completed, a brief summary of the findings will be available to you.

Please be advised that your participation in this research project is voluntary. Should you wish to withdraw at any stage, or withdraw any unprocessed data collected in your class, you are free to do so without any prejudice. Your decision to participate or not, or withdraw, will be completely independent of your dealings with the University of the Witwatersrand.
Should you require any further information, do not hesitate to contact me. My contacts are given below.

Mr. Nkosinathi Mpalami   011 717 5413 (h)
mpalamin@science.wits.ac.za.

TEACHER CONSENT FORM: Video and Tape recording

I ……………………………………. (please print your name in full) a Grade 11 mathematics teacher at ………………………………., am aware of all the data collection processes in the Use of Learners' Home Languages Project.

I give consent to the following:

- Being videoed and interviewed during the study
  Yes or No (circle your selection)

- The tape recording of my interview with the researcher
  Yes or No (circle your selection)

Name of Teacher ……………………………………
Signed …………………………………………….Date………………….

UNIVERSITY OF THE WITWATERSRAND: MATHEMATICS RESEARCH PROJECT

Dear parent or guardian

My name is Nkosinathi Mpalami. I am currently doing MSc degree in Mathematics Education. As part of the fulfillment of my degree, I am doing a research project in which I investigate how Grade 11 mathematics teachers in a multilingual classrooms use learners' home languages to promote learners' proficiency in Linear Programming. The focus of my study is on a Grade 11 mathematics teacher.

Your child's mathematics teacher and headmaster have given me permission to send you this letter to invite your child to participate in this research project.

All children whose parents agree that they take part in this research will be video recorded for five days during mathematics lessons in the months August and September 2006. The focus in these video recordings and lesson observations will be on how the teacher uses learners' home languages to promote learners' proficiency in Linear Programming.

Children whose parents do not agree that their children be video recorded will be kept away from the focus of the video recorder. This will not put them in a position where they are deprived from the lesson.

I intend to protect your child's anonymity and confidentiality. His or her real name will not be used in the final report. I will remove any reference to personal information that might allow someone to guess his or her identity. The results of the research may be reported at conferences, in journals and to research sponsors. In case I need to use the information in the video recording for conference or for teaching purposes, the children's faces will be hidden from public viewing. Permission from you will be requested before the video recording is used for conferences or for teaching purposes.

Remember that your child is not obliged to participate. Should you require any further information do not hesitate to contact me my details are given below.

Mr. Nkosinathi Mpalami 011 717 5413 (h)
mpalamin@science.wits.ac.za.

PARENT CONSENT FORM: Videotaping

I ……………………………………. (name of parent), hereby allow …………………………(name of learner) to participate in the study conducted by Nkosinathi Mpalami.

I give consent to the following:

- My child to be video recorded during the study

  Yes or No (circle your selection)

- The possible future use of the videotext for conference purposes

  Yes or No (circle your selection)

Signed …………………………………………….Date………………….