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TEACHING AND LEARNING LINEAR PROGRAMMING IN A GRADE 11 MULTILINGUAL MATHEMATICS CLASS OF ENGLISH LANGUAGE LEARNERS: EXPLORING THE DELIBERATE USE OF LEARNERS HOME LANGUAGE

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A research report submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in partial fulfillment of the requirements of the degree of Master of Science by coursework and research report.

Johannesburg, 2009

ABSTRACT

This study investigated the deliberate use of learners' home languages in the teaching and learning of linear programming. The study involved a Grade 11 teacher and his Grade 11 multilingual learners in a township school in the East Rand. Data was collected through lesson observations for five consecutive days, reflective interview with teacher and clinical interview with two learners. Analysis of data revealed that the teacher used learners' home languages to probe learners' understanding of specific terms frequently used in linear programming concepts, for example terms such as, 'at least' and 'at most'. Learners' responses suggest that they drew on their home languages for the meaning of these words. Learners explained the term 'at least' in their home languages as 'buncinci' in Isixhosa, 'bonnyane' in Sesotho and Sepedi and 'okungenani' in IsiZulu. Learners also used mathematical English term minimum to explain 'at least' and maximum to explain 'at most'.

Key words: Linear programming, learners home language, deliberate, mathematical language, at least and at most, Realistic Mathematics Education, Horizontal mathematization, vertical mathematisation.

DECLARATION

I declare that this report is my own unaided work. It is submitted for the degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination in any other university.

_____

(Thulisile Nkambule)

_____day of _____2009.

To:

Thandokuhle and Setsabile

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CHAPTER 1

INTRODUCTION TO THE STUDY

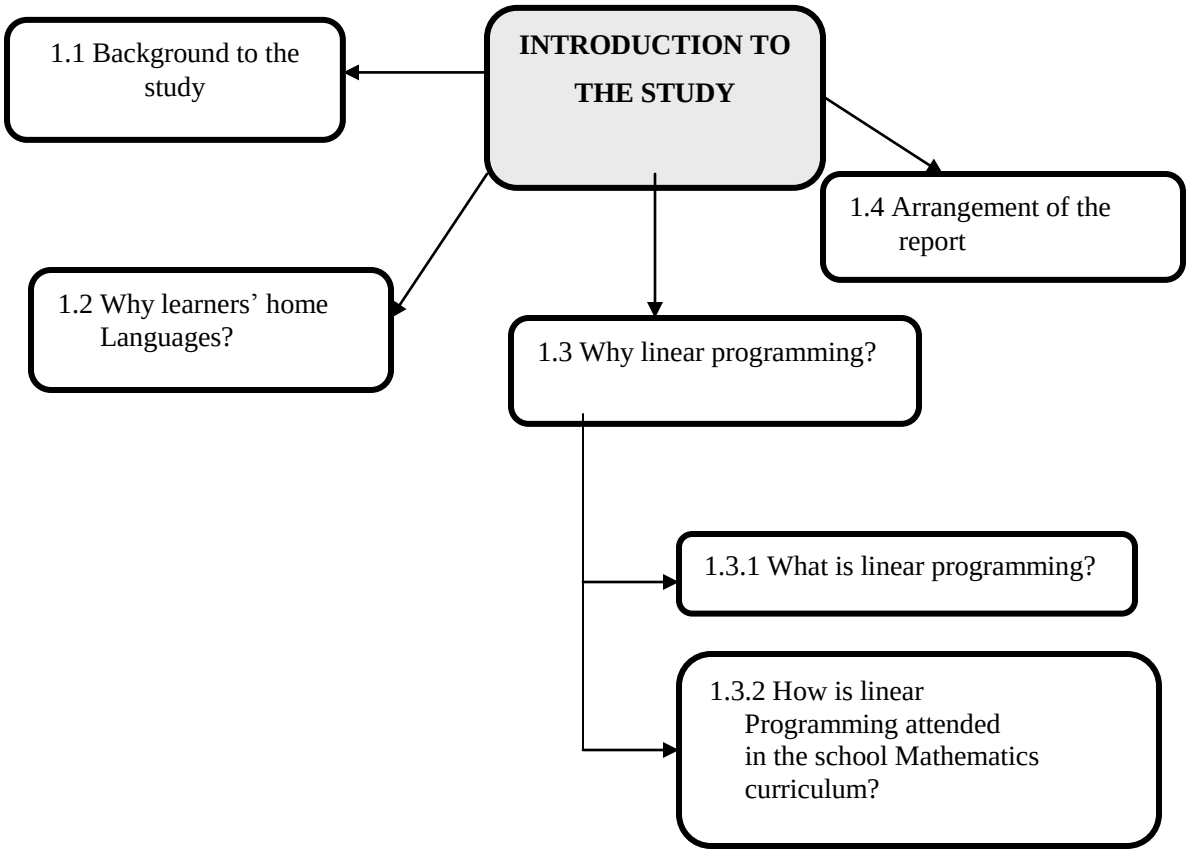

Figure 1.0: An overview of Chapter 1

This chapter describes the study

1.1 BACKGROUND TO THE STUDY?

This research came as a result of a pilot study I undertook in 2006 in which a Grade 11 teacher was trying a strategy of using the learners' home languages deliberately in the teaching and learning of linear programming. Both the teacher and learners are multilingual and while English is the language of learning and teaching (LoLT) in the school, it is neither the home language of the teacher nor the learners. The deliberate use of the learners' home languages means, "it is planned and not impromptu as it usually happens with code-switching in multilingual classrooms" (Setati, Molefe, Duma, Nkambule, Mpalami and Langa, 2007: 5).

The teacher encouraged learners to use their home languages when explaining and justifying their solutions. He asked questions to which learners were required to respond (both orally and in writing) in their home languages. This pilot study appeared to support Moschkovich's claim that mathematics is learned better if the learners' home language(s) are used as a resource (Moschkovich, 1999). Furthermore, it appeared to support Clarkson's view that home language(s) could offer a cognitive advantage in learning mathematics if students had the facility in both their languages (Clarkson, 2002). It is important, however, to note that both the work of Moschkovich (1999) and Clarkson (2002) is based in bilingual classrooms and not multilingual classrooms.

The study reported here sought to investigate further, whether and how the deliberate use of the learners' home language(s) in the teaching of linear programming can support the learners' understanding and engagement with linear programming tasks during the lessons.

The study was guided by the following questions:

1. How does a Grade 11 mathematics teacher in multilingual classroom use learners' home languages for teaching and learning linear programming?
2. How does the use of the learners' home languages support the learners' engagement with linear programming tasks during the lessons?
3. How do the learners draw on their home languages to solve linear programming tasks?

1.2 WHY LEARNERS' HOME LANGUAGES?

There is a continuing debate in South African education and the public domain regarding which language should be used for teaching mathematics in multilingual classrooms. This debate is because learners in many of these classrooms are not yet fully fluent in the language of learning and teaching (LoLT) which is English. While the South African language in education policy (LiEP) encourages multilingualism (Department of Education, 1997: 8) and research (e.g. Moschkovich, 2002: 208) supports the use of the learners' home languages, a recent analysis of the learners' and teachers' language choices for teaching and learning mathematics shows a preference for English (Setati, 2006). In her analysis, Setati (2006) argues that the preference for English is due to the desire to gain access to social goods rather than epistemological access. The view of many teachers and learners is that, English as the language of power in South Africa, is important for higher education, jobs and subsequently a better life hence their language preference.

Given this background, it is crucial to investigate teaching strategies that pay attention to how learners' home languages can be drawn on to facilitate mathematics learning. For such strategies to work they need to ensure that the learners gain epistemological access without losing access to English, which is

presently seen as a necessary condition for gaining access to social goods (Setati, 2006).

Previous research in mathematics education (Moschkovich 1999; Adler, 2001; Setati & Adler, 2001), argues that the learners' home languages are a resource for mathematics learning. The challenge, however, is that regarding the learners' home languages as a resource, tends to be seen as a threat to multilingual learners' development of fluency in English language.

The value of using the learners' home languages as a resource is also recognized by linguists, who argue that learners enter schools with a good foundation in their home language(s) and if this language is further developed, they will be able to transfer their conceptual understanding to the second language (Cummins, 1984). This suggests that if the learners develop proficiency in mathematics (e.g. understanding of linear programming) then the language in which the proficiency is developed will not be a constraint because they will be able to transfer that mathematical proficiency to their second language.

Cummins (1984) further argues for a 'common underlying proficiency' in which cross-linguistic proficiency can promote the development of cognitive academic skills. When children learn a language, they also learn concepts and relevant skills to use in the second language. According to Cummins (1984), language skills can be transferred from one language to the other. One can therefore assume that cognitive abilities acquired in the learning of one language can be put to use in the acquisition of the other language. For example if a student knows the concept of time in his/her home language, that skill can be easily transferred into the second language.

Cognitive abilities are viewed as an individual advantage and Grosjean (1995: 259) asserts, "Bilinguals are not the sum of two complete or incomplete monolinguals, but have a unique and specific linguistic configuration". This

means that bilinguals have the ability to use their languages individually or together.

Children learn a language from the members of a community and Valdes–Fallis (1978 cited in Moschkovich, 2002: 198) defines bilinguals as "the product of a specific linguistic community that uses one of its languages for certain functions and the other for other functions". This being the case it means that the classroom as a community of practice needs to provide conversational confidence so that when in the outside world the student can both linguistically cope and continue learning a language (Baker, 1994). The use of the learners' home languages in the teaching of mathematics in the classroom would enable the learners to continue using their home languages that they would have learned from the members of the community.

The language practices of the community are evident in code switching, which can be defined as the practice of using more than one language in the course of a single communicative episode (Moschkovich, 2007). Moschkovich further argues that bilingual children use the language of the person addressing them. Research in mathematics education recognizes code switching as a resource in the teaching and learning of mathematics (Setati, 1998; Setati & Adler, 2001; Khisty, 1995). Code switching shows translational skills and selective use of language by an individual. Gorgorio & Planas (2001:14) contend that:

> Code switching goes beyond mere translation, and further than switching from the first language to the language of instruction. It implies changing not only words, but also their meanings and the ways they are used.

Drawing on the resources of multilingual language practices in the teaching of mathematics has a potential to reinforce the idea of mathematics being "a distinctly human activity practiced by all cultures" (NCS, 2003: 9).

1.3 WHY LINEAR PROGRAMMING?

The revised South African curriculum places great emphasis on "the establishment of proper connections between mathematics as a discipline and the application of mathematics in the real-world contexts" (NCS, 2003: 10) and highlights task solving as a means to achieving this. Linear programming provides opportunities for such an approach in the mathematics classroom.

Linear programming was introduced into the South African curriculum in the mid eighties, for study by Grade 11 and 12 learners taking mathematics at a higher Grade level. With the discontinuance of the higher and standard Grade differentiation, linear programming is now offered to all learners' studying Mathematics at Grade 11 level as from 2007. Therefore, all learners are to have access, and be able to learn successfully. According to the new curriculum, learners are to develop flexible and integrated knowledge and learn through pedagogical orientation and processes that are learner-centred.

An emphasis on learner-centred practice is meaningful learning by advocating learners' active participation and involvement in the lesson. While on the other hand, learner conceptions and meanings are to be elicited, encouraged, valued, and brought into interaction with concepts and knowledge. Learner-centred practice is centrally driven by meaningful communication between learners and teachers, between learners themselves. Adler (2000b) has argued that such a curriculum requires cultural and social resources, thus the study explored how a Grade 11 teacher deliberately uses learners' home languages as a resource to support learners understanding and engagement in linear programming. It is my hope that the results of this study will serve to inform the way in which learners home languages may be used as a resource in the teaching of Mathematics.

1.3.1 What is Linear Programming?

Linear programming is a mathematical modelling technique useful for guiding quantitative decisions in business planning, industrial engineering and, to a lesser extent, in the social and physical sciences. It is the maximization or minimization of a specific performance index, usually of an economic nature like profit, subject to a set of linear constraints. For this exercise to qualify as linear programming the performance index should also be linear.

George Dantzig developed linear Programming in 1947. He was studying proposed training and logistics for the United States military training program, as a mathematical adviser to the US Air Force Controller in the Pentagon. Dantzig was also an expert on planning methods using desk calculators. His colleagues at The Pentagon, Hitchcock and Wood, asked him to find a method that would rapidly compute a time-staged operation, training and logistical supply program (Dantzig, 2002).

Dantzig was influenced by the work of Leontief, who proposed a large but simple matrix structure called the ‘inter-industry input-output model’ (Leontief, 1933) of the American Economy. In this model there was a one-to-one correspondence between the production processes and the items being produced by these processes. Dantzig (1937) also used ideas from a paper by von Neumann (1928) on game theory together with his ideas on steady economic growth to formulate a highly dynamic model that could change over time. He realized that The Air Force needed a model with alternate activities and which had to be computable; hence, he invented the simplex method.

The simplex method can be described as a dynamic linear program with a staircase matrix structure. The method generates a sequence of feasible iterates by repeatedly moving from one vertex of the feasible region set to an adjacent vertex with a lower value of the objective function. When it is not possible to find an

adjoining vertex with a lower value, the current vertex must be optimal and termination occurs. The simplex method is a tool for practical planning of large complex system (Dantzig, 2002)

Linear programming is about using the simplex method to formulate real-world tasks in mathematical terms, solved using computers and software nowadays. The standard form of describing a linear programming task consists of the following:

- a linear function to be maximized or minimized, e.g. $2x + 3y \leq 30$
- subject to linear constraints, e.g. $x + 6y \geq 24$ and $5x + 8y \leq 40$
- and non negative values, $x \geq 0$ and $y \geq 0$

(http://mathworld.wolfram.com/linear programming.html 22/03/2007)

1.3.2 How is Linear Programming attended to in the School Mathematics Curriculum?

According to the South African National curriculum statement (NCS, 2003:31), linear programming is introduced at Grade 11 level. Learners' continue to study linear programming at Grade 12 level. Below is what the curriculum statement stipulates as content that needs to be covered as well as the assessment standards.

Table 1.1: Content under linear programming in curriculum

The proposed content under linear programming for Grade 11	Assessment standards are as follows
▪ The learner must be able to **optimize** a function in two variables subject to one or more **linear constraints**, by the numerical search along the boundary of the **feasible region** ▪ The learner **solves** a system of linear equations to find the **coordinates** of the **vertices** of the feasible region.	We know this when the learner is able to: a) **Solve** linear programming tasks by **optimizing** a function in two variables, subject to one or more **linear constraints**, by numerical search along the boundary of the feasible region. b) **Solve** a system of linear equations to find the **co-ordinates** of the **vertices** of the feasible region. (DoE, 2003)

The curriculum shows that it is crucial that students perceive and learn mathematics in the context of its current use. The concepts are introduced as they are needed in task–solving situations and the document makes clear that it is crucial that students can use the mathematics in an out of school experience. The learners need to understand the meaning of terms such as *optimize, optimizing, linear constraints* and *feasible region* in order to be able to solve a linear programming task. This means translating these terms into symbolic mathematical language and then applying the necessary procedure in order to find the co-ordinates of the vertices of the feasible region.

Below is an example of a typical linear programming task, taken from the senior certificate examination question paper for 2005 (DoE/2005/253)

To meet the requirements of a specialized diet a meal is prepared by mixing two types of cereal, *Vuka* and *Molo*. The mixture must contain *x* packets of *Vuka* cereal and *y* packets of *Molo* cereal. The meal requires at least *15g* of protein and at least *72g* of carbohydrates. Each packet of *Vuka* cereal contains *4g* of protein and *16g* of carbohydrates. Each packet of *Molo* cereal contains *3g* of protein and *24g* of carbohydrates. There are at most 5 packets of cereal available:

a) Write down the constraint inequalities (6)

b) If *Vuka* cereal costs R6 per packet and *Molo* cereal also costs R6 per packet, use the graph to

determine how many packets of each cereal must be used for the mixture to satisfy the above

constraints in each of the following cases:

(i) The total cost is a minimum. (4)

(ii) The total cost is a maximum (give all possibilities) (3)

(13)

Figure 1.1: Linear programming task

The learners have to understand the task in order to translate it into symbolic mathematical language to come out with the constraint inequalities. For example, an addition sign denotes 'mixing' in mathematical language (+). 'At most five packets of cereal' means 'less than or equal to 5' denoted by $x + y \leq 5$. This part of the task is allocated '6' marks which is almost half of the total marks for the task. Therefore, if learners cannot write the constraint inequalities the chance of scoring less than 50% of the total marks is very high.

In the second part of the task, the phrase 'total cost' is used which suggests 'addition' in the context of mathematics. How then can mathematics educators help learners master the skill of extracting the mathematics from the given linear programming task? There is a need for a strategy that would enable the learners to gain epistemological access without losing access to the English.

Solution to the above task

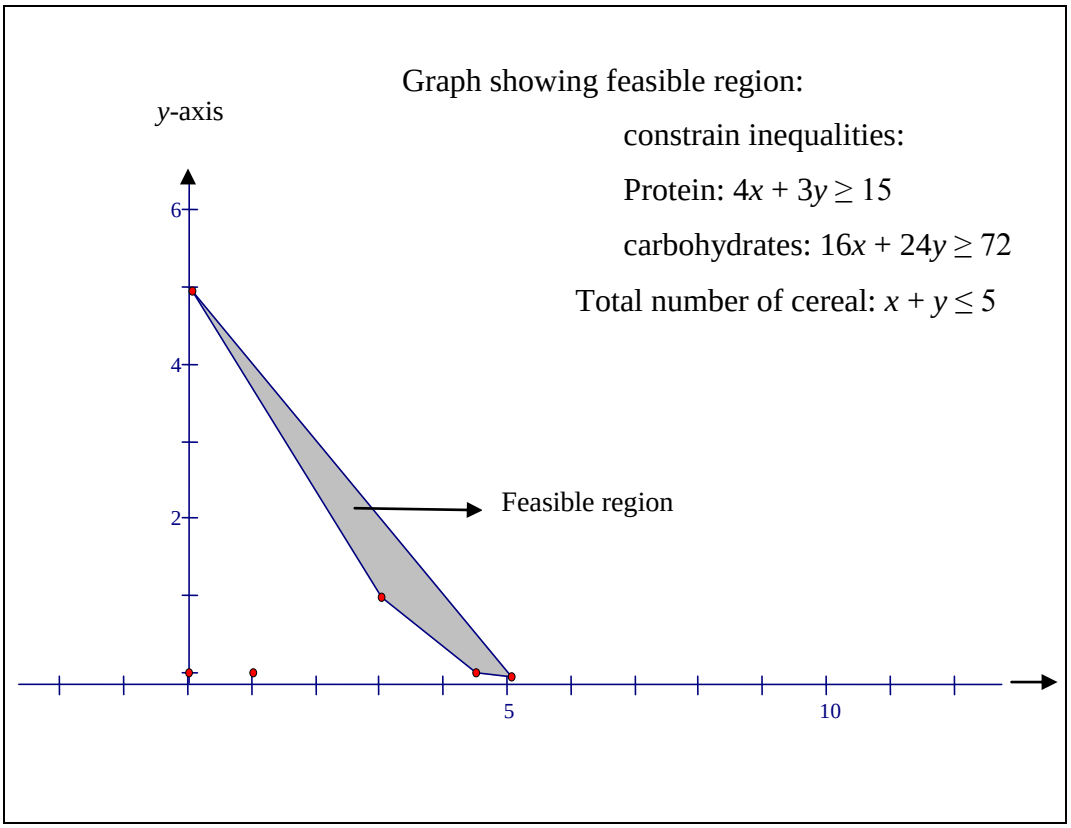

Figure 1.2: Graph showing feasible region

Below I show points found in the feasible region and the values of the objective function at each of the points in the feasible region:

Table 1.2: Points in feasible region

points	(0;5)	(1;4)	(2;3)	(3;2)	(4;1)	(5; 0)	**(3;1)**
value	30	30	30	30	30	30	**24**

The objective function is given by $6x + 6y$ hence minimum value occurs at (3; 1) and the value is R24 while maximum occurs at (0; 5), (1; 4), (2; 3), (3; 2), (4; 1) and (5; 0). The value is R30.

There is no doubt that the learner must be able to understand and translate the given task to mathematical language in order to find the solution. This study sought to find out how the learners' home languages can be used to support learners understanding and engagement with linear programming tasks. The next section looks at the arrangement of the report.

1.4 ARRANGEMENT OF THE REPORT

The report comprises seven chapters. In this chapter, I have stated the aims of the study and the background information that informed my focus on the use of learners' home languages in linear programming.

In the next chapter, I discuss the theoretical assumptions that guided the study. The theoretical framework is based on Realistic Mathematics Education (Freudenthal, 1973; 1991; Graveimeijer, 1994). The chapter also presents an overview of literature on teaching and learning mathematics, bilingual and the learning of mathematics and mathematical communication

Chapter 3 describes the research design and methodology used in data collection and analysis. The discussion on selecting the methods indicates how the study

was planned. I draw attention to the steps taken to ensure ethical considerations. Issues of validity and reliability are discussed to ensure rigour in this study.

Chapter 4 presents a descriptive analysis of the learner questionnaire which shows the language infrastructure of the Grade 11 class in which the study was conducted. The analysis shows languages learners indicated that they are confident in reading, writing, speaking and understanding. The analysis also shows the language learners would like to use when learning mathematics.

Chapter 5 presents an analysis of data collected through classroom observation and teacher interview. The analysis highlights how the learners' home languages were used in the teaching and learning of linear programming.

Chapter 6 presents an analysis of data collected through focus group interaction and a clinical interview. The analysis shows how learners draw on their home language when solving a linear programming task. The chapter also presents an analysis of a questionnaire issued after all lesson observations, to find the views of learners about the lessons.

Chapter 7, the final chapter, presents findings of how the home language supported learners' engagement with linear programming task. I also present reflections and limitations of the qualitative study. The reflections highlight the experiences that I gained when working on the project.

CHAPTER 2

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

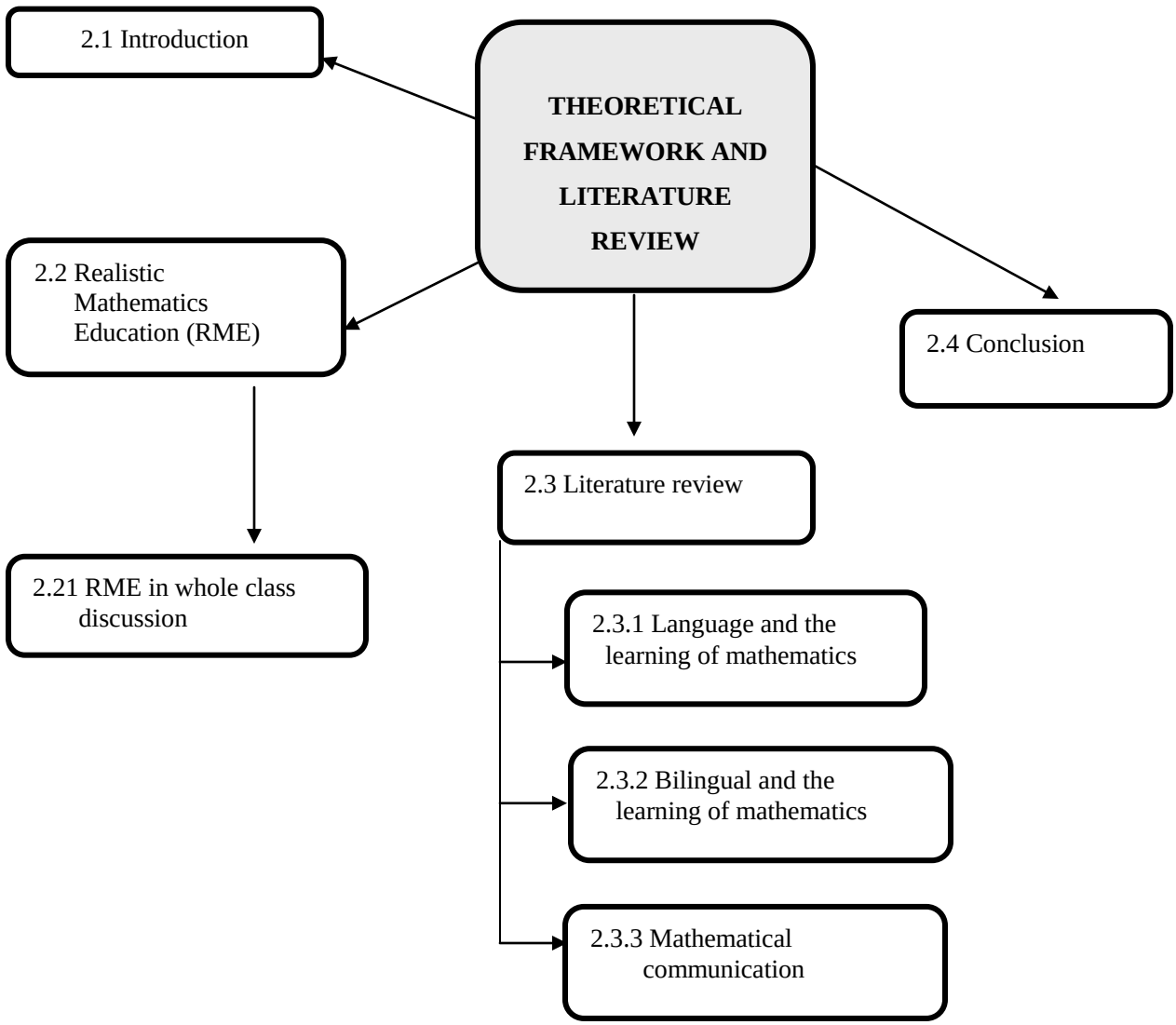

Figure 2.0: An overview of Chapter 2

This chapter describes the theoretical framework and literature reviewed to enhance the study.

2.1 INTRODUCTION

This chapter discusses the theoretical framework and the literature reviewed that informed my study. The theoretical framework establishes a viewpoint, a perspective, a set of lenses through which I viewed my study. A theory influences what one sees and what one does not see. The theory discussed centre on the learners' acquisition of mathematical knowledge. The process of acquisition of this knowledge is based on Realistic Mathematics Education (RME). RME deals with specific instruction for mathematics education and it explains how learners acquire knowledge through mathematisation.

The review of literature is divided into sections highlighting the main features of studies and views that have been expressed on the effect of language and the learning of Mathematics, bilingual education and the learning of Mathematics and mathematical communication.

2.2 REALISTIC MATHEMATICS EDUCATION (RME)

RME has its roots in Freudenthal's interpretation of Mathematics as a human activity (Freudenthal 1973) he named mathematisng. It is the Dutch answer to the need to reform the teaching of Mathematics. The activity-based interpretation of Mathematics affected the teaching methods and the goals of mathematics education. According to Freudenthal (1973), Mathematics can best be learnt by doing and mathematising is the core goal of mathematics education.

Mathematising

The actual activity of doing Mathematics should consist of organising or mathematising subject matter, taken from reality. The verb **mathematising** implies activities in which one engages for the purpose of generality, certainty, exactness and brevity (Treffers, 1987).

Learners should therefore learn Mathematics by mathematising subject matter from real context and their own mathematical activity rather than from traditional view of presenting mathematics to them as ready-made system with general applicability (Gravemeijer, 1994). These real situations can include contextual problems or mathematically authetic contexts for learners where they experience the problem presented as relevant and real.

According to Gravemeijer (1994), mathematising subject matter from context is the process when learners are given the opportunity to reinvent mathematical insights, knowledge and procedures through a process of progressive mathematisation. Gravemeijer asserts, "Freudenthal's view of mathematising relates to level-raising in a mathematical sense" (p.82). Moreover, he argues that level-raising is obtained when features that characterise mathematics such as generality, certainty, exactness and brevity are promoted in our teaching of mathematics.

Progressive mathematisation

In progressive mathematisation, learners go through stages referred to in RME as horizontal and then vertical mathematisation (Treffers, 1987). In horizontal mathematisation, learners are mathematising contextual tasks. In the process, learners use their informal strategies to describe and solve a contextual task. When starting from a context, learners model the task by finding relations and regularities that result in a mathematics structure, for example table, graph, or formula. The description "simplifies the task by describing relations and distinguishing matters of major and minor importance" (Gravemeijer, 1994: 83). In my view, the learners' informal strategies can be expressed in their home languages or the language of learning and teaching while describing the task.

Vertical mathematisation occurs when the informal strategies lead learners to solve the task using mathematical language or to find a suitable algorithm (Treffers, 1987; Gravemeijer, 1994). Horizontal and vertical mathematisation

happens through learners' actions as well as when they reflect on their actions. Freudenthal (1991) contends that

> Horizontal mathematisation leads from the world of life to the world of symbols. In the world of life one lives, acts (and suffers); in the other one symbols are shaped, reshaped, and manipulated, mechanically, comprehendingly, reflectingly: this is vertical mathematisation. The world of life is what is experienced as reality, as is symbol world with regard to abstraction. (p. 41)

According to Gravemeijer the boundaries between the two dimensions of mathematising are blurred. The basis is in what is understood to be reality and Freudenthal (1991: 17) contends, "I prefer to apply the term reality to that which at a certain stage of common sense experiences as real". Reality grows under the influence of the learning process of the learner.

For example, in a linear programming task on page 9, the process of extracting the important information required using an informal strategy such as trial error to solve the task, would be horizontal mathematisation. Translating the task into mathematical language through the use of symbols and later progressing to selecting an algorithm like: $x + y \leq 5$; $16x + 24y \geq 72$ and $4x + 3y \geq 15$ could be considered vertical mathematising as it involves working with the problem on different levels.

Different levels

The feature of RME that is related to mathematising is that learners pass through different levels of understanding on which mathematising can take place. That is from devising informal contexts-connected solutions to reaching some level of representation and finally having insight into the general principles behind a problem and being able to see the overall picture. According to Freudenthal (1991), the activity of mathematizing on a lower level can be the subject of inquiry on a higher level. This means that the organizing activities that have been carried out initially in an informal way, later as a result of reflection become more formal, which is progressive mathematisation.

In progressive mathematisation, representations of problem situation are seen as vehicles to elicit and support this progress. Representations of problem situations play a role of bridging the gap between the informal understanding and the understanding of formal system. These representations, referred to as models in RME, referres to visual sketches, diagrams, paradigmatic situations, materials and even symbols (Treffers, 1987).

Models

Models have to be rooted in realistic in order to give the necessary support to the learning process, imaginable contexts and be flexible in order to be applied at a general level. This implies that models should support progression in vertical mathematising. The students should be able to go back to a lower level. Furthermore, models should be re-invented by the students on their own. Models should behave in a natural, self-evident way. They should fit with the students informal strategies. As if they could have been invented by them and should be adapted to new situations.

Summary

In RME, the starting point of instructional experience should be real to the children, so that they can immediately engage in personally meaningful mathematical activity (Streefland, 1991 cited in De Lange, 1996). The learners' informal mathematical activity should correspond to a basis from which they can abstract and construct more and more complicated mathematical concepts. While engaging in these mathematical activities, learners will be using horizontal and vertical mathematisation and in the process learners will be using their home languages, mathematical symbols and the language of learning and teaching interchangeably. Hence, move gradually to the importance of the shift from 'ordinary' language to specialised language and mathematical, symbolic representations.

Therefore, in my view, RME offers a framework for developing the learners' formal mathematical task solving skills while still developing their language. This means therefore that in linear programming, learners can be presented with well chosen contextual tasks to give them the opportunity to develop their informal strategies. At the end, learners would be able to build on their everyday language while acquiring knowledge for which they have been responsible. The following table presents a summary of the framework for language development in RME.

Table 2.1: Language development in RME

Concept	Horizontal mathematisation	Vertical mathematisation
	Modelling in learners home languages	Reformulating reflecting using mathematical language

2.2.1 RME in whole class discussion

Class discussions of solution procedures and task situations are one of the core activities in RME instructions. The discussions centre on the efficiency of the solution procedures and the interpretations of the task situations. The discussions include understood negotiation of concepts such as meaning of 'at least'. According to Gravemeijer (1994), part of the whole class discussion refers to the interpretation of the situation sketched in the contextual task. This might involve a shift of attention towards a reflection on the solution procedure from a mathematical point of view.

DeLange (1996) argues that learners should be given the opportunity to reflect on their personal processes of mathematisation, discuss their activities with other learners in order to evaluate the products of mathematisation and interpret the results. According to De Lange, interpretations of results are directed at the real life character of contextual tasks, since there is always a tension between practical solutions and a mathematical interpretation of the task. The learners' reflections

and discussion on their actions might be in their home languages or in the language of learning and teaching.

The next section will discuss literature reviewed to enhance my study.

2.3 LITERATURE REVIEW

Literature was searched for information that would enhance the study. According to McMillan and Schumacher (2006), literature review is used to serve as a theoretical background relating research, which surrounds and supports the study. It also helps to indicate any gaps in previous research. In this study, aspects reviewed included studies that have argued for the use of the learners' home languages in the teaching and learning of mathematics.

2.3.1 Language and the learning of mathematics

Pimm (1981, 1991) argues that learning mathematics is like learning a language. Pimm analysed the spoken and written language of mathematics. He described the relationship between mathematics and language in terms of register. According to Pimm, part of learning mathematics is acquiring control over the mathematics register. Halliday (1975 cited in Pimm, 1991: 17) defines a mathematics register as "A set of meanings that is appropriate to a particular function of language, together with the words and structures which expresses these meanings". The mathematics register includes words, phrases, symbols, abbreviations and ways of speaking, reading and writing that are specific to mathematics.

Pimm further argues that acquiring fluency in the mathematics register, learners need to learn to work within the mathematics register and understand its particularity. Pimm enlightens that learning mathematics in school comprises both informal and formal components. Informal language is the kind of language learners' use in their everyday experiences to express their understanding of

mathematical concepts. Formal mathematical language refers to the accepted use of terminology developed in schools.

Educators have acknowledged language as a tool for teaching and learning. Mercer (1995) argues that people use language to get things done and to engage in their interests. Using language to get things done depends on how well one is able to communicate his ideas to other people and how those people understand his ideas. In most cases, instructions are passed on through talking or writing using a language that both parties understand. In the same way, a teacher negotiates meanings with learners in a language that they both understand. Learners use language to communicate amongst themselves and with the teachers. They use language to think (Orton, 1992) and Mercer (1995) argues that language is both an individual and a social mode of thinking. Thinking is a process that assists learning and thus language structures that are not fully formed may set hurdles in learning.

According to Thurston (1995) in order to achieve the necessary comprehensively mathematical understanding, successful communication of mathematical ideas is the key. Language forms an integral part of this communication. Bohlmann (2001) contends, “Language is the medium by which teachers introduce and convey concepts and procedures through which texts are read and tasks are solved” (P.6).

Students have to understand the mathematics concept as well as communicate their understanding of these concepts verbally and in writing. The teacher presents concepts written or verbally using mathematics language, and everyday language, students have to be proficient in both languages. Moreover, competency in everyday language does not imply competency in the mathematical language (Lemke, 1990).

2.3.2 Bilingual education and the learning of mathematics

Research has presented the learners home languages as a resource for learning mathematics (Adler, 1998, 2001; Khisty, 1995; Moschkovich, 1996, 1999; Setati & Adler, 2001). These studies have argued for the use of learners' home languages as a support in the learning and teaching of mathematics. The studies seem to agree that to facilitate multilingual learners' participation and success in mathematics; teachers should recognize their home languages as legitimate languages of mathematical communication (Khisty, 1995; Moschkovich, 1999, 2002; Setati & Adler, 2001). The use of the learners' home languages in these studies is through code switching, mainly to provide explanation to learners in their home languages. In this study, the use of the learners' home languages was deliberate, strategic and proactive (Setati *et al*, 2007). The argument is that learners would develop proficiency in the LoLT while learning mathematics.

Moschkovich (1996, 1999) has shown that learners draw upon various resources such as gestures, experience, representations and code switching to make sense of mathematical task. In my view, learners must first have opportunities to make sense of the mathematical task in order to participate in solving and discussing it. The home languages might support learners make sense of the task.

Moschkovich (1999) documents strategies that the teacher used to support students ability to communicate their thinking during whole group discussion in English. The strategies included accepting students' contributions and probing students for clarification of their ideas. For example, Julian commented thus, when asked about differences between rectangles and triangles, "The rectangle has para…parallelogram (running his fingers along the lengths of the rectangle) and the triangle does not have parallelogram" (p.14). Contributions like Julian's are common when students communicate their thinking in a language that they are in the process of acquiring (Adler, 1997, 1999). However, Moschkovich describes how the teacher supported Julian in further clarifying his ideas and focusing on

the mathematical content of his contribution rather than on his unclear use of terminology.

Additionally, Moschkovich argues that the teacher revoiced (O'Connor & Michaels, 1996) Julian responses and it opened a space for students to comment on the correctness of the teacher's interpretation, thereby creating more opportunities for students to communicate their thinking.

According to Kern (1994 Cited in Clarkson, 2007), the learner processes thought more easily because the home language facilitates semantic processes. Kern conducted a study on the language of thought for the specific task of comprehending foreign language texts. He explored the actual uses for translation into learners' home languages in the language learning process. He found that thinking in the home language converts the input into terms that are more familiar and it enhances confidence in their ability to understand, thus, reducing feelings of insecurity. Using home language also serves as a means of maintaining concentration long enough for meaning to be put together and assimilated. When learners think in their home languages the "concepts are likely to come alive because the learner's network of associations is usually richer than in the second language" (Clarkson, 2007: 193).

Kazima (2006) reports on a study where she explored the meaning students assign to some probability words prior to instruction. In her study, she considered the effect of the learners' home languages through which students understood the probability language. She found that students bring a range of meanings to probability words such as certain, likely, unlikely and impossible. Kazima argues that students' interpretations of these words are influenced by linguistic structure in the students' home language and by interaction between the two languages in Malawian society. Therefore, the meanings of mathematical words cannot be considered separately from the ways that learners understand those words in their

home language. In addition, these informal and previous meanings interact with learning.

She argues that students' responses showed that giving an example of a word requires more than knowing the meaning of the word; it requires an understanding of the concept as well. She contends that there is a possibility "that when students encounter English probability vocabulary, they interpret the words in Chichewa, do the thinking in Chichewa, and then translate their responses in English" (P.187).

Clarkson (2007) reports on how four bilingual students used their home language, Vietnamese, as they solve mathematical tasks. All four students generally used Vietnamese at home. The students had indicated that they had used their home language when solving the tasks especially when they found it difficult. Clarkson investigated the issue of switching between languages when they solved tasks and he argues that switching between languages has a metacognitive function, which gives students access to additional or alternative meanings and relationships. Clarkson further argues that teachers who acknowledge the fact that student's do use both languages when doing mathematics enhances their student's long-term mathematical proficiency (p. 213)

Gerber, Engelbrecht, Harding & Rogan (2005) investigated the difference in performance of students whose home language was Afrikaans. The Afrikaans students attended Afrikaans lectures and other Afrikaans students attended English lectures. Their findings revealed that Afrikaans students who received instructions in Afrikaans outperformed Afrikaans students who received instructions in English. They argue that linguistically bilingual (Cummins, 1978 cited in Gerber et al, 2005) is not sufficient to ensure achievement in mathematics.

Varughese and Glencross (1996) investigated understanding of mathematical terms such as ‘integer’, ‘perimeter’, and ‘multiple’ among first year mathematics students at a South African University. These students were learning mathematics through the medium of English, their second language. They found that the students had difficulty in understanding of these terms.

Secada & Dela Cruz (1996) argues that teachers simplify the language of the task in an effort to make the mathematics idea comprehensible. However, simplifying the mathematical language may obstruct rather than enhance the students’ ability to make sense of content. According to Gorgorio & Planas (2001), simplifying the concepts can make it more difficult for students to make connections between ideas. Understanding the language is part of making sense of mathematical task and making sense involves understanding contexts, mathematical concepts and representations. In this study, the learners’ home languages are used to make mathematical ideas comprehensible so that learners’ can make sense of the tasks.

Rakgokong (1994) conducted a study whereby learners were given tasks in English only, English and Setswana and Setswana only. Learners were to discuss these tasks using the languages of the tasks. He reports that learners who were given English and Setswana performed better than the other groups. He argues that second language does not hamper pupil’s progress in problem solving only but also in procedural understanding of division, even though it requires minimal use of language.

Rakgokong contends that using English only as LoLT in multilingual primary mathematics classrooms in South Africa has a negative effect on the learners meaning making and problem solving abilities. His study has shown that in the group given tasks in English only, learners were not able to engage with the tasks. Yet with the Group given English and Setswana there was evidence that “both Setswana and English when used interchangeably by learners at their own free

will, can enhance meaning when they are engaged in a situation where discussion is encouraged" (p. 17).

However, other researchers (Frederickson and Clive, 1990 in Baker, 1993) argue that school performance is determined by a complex set of inter-related factors. Poor perfomance cannot be pointed to the learner's limited language proficiency in isolation from the wider social, cultural and political factors that infuse schooling.

2.3.3 Mathematical communication

Reform curriculum places emphasis on the important role of mathematics communication in the mathematics classroom. The most publicised evidence of this reform in South Africa takes the form of the National Curriculum Statement (NCS: 2003) for Grades 10 to 12. The NCS documents thus, "Mathematics enables learners to communicate appropriately by using descriptions in words, graphs, symbols, tables and diagrams" (p.9). In reform classrooms, the teacher is expected to organize instructions to include a wider variety of opportunities for students to discuss Mathematics including group work, class presentations and teacher led discussions. The opportunity to use learners' home languages is created through such interpersonal interaction.

In addition to broadening the opportunities for students to talk in the classroom, emphasis on classroom communication carries the expectation that students will negotiate their informal meaning. According to Tharp & Gallimore (1988), the kind of discourse that promotes the negotiation of informal meaning is instructional conversation. Whereby the teacher listens carefully to grasp the learner's communicative intent and shape the discussion to meet emerging understanding of the learners. They further argue that instructional conversation helps to form communities of learners in which learners and teachers assist in one learning.

Language and communication are emphasised in Learning Outcome 2 in the NCS document which focuses on patterns, functions and algebra thus "the learner should be able to recognize, describe and represent patterns and relationships and solve problems using algebraic language and skills (DoE, 2003).

Moschkovich (2002) argues that mathematics classrooms are shifting from a focus on primarily silent and individual activities as "students are now expected to communicate mathematically, both orally and in writing, and participate in mathematical practices, such as explaining solution processes, describing conjectures, providing conclusions, and presenting arguments" (p. 190). She emphasises the importance of mathematical communication. Moreover, classroom instruction can support learners in learning to communicate mathematically. To ensure fruitful interaction in a mathematics classroom; teachers have to have the skill to probe learners to substantiate their answers (Ball and Bass, 2003). They argue that teachers should be able to help learners justify their claims.

Prior research has argued that teachers play an important role in providing learners with access to mathematical words and ways of talking (Khisty, 1995). In this study, the likelihood that students will learn to communicate their mathematical ideas is maximised when students are encouraged to use their home language to support their communication of ideas.

According to Khisty (1995) talk is a vehicle by which an individual internalises meaning and develop a sense of personal power in mathematics. Adler (2001) contends, talk in a mathematics classroom raises dilemmas for a second language mathematics teacher. Therefore, the learners' home language is a resource, which could minimise the dilemmas in a mathematics classroom of multilingual learners.

Fraser, Murray, Hayward & Erwin (2004) argue that when teaching mathematics, social interaction creates opportunities for learners to talk about their thinking and

this encourages reflection in learners. They contend, “To verbalise what one is doing ensures that one is examining it.” (p. 27). As learners learn mathematics, they share ideas, which require them to convince others that the procedures they are using to solve tasks are valid; they have to use arguments that are convincing to other learners. Studies have shown that when learners share ideas they use their home language. This study sought to find out whether the use of the home language would support learner engagement with the tasks.

Research document challenges related to conversation about mathematical ideas in linguistically diverse classrooms (Adler, 1997; 1999; Gorgorio & Planas, 2001). The use of the learners’ home languages might minimize the challenges and give learners an opportunity to communicate their thinking to the teacher as well as their peers. Communicating thinking involved explaining and justifying an idea, agreeing or disagreeing with a mathematical claim.

2.4 CONCLUSION

This chapter described the theoretical framework that informed the study. The framework is based on RME (Freudenthal 1991,1973; Vos 2002; Van den Heuvel-Panhuizen, 2001; De Lange (1996) and Gravemeijer (1994).

The literature reviewed showed an overview of studies that argue for the use of the learners’ home languages as a support in the teaching and learning of mathematics. The next chapter describes the research design of the study and methods that were used to collect data.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

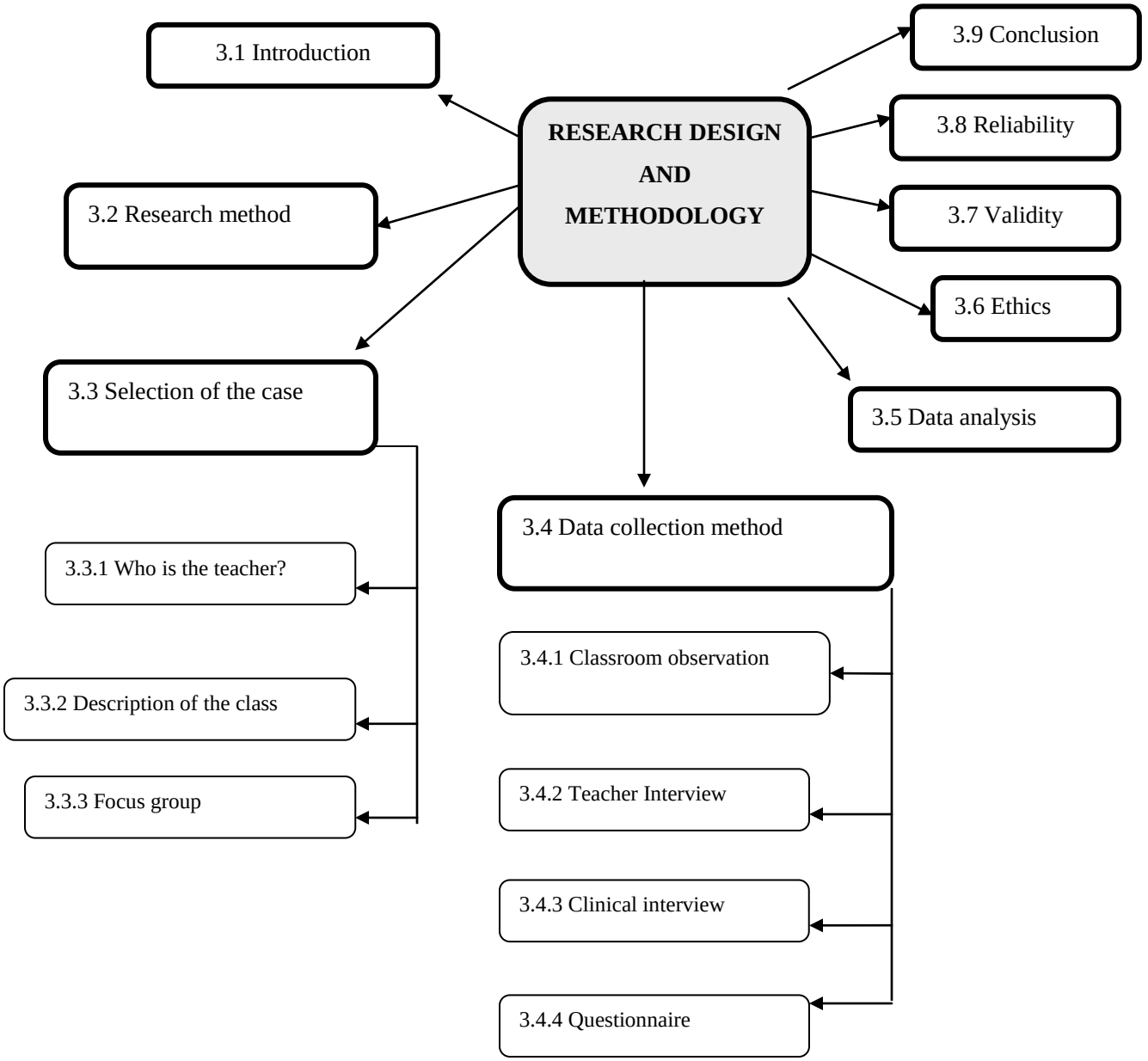

Figure 3.0: An overview of Chapter Three

This chapter describes and substantiates the research approach followed in exploring the strategy of using learners home languages in the teaching of linear programming

3.1 INTRODUCTION

In this chapter, I explicate the research methods and instruments that I used in collecting data for this study. I will also explain how I selected the sample.

The research design explains the plan used to select the subjects, research sites and the data collection procedures employed to answer the following questions also stated in Chapter 1:

1. How does a Grade 11 Mathematics teacher in multilingual classroom use learners' home languages for teaching and learning linear programming?
2. How does the use of the learners' home languages support the learners' engagement with linear programming tasks during the lessons?
3. How do the learners draw on their home languages to solve linear programming tasks?

The chapter will also present ethical issues considered and discuss how issues of validity, reliability were attended to. I will further discuss limitations of the research approach undertaken and instruments. Below I describe and give a rationale for the research methods used.

3.2 RESEARCH METHOD

This was a qualitative case study focusing on one teacher and his Grade 11 multilingual class in a township school in the East Rand. The qualitative approach was found to be most suitable as it recognizes that "what goes on in our schools and classrooms is made up of complex layers of meanings, interpretations, values and attitudes" (Hitchcock & Hughes, 1995: 25). In order to have a firm understanding of these variables, a qualitative approach enabled an "in depth study of a series of linked cases over a defined period of time" (Hitchcock and

Hughes, 1995: 317). Opie (2004: 74) further elaborate this point by arguing that a case study "can be viewed as an in-depth study of interactions of a single instance in an enclosed system".

The case in focus in this study is a teacher and his Grade 11 multilingual class working with linear programming concepts. The in-depth study of the selected case enabled me to explore how the learners' home languages are used while interacting with these linear programming concepts. Leedy (1997) argues that such a study intends to collect a massive amount of verbal data from participants and Merriam (1998) contends that it "provides a thick and rich description of the teacher's actions" which would be used to gain insight into how the learners' home languages are used when teaching linear programming.

The findings of this study will not be meant to implement changes, but to help me gain insight into learners thinking processes when using their home languages to support engagement with linear programming concept.

3.2.1 Limitations of a case study

Naturally, there are limitations to a case study design. According to Opie (2004: 78), a case study "does not implement changes as a result of its findings" and case studies are not meant for generalization. The findings of this study cannot necessarily be generalized to other teachers in multilingual classrooms. Mainly because this study involved one teacher observed over five days. However, Opie (2004) argues that the values of educational research are the details, which can be uplifted and related properly to another teacher working in a similar situation. Opie further asserts that even though a case study provides a thick description and analysis of a phenomenon and might influence policy, it "may be too lengthy, too detailed or too involved for busy policy makers and educators to read"

3.3 SELECTION OF THE CASE

In this study, I used purposive sampling (Cohen & Manion, 1994) to select the case (Grade 11 teacher and his Grade 11 multilingual learners). According to Cohen & Manion, "in purposive sampling, the researcher handpicks the cases to be included in his sample on the basis of his judgement of their typicality" (p.77). And Patton (1990 cited in Maxwell, 1992: 70) calls it purposeful sampling and he defines it as "a strategy in which particular settings, persons, or events are selected deliberately in order to provide important information that can't be gotten as well from other choices".

It was important that the selected teacher is appropriately qualified and regards the home languages as a resource for teaching and learning of mathematics. The teacher regards the home languages as a support in the teaching and learning of Mathematics. Furthermore, the pilot study mentioned earlier was done in his class.

3.3.1 Who is this teacher?

In my study I purposely selected a Grade 11 qualified and experienced teacher who is studying at the University of Witwatersrand. The teacher's home language is IsiZulu. However, he speaks and understands eight languages, Isixhosa, Isiswati, Ndebele, Sepedi, Sesotho, Setswana as well as Afrikaans. The home languages of the learners are IsiZulu, Isixhosa, Sesotho and Sepedi. The teacher teaches two Grades, Grade 11 and Grade 12. He is an experienced teacher who has been teaching Mathematics for over fourteen years. He is also the head of the Mathematics department. He has been involved in the marking of Grade 12 Mathematics scripts for over ten years. Furthermore, he has been teaching in the school for fourteen years. The language of teaching and learning in this school is English.

This teacher is currently studying towards a Master's degree in Mathematics education at the University of Witwatersrand. He completed a B.Sc(Honours) degree in the same institution in 2006 and he is also a member of the Language and Mathematics research group of the Marang Centre at the University of the Witwatersrand. The Language group now is exploring pedagogy for teaching and learning Mathematics in multilingual classrooms.

3.3.2 Description of the class

Classrooms are complex social environments. They consist of different groups of people who interact with each other in different languages (Best, 1977). The Grade 11 classroom was no exception. The class had 46 learners, 27 boys and 19 girls ranging from 15 – 18 years old. Most learners were multilingual as they indicated that they could speak, read, write or understand at least three languages. I am specifically focussing on Grade 11 level because of the teacher and the fact that linear programming is introduced at Grade 11.

The Grade 11 learners sat in groups according to their home languages. There were five or six learners in each group. There were eight groups in total: one group of IsiZulu, one group of IsiXhosa, three groups of Sepedi and three groups of Sesotho. The sitting arrangement was such that learners were facing each other and were able to face the board as well. There was a teachers' chair and a table in front of the class. The chalkboard was in good condition and there was enough white chalk and coloured chalk. There was also enough light in the classroom.

I was taking notes when the teacher was interacting with the learners during whole class discussions, and when learners were interacting with each other during group discussions.

The data collection process took place during the third term of the school calendar, from the 27th to the 31st of August 2007. Below I discuss the data collection methods employed in this study.

3.4 DATA COLLECTION METHOD

Qualitative approaches uses triangulation (Opie, 2004) which is the use of more than one method of collecting data. This study was no exception as it employed more than one method of collecting data. These methods of data collection used were classroom observation for five consecutive days, teacher interview, learner clinical interview and a learner questionnaire.

3.4.1 Classroom observations

The study sought to explore how the learners' home languages are used to support learners understanding and engagement of key concepts in the teaching and learning of linear programming. Doing lesson observations afforded me the opportunity to gain insight in the way the teacher and the learners used the home languages while learning linear programming.

A video camera captured all the five lessons. The video recordings focused on learner-teacher interactions, learner-learner interaction during whole class discussions. The main purpose of video recordings was to get information to refer to when analyzing the data. It gave me an opportunity to review classroom action during the analysis of the data.

The disadvantage with video recordings is that it focuses on one point at a time hence it might not show all the interactions. To guard against this disadvantage, during observation I was taking notes as well. The other disadvantage is that videoing might have technical tasks of focusing and quality of sound. To minimize these videoing tasks a knowledgeable person operated the video.

According to (Opie 2004) observational method as a technique for gathering data has an advantage in that the researcher can record information about the environment and the behaviour of the teacher and the learner's directly. Such as what they say to one another, which language is used by both teacher and learners for questions, answers, explanations, justifications and generalizing? Patton (1994 cited in Cohen & Manion, 2000) argues that observation affords the researcher the "opportunity to look at what is taking place in its natural settings rather that at second hand".

From my experience as a teacher, the participants negotiate what happens in the classroom. Observations enabled me to understand the content of the situation being observed. I was also able to see things, which participants might not freely talk about during interview.

During lesson observations, I was a non-participant observer and I tried not to have any effect as possible. Opie (2004) concurs with Cohen & Manion (1994) that, a non-participant observer does not interact with the subjects during data collection. The advantage of being a non-participant was that I was able to take notes during the lessons and I observed the most and intruded the least (ibid). I also avoided eye contact as I was sitting next to the learners because I believe that if you do not look you are not seen. Where learners talked to me, I always made sure that I referred them to the teacher and I smiled back. The other advantage of being a non-participant observer was that the school environment was not familiar to me as I was there as a researcher for five days.

The teacher grouped learners according to their home languages which were Sepedi, Sesotho, Isixhosa and IsiZulu. I focused on one group of learners (isiZulu) when learners were working in groups groups because I understand isiZulu. My home language is Isiswati however; I do understand Isixhosa as well as Ndebele.

Focusing on one group enabled continuity in terms of what they were doing rather than moving from one group to another and getting small pieces from everywhere. Therefore it would not have been possible to focus on the whole class during group discussions. I will refer to this group as the focus group. This enabled me to take field notes of what the learners were saying during group discussions.

Field notes on lesson observations included how the learners used their home languages as a support in solving linear programming tasks, their involvement in group and class discussions, how they responded to their teachers and peers' questions. On the instructional strategies, I noted the extent to which the teacher responded to the learners' needs and how he encouraged learners to use their home languages. Taking field notes during classroom observation helped to keep me focussed.

The disadvantage with lesson observations is that "people might change the way they behave when being observed" (Opie, 2004: 122) by being on guard of what they say or do. To guard against this disadvantage, five consecutive lessons were observed. The teacher and his learners got used to my presence. Another disadvantage with lesson observations is that it does not reveal what learners' think. So I also used clinical interview (see discussion below). Another disadvantage is that observations are influenced by observer interpretations. To guard against this I transcribed the data and interviewed the teacher after I had analysed the data. This enabled me to find out from the teacher if my interpretations were correct and some of the things that the teacher said and did were clarified in the teacher interview, which I now turn to.

3.4.2 Teacher interview

Interviews provide a useful procedure through which it is possible to find out teachers' views about issues arising out of the research. Interviews also

supplement information obtained from observations. In this study, a semi-structured interview was conducted after having observed the five lessons. The semi-structured interview was selected because of its flexibility. Opie (2004: 118) argues that "structured interviews will allow for a depth of feeling to be ascertained by providing opportunities to probe and expand the interviewee's responses". He further argues that the main advantage of semi-structured interviews is that it allows the researcher to clarify questions or rephrase questions as well as probing the interviewee to get a clear understanding.

In this study, I was able to probe for more insights in the way the teacher used the home languages for specific incidents. During the interview, video recordings of the lessons were used to focus the teacher's attention on specific incidents during the lessons observed. Firstly, this was done to probe the teacher on what was happening during those incidents. Secondly, it was aimed at finding the teacher's interpretations of the incidents so that he could question or confirm my interpretations.

The incidents focused on the way the learners' home languages were used as a support in the teaching and learning of linear programming concepts. The teacher was also questioned about his views on the success of how he uses the learners' home languages in multilingual settings. The interview was tape recorded and transcribed. Both verbal and non-verbal behaviour was noted which was an advantage of the interview.

However, interviews present challenges to the researcher in terms of interviewing and listening skills. According to Opie (2004) poor listening and interviewing skills may result in important information being missed during the interview. Furthermore, interviews demand that the interviewer is able to maintain control of the interview, to probe gently, be able to manage personal space and not to be judgemental. Below I discuss the learner clinical interview.

3.4.3 Learner clinical interview

Clinical interview is a face-to-face meeting between the subject and interviewer (Posner & Gertzog, 1982) aimed at eliciting information from the interviewee. The aim is to get the interviewee to speak in order to obtain rich data. The advantage of a clinical interview is that the researcher is able to probe areas of knowledge domain that are of interest. According to Brown & Dowling (1998: 60), "clinical interview is concerned with how people think and how they construct meaning". In addition, Bell (1993) asserts that clinical interviews investigate motives and feelings. The way in which a response is made can provide information that a written response would conceal. For example, tone of voice, facial expressions and body language like gestures.

Clinical interviews were used in this study to gain insights into learner's thoughts about solving linear programming tasks. It was used to dig deeper into the learners' conceptual understanding of the approach used by learners when solving linear programming tasks. The clinical interview is used in my study to gain insight into what goes on in the mind of a subject concerning areas of a particular domain (Fraenkel & Wallen, 1993).

Through the use of clinical interviews I gained insight into the way the learners used the home language. It allowed me to access learners' thinking processes when using the home language. By allowing learners to talk, I had access to the learner's conceptual understanding of the task in their home language. Furthermore, the learners experiences were revealed (Foddy, 1993) thus allowing me to ascertain the extent to which home language can be used to solve linear programming tasks.

The disadvantages of clinical interview are that they take time (Opie, 2004). This is because of the probing that the researcher has to do to ensure that all the

information that is sought is obtained. The other limitation is that the quality of responses depends on the interviewer's skill to probe.

In this study, two learners from the focus group were selected for a clinical interview and they were both tape-recorded. These two learners were chosen so as to limit the size of the study. According to McMillan and Schumacher (1993) samples in qualitative research can range from 1 to 40 or more. This small sample allowed me to conduct an in-depth interview with each learner.

The two learners were interviewed after all the five lessons were observed. During the clinical interview, learners were given a linear programming task in English and the learners' home language (isiZulu) to solve as they explain their thinking. Learners were given an opportunity to choose which language they want to be interviewed in. The interview gave me a chance to probe learners as they explain their thinking while solving the task.

3.4.4 Learner questionnaire

A learner questionnaire was issued before data collection to find the language infrastructure of the class. Another questionnaire was also issued after lesson observation to find the views of the learners about the lesson. Learners indicated their responses by ticking relevant boxes. A second questionnaire was issued at the end of the data collection process. This enabled me to find the learners responses towards the use of their home languages in the teaching and learning of linear programming.

The advantage of administering questionnaire personally is that I was able to explain the meanings of items that are not clear to the learners (Best, 1977). The disadvantage of a questionnaire is that learners may not reveal their actual thoughts of the questions. Next, I discuss how the data that was obtained by the above methods was analysed.

3.5 DATA ANALYSIS

Data analysis is about processing data so that what has been learned can be communicated to others. I transcribed all the data collected from videoing and tape recordings. Both inductive and typological analysis (Hatch 2002) was used in this study. Hatch (2002: 161) defines inductive data analysis as "a search for patterns of meaning in data so that general statements about phenomena under investigation can be made".

In typological analysis, categories are predetermined and could be generated from theory, common sense and research objectives. To analyse the use of learners' home languages in solving linear programming tasks, I generated categories from theory, i.e. Realistic Mathematics Education, which include horizontal mathematisation and vertical mathematisation, planning and carrying out of solution steps, generating explanations, identification of mathematical structures and concepts. I then looked for relationships between the categories in order to put together a series of insights.

Lesson transcripts were categorised according to RME's two dimensions of mathematising distinguished by Treffers (1987), horizontal and vertical mathematisation, in order to explore how the use of learners' home languages enabled learners in solving linear programming tasks. I further divided the two dimensions to subcategories as action to what a learner did or displayed in each category. However, I did not count the utterances in the transcripts because of the qualitative nature of the study. But I traced the development of progressive mathematisation in relation to the interactions. In addition to that, I checked the language used for the utterances evidencing the activity. Below the dimension and subcategories are shown:

Horizontal mathematisation

- Displaying horizontal mathematisation: Any evidence of informal language used in modeling the task. Which include verbalizing, extracting mathematics information using home languages. (HD)
- Reinforcing modeling by learner or teacher providing support to enable learner to model the task (HR)
- Challenging learner to model the task through questioning or probing. (HC)

Vertical mathematisation

- Displaying vertical mathematisation: When learner shows evidence of mathematical language. Which would be displayed by construction of symbols, algorithm and reflecting on the results of mathematising? (VD)
- Reinforcing vertical mathematisation by teacher or another learner to encourage or motivate each other to utilize their understanding of the concepts. (VR)
- Challenging vertical mathematisation by stimulating or provoking learners questioning or probing. (VC)

Data from the questionnaire was analysed using statistics presented in a form of tables, bar charts and pie charts. According to Opie (2004: 142), charts and graphs "can be very valuable methods of presentation of data because people can find it easier to see spatial relationships than numerical relationships".

Before data collection, I had to ensure that all research ethics are adhered to. The next section outlines the steps that were followed in an attempt to consider research ethics in South Africa.

3.6 ETHICAL CONSIDERATIONS

Cohen & Manion (2000) argue that carrying out research demands that the researcher obtains consent and cooperation of the participants and the institutions

that provide research facilities. In this study two institutions are involved. Wits University under whose name the study was conducted and a secondary school in Gauteng whose teacher and learners were involved in the study. Opie (2004) further argues that the issue of access and acceptance is very important in pursuing a study.

In educational research, ethics are about process and power. Issues of process have to do with requesting ethical clearance from the research ethics committee of the University of Witwatersrand and the Gauteng Department of Education (GDE), and gaining access to schools and participants. Issues of power are mainly about the relationship between the researcher and participants. Before embarking on the research, I applied for ethical clearance from the Gauteng Department of Education and from the ethics committee at the University of the Witwatersrand to ensure that the rights of all the people who would be participating in this research are respected (see Appendix Q). I submitted a research proposal that provided the overall picture of the study.

Participants in research have the right to be informed that they are being researched and about the nature of the research. To honour the ethical process as well as ensuring that my research does no harm to the participants, I wrote letters requesting permission to gain access to the school from the head teacher (see appendix G), the subject teacher (appendix I) and the Grade 11 learners (appendix N). I also send letters and consent forms to parents asking them for permission for their children to participate in the study (appendix L & M). In the letter, I made it clear that the learners are not forced to participate.

Participants were assured confidentiality of results, anonymity of school and participants. I made sure that the names of the people involved in the study were not revealed against their wishes. In any of my writings, pseudonyms will be used to protect the identities of participants. They were also made aware that their

participation was voluntary. Data that was collected was kept in a safe and secure place.

Below I discuss the measures that were put in place to minimise threat to validity and reliability.

3.7 VALIDITY

Validity refers to the correctness of conclusions we draw from the data collected. Maxwell (1992) argues that validity in qualitative research is part of the relationship between an account and something outside that account. Validity lies in an account that involves description, inference and explanations. In this qualitative research, not all possible accounts of the teacher, learner or observer will be useful.

Maxwell argues that validity is not an essential property of a particular method but is about the data and conclusion drawn from that data. He further argues that qualitative research depends on five categories of validity, namely: descriptive validity; theoretical validity; interpretive validity; generalizability; and evaluative validity. The data created by this study is conducive to descriptive validity, interpretive validity and theoretical validity of which I present a brief description of each below.

3.7.1 Descriptive validity

Descriptive validity refers to accurate reporting of fact (Maxwell, 1992). In this study it refers to the accurate description of what happened and what was said during classroom observation, and also refers to what was said in the interview. Descriptive validity was achieved by the use of a video camera during classroom observations and tape recorder in the learners' interview and teacher interview.

The video showed verbal and non-verbal features that could be seen by anyone who could reanalyse the data on this research (Opie, 2004).

The use of video camera increased validity in that other people who may be interested in the data can see and hear what the researcher observed. According to Freankel and Wallen (1990) this is a strength in that experts can also see what was observed and offer helpful insights. Using video also provided evidence between interpretations and descriptions. Non-verbal features were easily seen in the video than in the field notes.

3.7.2 Interpretive validity

Maxwell (1992) argues that interpretive validity is concerned with the participants engaged in the study. It is concerned with what the participants and behaviours mean to the people engaged in and with the study. Interpretive validity also refers to a common understanding of the language used by the researcher so that what is interpreted is understood from the participant's point of view.

Interpretive validity was achieved through teacher interview. The teacher interview helped me to understand why the teacher conducted the lesson the way he did so that my experience may be removed from the interpretation of data. The learner interview helped me understand how the learners' draw on their home language when solving linear programming. A colleague, who is fluent in the learners' home languages, checked the interpretations in this study.

3.7.3 Theoretical validity

Theoretical validity refers to an assumption explaining an observable fact. Maxwell, (1992) argues that when facts are determined there may still be differences of opinion on the terms used to explain the situations. Theoretical validity in this study was carefully addressed by using the concepts that RME

employs, which is about how learners go through the stages of horizontal and vertical mathematization when solving linear programming tasks. Below I discuss the issue of reliability.

3.8 RELIABILITY

Reliability refers to "the extent to which a method or a tool gives consistent results across a range of settings and if used by a range of researchers" Wellington (2000 cited in Opie, 2004: 66). In qualitative research, consistency of results cannot be guaranteed because of the bias inherent in individuals. Different researchers may interpret the same data presented differently. Opie (2004) views reliability as the property of the whole process of data gathering.

Factors that may affect consistency, which may then affect the outcome of the study, were related to observer effect, observer bias and use of tape recorders as well as video-tape. I will briefly discuss each factor below.

Observer effect

The presence of an observer can have an effect on the behaviour of the participants. In the case of unexpected observers, Fraenkel and Wallen (1990) argue that they are likely to distract learners such that they do not pay the kind of attention they normally pay in class. In this study, teachers and learners were informed prior of our visit and its purpose. They were arleted about the video recording of the sessions with the hope that they would not pay attention to the video.

Furthermore, to minimise this effect, five consecutive lessons were recorded so that learners got used to the presence of researchers and their camera in their class. Ary, Jacob & Razavieh (1990) asserts that after a few observations, participants pay little attention to the observers.

Observer bias

The researcher, as an instrument in qualitative research, possesses characteristics or ideas that may bias what they see or hear (Ely, 1991). The limitation of collecting data in this way is that the researcher is not totally objective in that even when using a video camera, she is selective in what she chooses to record. The same goes for clinical interviews as well as reflective interview where probing may be done with a certain bias. In the case of clinical interview, this effect was minimised by asking questions while the learner was solving the task. In reflective interview, video recordings of the lesson were used to focus the teacher's attention on specific incidents.

Use of video tapes and tape recorder

Sometimes it is difficult to record what is seen and heard. It is even more difficult to record the gestures and facial expressions that convey certain feelings of teachers and learners in classroom observations, during clinical interview and reflective interview and yet these could be valuable data. To overcome these shortcomings, the video camera was used to capture the events in the classroom observation. Clinical interview and reflective interview were tape recorded. The use of the video camera increase reliability of the data in that other people who may be interested in the data can hear or see what the researcher observed. Fraenkel & Wallen (1990) view this as strength in that experts can also see what was observed and offer helpful insights.

Reliability in the interpretation of data

Transcription of data ensured that all what was said and observed was re-represented on paper for careful analysis and interpretation. Observation and interview transcripts and audio tapes were given to a second person to check for accuracy of the transcription. The analysis was given to the teacher to check the inferences made to make sure that they are in agreement with the transcript. Research questions which guided the inquiry were also used to guide open coding, which was used to form categories that were used to interpret data. The

interpretation of data was guided by horizontal and vertical mathematisation as discussed in section 3.5. According to Opie, (2004) writing a report is a way of exchanging ideas. It is important that readers of my research feel convinced about statements made.

3.9 CONCLUSION

In this chapter, I have indicated that this study is using the qualitative approach. Classroom observations, teacher interview, learner clinical interviews and a learner questionnaire were the methods of data collection in this study. I mentioned that the lessons were observed over a period of five days. I highlighted the advantages and disadvantages of the methods used as well as the instruments.

The analytical framework provided a description of how data were analysed and interpreted. The data reduction process followed a typological analysis process proposed by Hatch (2002). This strategy involved generating or identifying categories (typologies). The labels were mainly related to RME constructs.

Issues of ethics, validity and reliability were discussed. I pointed out that findings of this study are not meant for generalization. However, the use of video camera and tape recording ensured that everything that was said would not be missed.

In the next chapter, I provide an analysis of a learner questionnaire issued before classroom observation to describe the language infrastructure of the Grade 11A class.

CHAPTER 4

ANALYSIS OF LEARNER QUESTIONNAIRE

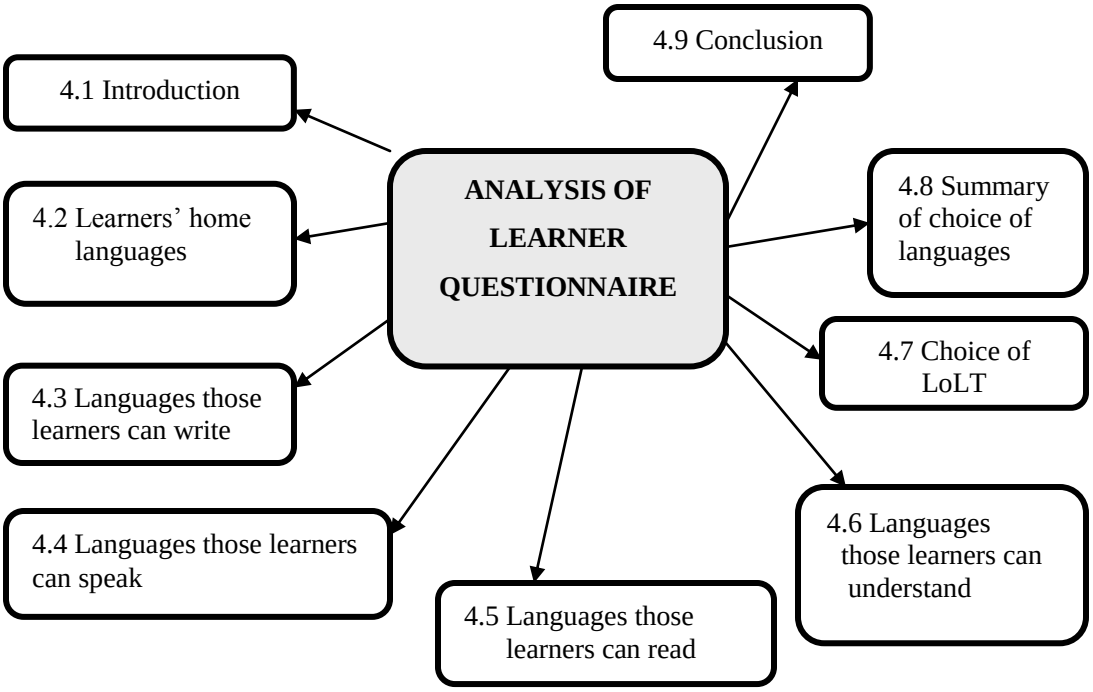

Figure 4.0: An overview of Chapter 4

This chapter describes the language infrastructure of the Grade 11A class.

4.1 INTRODUCTION

This section presents an analysis of data collected through a learner questionnaire issued before classroom observations. The aim was to find the language infrastructure of the Grade 11A class I observed. The language infrastructure of Grade 11A show that the learners in this classroom are multilingual that is, each one of them can speak, read, write or understand at least four languages. Therefore, the strategy of grouping learners into their home languages enables learners to interact in any language they feel comfortable.

The analysis illustrate that in addition to their home language, learners are able to communicate in other African languages. I will first present an analysis of the home languages of the learners. It is also worth mentioning that these home languages are the languages learners are studying. I will first look at the learners' home languages.

4.2 LEARNERS HOME LANGUAGES

Table 4.1: Learners home languages

Home languages	Number	Percentage (%)
IsiZulu	6	13
Sesotho	15	33
Sepedi	18	39
Isixhosa	5	11
Tsivenda	0	0
Setswana	1	2
Isiswati	1	2
Xitsonga	0	0
Afrikaans	0	0
Isindebele	0	0

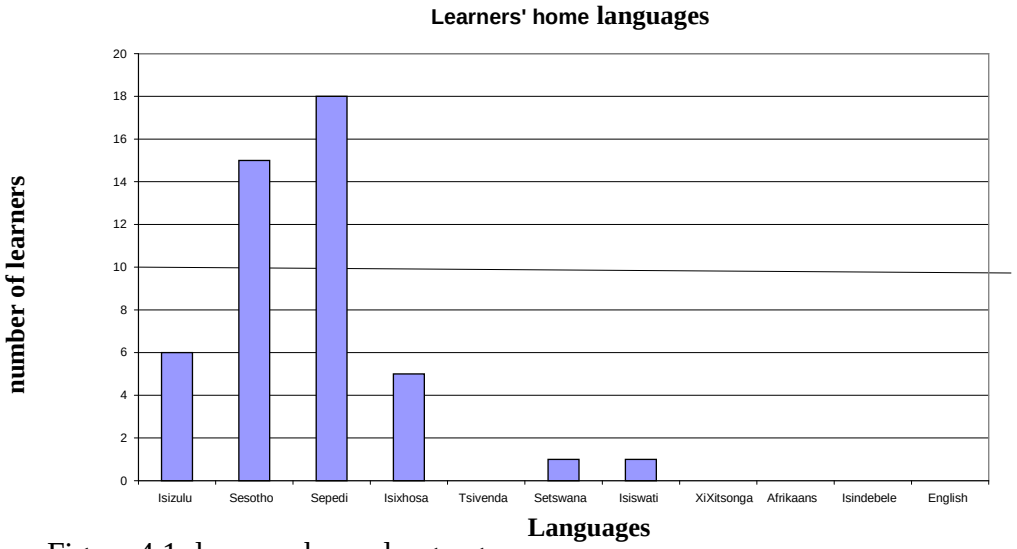

Figure 4.1: learners home languages

Out of the eleven official languages in South Africa, Table 4.1 and figure 4.1 show that the learners' home languages were Sepedi, Sesotho, IsiZulu, Isixhosa, Setswana and Isiswati. There were no learners who indicated that their home language was Tshivenda, Xitsonga, Afrikaans, Isindebele and English. Most of the learners (39%) in this class had Sepedi as their home language, followed by Sesotho with 33%. So when learners were grouped according to their home languages there were three groups of Sepedi, three groups of Sesotho, one group of isiZulu and one group of Isixhosa. The next table presents an analysis of the languages that the learners indicated fluency in writing.

4.3 LANGUAGES THOSE LEARNERS CAN WRITE

Table.4.2: Languages those learners can write

Languages	write	Percentage
IsiZulu	10	21
Sesotho	12	26
Sepedi	16	35
Isixhosa	5	11
Tsivenda	0	0
Setswana	2	4
Isiswati	0	0
Xitsonga	0	0
Afrikaans	0	0
Isindebele	0	0
English	46	100

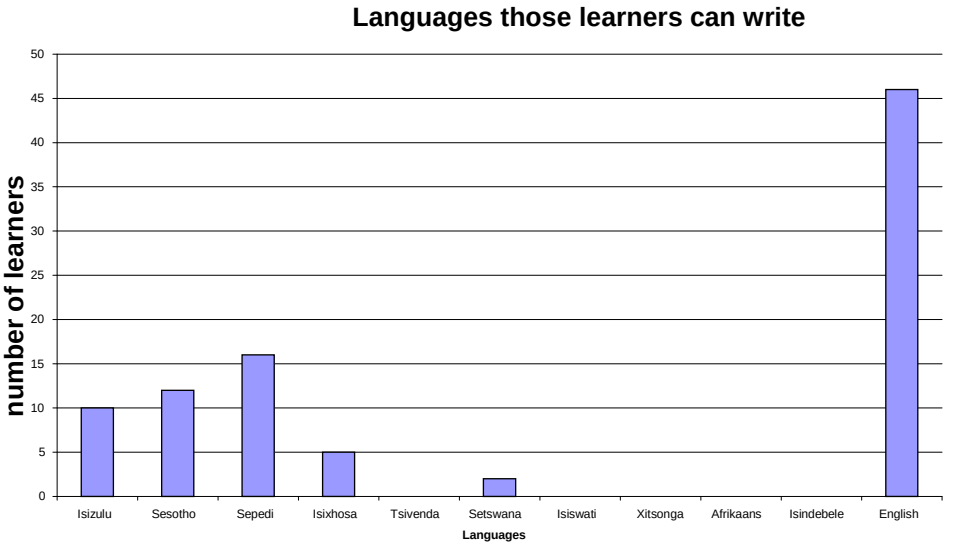

Figure 4.2: Languages those learners can write

All the learners in this class indicated that they could write English. This is not surprising because English is the language of learning and teaching in this school. However, the number of learners who can write the home languages changed. Some learners did not feel confident to write in their home languages, but did feel confident to write in another home language.

The number of learners whose home language is IsiZulu is six as shown in table 4.1, the number of learners who felt confident to write IsiZulu was 10 as shown in table 4.2. Five of them were learners whose home language is IsiZulu and five learners were learners with other home languages. This means that some learners felt that they could write IsiZulu, even though it is not their home language. Two learners had Isixhosa as their home language, two learners whose home language was Sepedi and one learner whose home language was Isiswati. There was one learner who indicated that he is not confident in writing IsiZulu even though it is his home language. Other learners felt confident to write in their home languages and none of the learners could write Tshivenda, Xitsonga, Afrikaans and Isindebele.

The next analysis represents languages that the learners indicated that they have fluency in speaking.

4.4 LANGUAGES THOSE LEARNERS' CAN SPEAK

Table 4.3: languages those learners can speak

Languages	speak	percentages
IsiZulu	22	48
Sesotho	18	39
Sepedi	22	48
Isixhosa	6	13
Tsivenda	0	0
Setswana	4	9
Isiswati	3	7
Xitsonga	2	4
Afrikaans	0	0
Isindebele	2	4
English	39	85

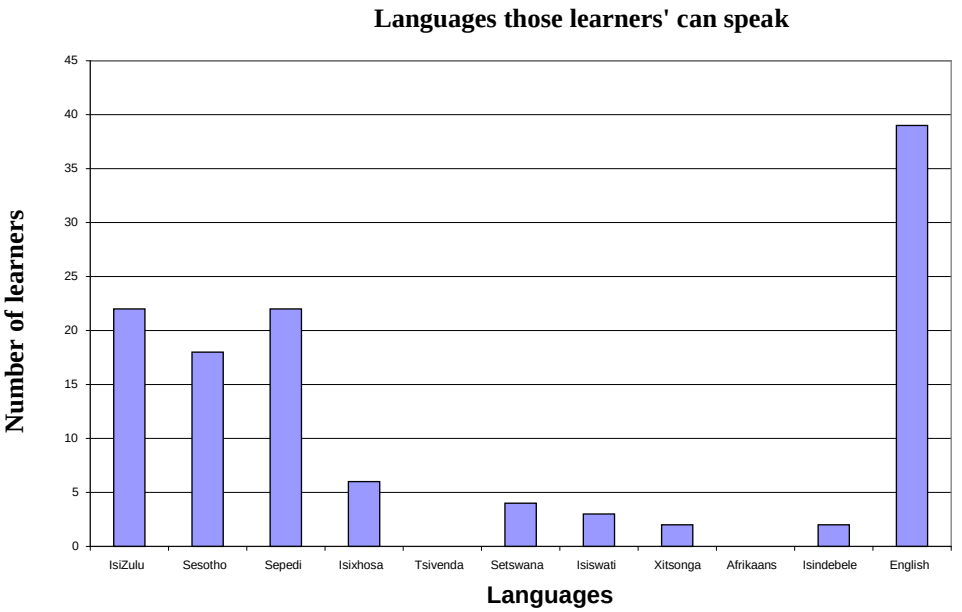

Figure 4.3: languages those learners can speak

The data shows that learners share fluency in the speaking of the languages. Even though their home language is IsiZulu, they are still able to speak other languages. Alternatively, even though their home language is Sepedi, they are still able to

speak other languages. It was therefore not surprising to hear learners speaking other languages even though it was not their home language. IsiZulu and Sepedi are the languages spoken by 48% of the learners in this class. Seven of the learners indicated that they could not speak English even though they are studying the language. The next data will look at languages that learners can read.

4.5 LANGUAGES THOSE LEARNERS CAN READ

Table 4.4: Languages those learners can read

Languages	read	Percentages (%)
IsiZulu	13	28
Sesotho	13	28
Sepedi	17	37
Isixhosa	5	11
Tsivenda	0	0
Setswana	2	4
Isiswati	0	0
Xitsonga	0	0
Afrikaans	0	0
Isindebele	0	0
English	46	100

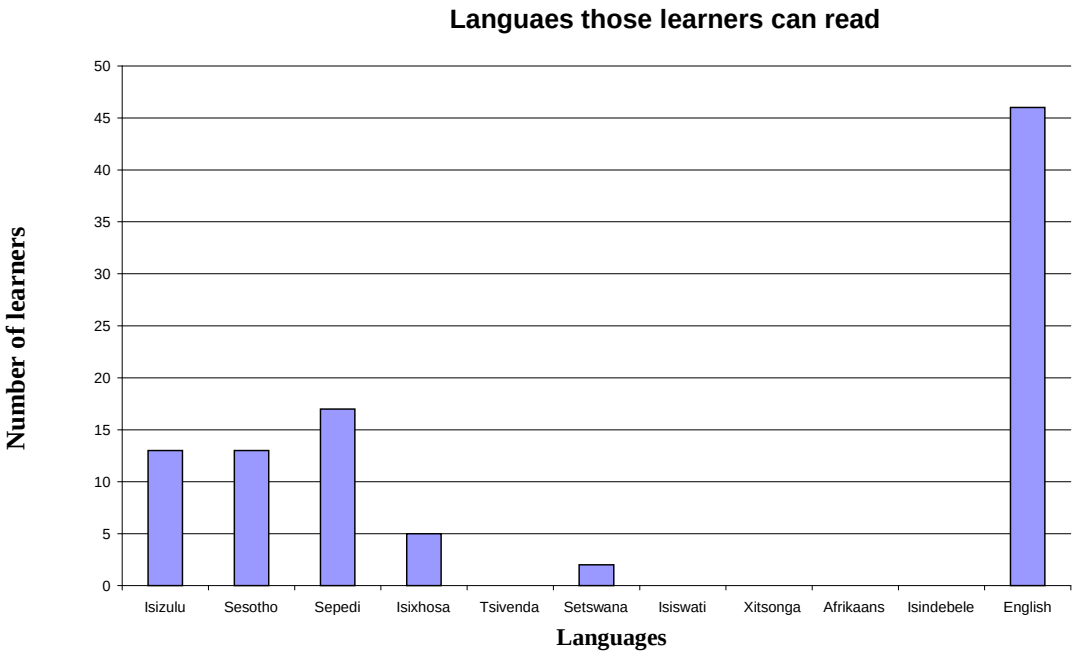

Figure 4.4: languages those learners can read

The data shows that some learners cannot read in their home languages. One learner from IsiZulu group, two learners from Sesotho group, one from Sepedi group and one Isiswati indicated that they could not read in these home languages. The data also shows that other learners are able to read other languages, like IsiZulu even though it is not their home language. All the learners indicated that they can read English. The next section will look at languages that the learners can understand.

4.6 LANGUAGES THOSE LEARNERS CAN UNDERSTAND

Table 4.5: Languages those learners can understand

Languages	understand	Percentages (%)
IsiZulu	28	61
Sesotho	17	37
Sepedi	24	52
Isixhosa	12	26
Tsivenda	2	4
Setswana	8	17
Isiswati	3	7
Xitsonga	3	7
Afrikaans	0	0
Isindebele	1	2
English	45	98

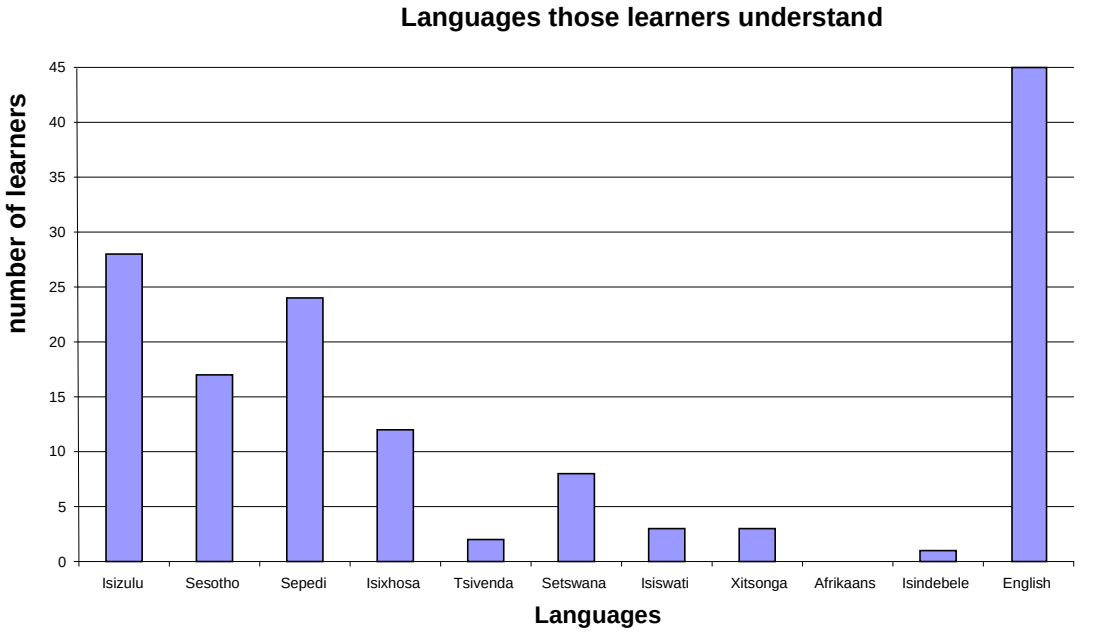

Figure 4.5: Languages those learners can understand

The learners indicated that they understand other languages; IsiZulu is understood by 61% of the learners followed by Sepedi, which is understood by 52%. 98 % of the learners indicated that they could understand English, the language of learning and teaching. This indicates the multilingual nature of the classroom and indeed of many multilingual societies. The fact that even if people do not have a language as their first and are not able to speak, read or write it, they are still able to understand it. It would not be surprising thus to find students talking to one another in multiple languages. This was evident during classroom discussions.

I will now look at the learners' views concerning the choice of language when learning mathematics. Learners indicated their choice of language as follows:

4.7 CHOICE OF LANGUAGE

Learners were to indicate a language they would choose to learn mathematics if they were given a choice to choose. Learners' choices are indicated in Table 4.6 and figure 4.6.

Table 4.6: Choice of language when learning mathematics

Languages	Number of learners	Percentages (%)
IsiZulu	2	4
Sesotho	8	17
Sepedi	8	17
Isixhosa	1	2
Tsivenda	0	0
Setswana	1	2
Isiswati	0	0
Xitsonga	0	0
Afrikaans	0	0
Isindebele	0	0
English	32	70

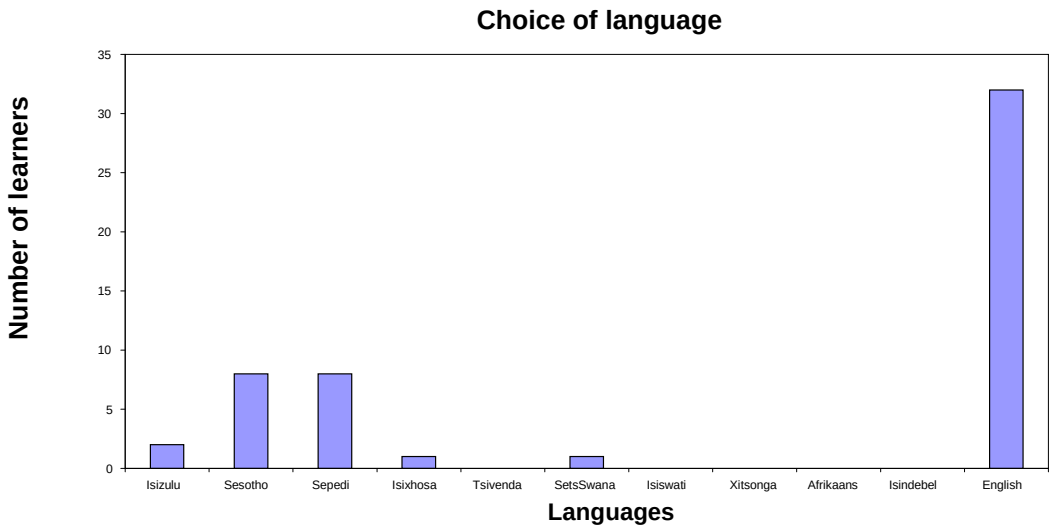

Figure 4.6: Choice of language when learning mathematics

The data in table 4.6 shows the languages preferred by the learners and 70% of the learners preferred to learn in English. Further analysis of the data shows that the choice of languages preferred by the learners when learning mathematics was in three categories as follows:

a) Learners' preferred to learn mathematics in their home language only,
b) Others preferred to learn mathematics in English and home language
c) Others preferred to learn in English only.

I will further look at the analysis of the data in terms of the three categories I have mentioned.

4.8 SUMMARY OF CHOICE OF LANGUAGES

I will now look at the same data in table 4.6 to show that some learners preferred to learn mathematics in English only while others preferred to learn mathematics both in home language and in English and others preferred home language only. The analysis shows that 61% preferred English only. A recent analysis of why learners prefer to be taught mathematics in English only suggests that these

learners are concerned with access to “social goods” and as a result do not focus on epistemological access but argue for English as the language of learning and teaching (Setati, 2006).

Table 4.7: Summary of choice of language

Choice of language	Number of learners	Percentages (%)
English	28	61
English & home language	7	15
Home language	11	24

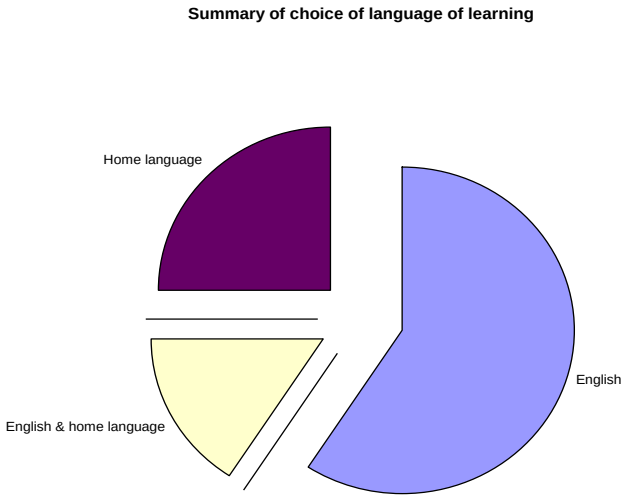

Figure 4.7: summary of choice of language

Some learners preferred to learn mathematics in their home language as 24% of the learners preferred home language only and 15% preferred to learn mathematics in both home language and English. According to a study reported in Clarkson (2007) children switch between languages when solving mathematical tasks. Therefore it is important that the learners’ home languages are regarded as legitimate languages of interaction and that they may be used in a range of mathematical Discourse (Setati 2005). In the use of the learners’ home languages, the teacher would be creating opportunities for learners to exchange a few words in their own thinking as well as challenging each other.

4.9 CONCLUSION

The data I presented in this chapter show those learners in the Grade 11 class I observed could interact in more than one language. The analysis shows the common feature of most South African classroom. This is that most learners in these classrooms are multilingual. It was therefore not surprising to see students switching languages. Khisty (1995) contends that a classroom that is rich in language facilitates learning among children.

The data also shows that 61% of the learners preferred to learn mathematics in English only. Some learners did indicate that they preferred to learn mathematics in their home language. The analysis does not show how the teacher and learners used the home language. The next Chapter will look at an analysis of data collected through lesson observation.

CHAPTER 5

DATA ANALYSIS: CLASSROOM OBSERVATION

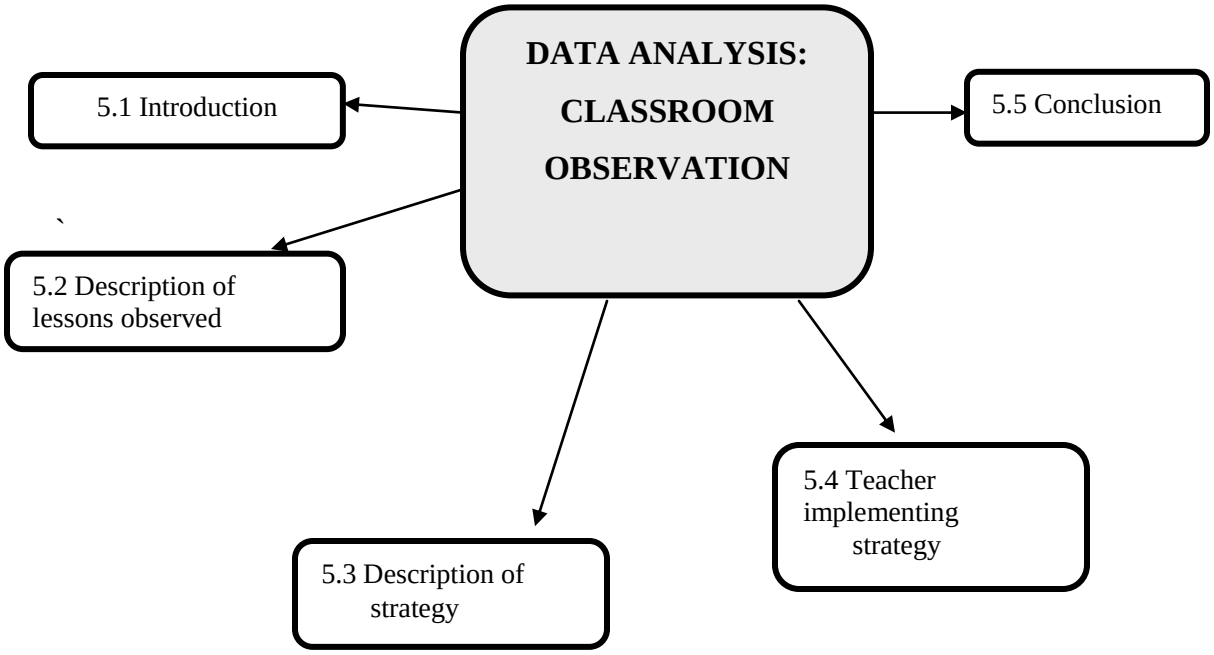

Figure 5.0: An overview of Chapter five

This chapter presents an analysis of data collected through classroom observation.

5.1 INTRODUCTION

This chapter presents the analysis of the data collected through lesson observations and teacher interview. The observations were a window through which to look at how the teacher implemented the strategy of using learners' home languages when teaching linear programming. I first present a description of the lessons observed followed by how the teacher implemented the strategy in Grade 11A. I will then present an analysis of the teacher negotiating the meaning of the phrase 'at least' and the phrase 'at most'.

5.2 DESCRIPTION OF THE LESSONS OBSERVED

The Grade 11A class observed had 46 learners in total, 19 girls and 27 boys. The pupils interacted with the teacher very well during class and outside class. The manner in which they interacted with their teacher inside and outside classroom suggested that they have a good relationship. I observed five consecutive lessons focusing on linear programming.

The first two lessons observed focused on the meaning of the two phrases 'at least' and 'at most'. This may possibly be the consequence of introducing a new idea with its mathematical language. The analysis shows that the teacher encouraged learners to draw on their home languages in order to understand the key concepts in linear programming. The section below provides a brief overview of the lessons observed.

Lesson 1

To introduce the first lesson, the teacher mentioned that they will be looking at linear programming and he started by asking the learners for the meaning of the concept linear programming. He then gave examples of the application of linear programming as well as the definition of linear programming. The teacher gave

learners tasks on sheets written in both English and learners' home languages - IsiZulu, Sesotho, Isixhosa and Sepedi. The tasks were exploring the meaning of the phrase 'at least'. The teacher made learners aware that they were free to interact in whatever language, home language or English.

Learners discussed the tasks in groups, which was according to their home languages as mentioned in the methodology section in Chapter 3 Section 3.3.2. After discussing the task as groups, whole class discussion of the groups' responses to the task followed. The teacher mentioned that he would choose any member of the group to present the groups findings to the whole class. During group discussions, there was extensive interaction in the learners' home languages as well as English and code switching. During the whole class discussion, the teacher communicated with learners in English and isiZulu. Learners were also mainly communicating in English and their home languages.

Lesson 2

The second lesson started with the teacher going over the meaning of the phrase 'at least' in different home languages as well as the mathematical meaning. The meanings of 'at least' in the learners' home languages were 'okungenani' in isiZulu, 'buncinci' in Isixhosa and 'bonnyane' in Sepedi and Sesotho. The mathematical meaning of the word 'at least' was identified as 'minimum' and the symbolic representation was 'x greater than or equal to 10' and was denoted as $x \geq 10$ in relation to the task they were solving.

The teacher then gave learners a task to solve first as a group. The task was exploring the meaning of the word 'at most'. Like in day one, whole class discussions of the groups' findings followed. The mathematical meaning of the word 'at most' was identified as 'maximum' and the symbolic representation was x less than or equal to 150 which was denoted as $x \leq 150$ in relation to the task they were doing. The teacher was moving from group to group to check what

learners were doing and help them if they had any problems with the tasks they were solving.

Lesson 3

The third lesson started with the teacher reviewing the meanings of the word ‘at least’ or ‘minimum’ amount and ‘at most’ or ‘maximum’ amount. He also asked learners to give symbolic meaning in relation to the tasks they were solving on day 1 and day 2. The teacher mentioned that in most cases *x* and *y* are the symbols used to represent an unknown, but it can be any symbol.

The teacher then gave learners a task which required them to find constrain inequalities as well as drawing graphs to show the feasible region. They first discussed constrain inequalities before sketching the graphs. It took them time to find the constrain inequalities. The teacher gave them an example of a hairdresser who specialises on platting singles and dreadlocks. They discussed the example, came out with restrictions and then related the example of a hairdresser to lesson three’s task. Learners were able to find the restrictions. However, they had to draw the graphs as homework.

Lesson 4

The fourth lesson started with the teacher going over homework where learners had to sketch a graph to show the feasible region for day three task. Before sketching the graph, the teacher asked learners to write down the inequalities they had to sketch. The teacher called on one student to sketch the graph on the board, he asked the student to explain to the whole class what he was doing. He also invited the rest of the class to assist where necessary.

After drawing the inequalities and showing the feasible region, the teacher noted that part of the shading does not belong to the feasible region. He asked learners if

the shading was correct and it took them some time to notice the part that was not suppose to be shaded. The teacher gave learners a task to solve on day four. The task-required learners to find constrain inequalities as well as the objective function. Interactions continued to be in a mixture of the learners' home languages and English.

Lesson 5

The fifth lesson started with the teacher distributing tasks, which learners had to solve first as a group, and then followed by whole class discussion. The class continued to solve linear programming task and they were now familiar with the language of linear programming. Learners were able to find the symbolic representation of the statements as well as the objective function

The teacher then asked learners to draw the graph to show the feasible region. Learners were able to draw the graph and they then calculated the values of the objective function to find the minimum cost.

Classroom observation on day five was followed by issuing of a learner questionnaire where learners indicated their views about the use of their home languages in the teaching of linear programming. A clinical interview of two learners selected from the isiZulu group was conducted after the learner questionnaire. During the interview, learners solved a task. I was asking them question as they were solving the task. The next section shall look at a description of the strategy used by the teacher in this study.

5.3 DESCRIPTION OF STRATEGY

The strategy involves the deliberate use of the learners' home languages. The word deliberate is emphasised because the use of the learners' home languages is "planned and not impromptu as it usually happens with code switching in

multilingual classrooms" (Setati, Duma, Nkambule, Mpalami and Langa (2007: 4). The strategy views the learners' home languages as a transparent resource. The tasks given to learners are in multiple languages and there are occurrences where learners answer to the questions in their home languages. Learners are also encouraged to use their home language when interacting during the lessons.

The strategy also involves the selection of real world interesting and challenging tasks, whereby learners "experience a process similar to the process by which mathematics was invented" (Gravemeijer, 1994:90). According to Freudenthal (1991), the students should experience mathematics as common sense. Goffree (1993: 42) contends that:

> Initially one has a lot of natural common sense but when challenged by rich contexts, inspired by the opportunity to make inventions oneself and guided by someone who knows about mathematics when looking for more certainty, then common sense would be enriched with mathematics.

The tasks presented to the learners involved mathematical authentic contexts like borrowing money, Mandla cinema, a farmer and a hairdresser. In RME terms the tasks should be real in the minds of the learners so that they can experience the problem as real and relevant as shown in the following extract for lesson 2 task.

287	Mkhonta	Awuthi ngicale ngaloya masesikhuluma ngerisk, ngerisk lomuntu angeke kuthi nakucala ibusiness kufika abantu abawu 39 ngizishila ngibheke ukuthi kulandelani. Lomuntu lo ulethe inkinga kusho ukuthi labantu laba ngibo abahlala beza. And uyaluza lomuntu lo, hhayi ukuthi iyacala ukwenzeka lento le sekuyisikhathi yenzeka. [Let me respond to the first one about risk in business, the person will note when starting the business that there are at first 39 people and then look at the next number. This person has a problem; it means the 39 people are the ones who always come for the show. And he. He has brought the problem to us to solve. This is not the first time such a thing happen, it has been going on for some time]

The extract illustrate that the task was real in the mind of the learner as he argues "the person has brought the problem to us to solve". To him the task was relevant, as it required a solution to the problem of 39 people. The tasks attracted the learners' attention and encouraged them to engage in mathematical thinking as

well as discussion. The tasks made it possible for students to produce mathematical arguments and to support their claims in their home languages. Elbers (2003) argue that mathematics taught and learned in this way, loses its character as school mathematics because it "helps students to connect everyday knowledge and mathematics and to enrich common sense". (p. 79). These tasks which were presented to the learners served as a starting point for the learners to develop mathematical understanding.

The next section will look at how the teacher implemented the strategy in Grade 11A.

5.4 ANALYSIS OF HOW THE TEACHER IMPLEMENTED THE STRATEGY

This section will focus on how the teacher implemented the strategy of using learners' home languages in the teaching of linear programming. The data presented and discussed in this chapter examine:

- How the teacher used the learners home languages deliberately in the teaching of linear programming
- General implementation of the strategy:
    - Approaches adopted
    - Teacher-student interactions
    - Implementation of the strategy
        - To help learners in modelling the tasks, horizontal mathematisation
        - To help learners do vertical mathematisation

5.4.1 Teaching a mathematics classroom

Classroom environment

During the lessons observed, the teacher encouraged inquiry where all the learners had mutual respect and listened to each other's ideas. Although he did not formally develop written classroom norms, he did set up expectations regarding how they should interact with one another. He was facilitating as well as keeping an eye on the learners' behaviour, as they were engaging with the tasks. The extract below is a typical example of how the teacher set up a classroom environment that ensured that learners were listened to and respected.

22	Teacher	Khulumela phezulu Thato [Speak louder]
55	Teacher	yes listen carefully, yes
90	Teacher	All right all right asizwe la [let us listen to this one] listen

In the above extract, the teacher appealed to learners to listen to the student who was explaining. The teacher used the words, "yes listen carefully, yes" in utterance 55 and "let us listen to this one" in utterance 90. Using the words "let us listen to this one" shows that the teacher was urging the whole class to respect the learner who was talking. The teacher was also concerned that each learner in class heard clearly, what was being said. While the teacher was creating opportunities for learning by urging the learners to listen to each other, he also encouraged those who were explaining to others to speak louder. Like in utterance 22, the teacher said, "speak louder". This is a clear indication that the teacher wanted to create a classroom environment in which students make their thoughts and solutions explicit (Elbers, 2003, Lampert, 2001). According to Mercer (1995), students have to reveal their ideas and make them noticeable by putting them into words.

Yackel and Cobb (1996) argue that classroom norms can be established in which students justify their mathematical claims instead of turning to the teacher like in utterance 255 below.

255	Teacher	Okay, okay, alright okay akebajustifaye ipoint labo okay [Okay, let them justify their argument]

The teacher also appreciated the learners' attempt by using statements like 'very good'. In my view, he was appreciating their thinking as shown by the following extract:

548	Takiso	Thishela, first of all we are talking about cows here
549	Teacher	Yes very good we are talking about cows here. Case closed.
551	teacher	Yes, very good. We are talking about living things here. Do you have negative cow? Okay okay yes

The kind of environment that the teacher created here shows that the teacher wanted everyone to be responsible for his or her learning. Elber (2003: 81) asserts, "Encouraging students to take part in a community of inquiry changes work in the classroom. It asks of students to make their thoughts and solutions explicit".

In a community of inquiry, the interactions created an opportunity for students to argue for their ideas meaningfully and to be able to explain meanings in order to be challenged by other students and improve on them. For example in the extract below:

406	Teacher	Woza, then you must explain. You explain everything you don't just write you explain everything. I said you talk and explain. Mkhonza explain please.

The above extract suggests that the teacher encouraged communication among learners which made lessons more interactive through discussions in appropriate ways, to produce spoken and written texts in an appropriate form thus encouraging participation. While learners were engaged in discussions in which their ideas were of central interest to the discussions in the lesson, the teacher also encouraged learners to ask questions as shown in the following line.

444 Teacher But anikabuyi la. Anikacabangi iquestion kucala. [But you have to come back to this one here. You did not think of a question first.] You don't want to reason Grade 11 A. My question is simple, ukuthi [question is] $x > 1$ $y > 1$. How can you question that? You must question that. $x > 1$, $y > 1$ you must question that, how can you question that Yes Brandon, yes Errol

Allowing learners to ask questions if they did not understand enabled them to construct meaning together. It also resulted in learners coming into agreement over the sense of their different meanings. The ideas presented by learners were discussed and learners benefited from the discussions. In my view learning mathematics in this manner implies that it is being able to say things and share meaning of concepts. The section that follows discusses the types of interaction in the classroom.

Types of interaction

The teaching approach followed by the teacher was that of group work followed by whole class discussions in all five lessons observed. During group work, the teacher moved around in groups assisting and stimulating where necessary. Group members solved linear programming tasks written in both English and the learners' home languages. Learners discussed and exchanged ideas on what they were thinking about the task in their home language.

During the whole class discussions, learners reported their group findings, which in some cases; learners gave examples to compliment their response to the task. Reporting of findings by groups gave learners an opportunity to voice their own deliberations and make them available to the whole class. Other learners asked questions based on the group findings. All members prepared themselves to answer because they were not sure when they would be asked to present their findings as the teacher had pointed out that he will choose any member of the group to present the groups findings as shown by the following extract.

49 Teacher Ngizozikhethela ukuthi kulegroup ngithatha bani, kulegroup ngithathabani azosichazela. Angithi nicale nayi-discusa as a group [From the different groups, I shall select one person to explain to us. You started off in a group discussion.]

The above extract suggests that the teacher was encouraging a free exchange of relevant ideas and the active participation of all involved in the group discussions. Suggesting that the teacher and learners used language as a resource with which to construct, negotiate and communicate mathematics meaning.

In whole class discussion, the teacher was able to insert elements of interactive processes into his teaching. Finding constrains inequalities occupied most of the time of the lessons. In RME terms, the teacher created a learning environment in which students were actively engaged in sense making. The teacher's approach promoted horizontal and vertical mathematisation, which create opportunities for sharing and negotiation of meaning of concepts.

The next section presents an analysis of how the teacher implemented the strategy on day 1. In this lesson, the teacher planned to start with students' existing ideas and understandings about linear programming.

5.4.2 Implementation of the strategy

This section investigates opportunities that the teacher made available for learners to solve linear programming tasks. One of the aims of using the learners' home languages had been to support the learners' engagement with linear programming tasks during the lesson.

This section will attempt to:

- Establish how the Teacher was implementing the strategy in his classroom
- Explore and discuss any evidence of what the teacher was doing to support learner engagement with the tasks.
- Discuss teacher-students interaction in the classrooms
- Discuss student-student interaction in the classroom

Teacher implementing strategy of using learners' home language deliberately

In the analysis below, I use excerpts from transcripts of lesson to support the claims that I make about how the teacher used learners home languages deliberately in the teaching of linear programming.

On day one, the teacher encouraged learners to use their home languages when expressing their views. The teacher started by telling learners that they will be looking at linear programming and he asked learners to define linear programming encouraging them to use their home languages during the lesson as shown in excerpt 1 and 2.

Episode 1: Definition of linear programming

Excerpt 1

10	Teacher	Right okay, as you know that today we are going to look at linear programming. What is linear programming? … And remember one thing you are free to express in your mother tongue. Just tell me that what you understand by the word Linear programming?
17	Errol	I think linear programming is taking into account certain conditions.
18	Teacher	certain conditions. What is LINEAR PROGRAMMING mawucabanga mayithatha those certain conditions conditions kufanele ini?[(What is LINEAR PROGRAMMING when you think of it taking those certain conditions, condition is it how it should be?]
19	Errol	Like may be lets say you have a store you are selling different particulars you have to dertemine profit. And how many products are you going to use..(inaudible)

In utterance 18, the teacher code switches, English and isiZulu, his home language, to encourage the learner to explain what he meant by certain conditions in his home language. This suggests that the teacher used isiZulu as a resource to encourage learners to regard their home languages as resources in the mathematics classroom. He further asked for other suggestion from the other learners for the definition of linear programming, encouraging them to use their home languages as indicated in the following extract.

Excerpt 2

20	Teacher	Okay omunye uthini mawuzwa nje legama elithi linear programming ucabangani nje. Yes Xhakaza mawuzwa nje legama elithi linear programming noma **ungathetha** sisi yes Thato [Anyone with a different suggestion, when people talk about the word Linear programming what comes to mind. Yes Xhakaza, **you can use IsiXhosa**, any suggestion on linear programming you can put forward your suggestion yes Thato.]
39	Learner	Maybe it involves ka number line eh straight line
40	Teacher	Why straight line?
41	Learner	Because linear
42	Teacher	Linear, that is what I was looking for, mawukhuluma ngelinear ukhuluma ngestraight line [.. when you talk about linear you are talking about a straight line], because you have been doing linear graphs. Ngithi uma umuntu ekhuluma nge linear leloyaziyo asikakhulumi ngen..ngekuthi nje nakunegama elithi linear [I am saying that if a person talks about a linear that you know we have spoken about, it is just that when there is a word that mentions linear...] you think of a ....

The teacher solicited learners thinking (utterance 20) in isiZulu to encourage them to use their home languages. His use of isiZulu encouraged learners to use their home languages. According to Moschkovich (1999), learners tend to use the language used by the interlocutor. In utterance 20, the teacher encouraged Xhakaza to draw on her home language, isiXhosa, when defining linear programming. Through the interaction the teacher managed to encourage the learners to use their home languages.

The interaction started in English and changed to learners' home languages. The teacher initiated the switching in utterance 18. Furthermore, the teacher solicited students thinking of what linear programming meant and he wanted learners to relate linear programming to linear functions (utterance 42). This suggests that the teacher was constructing a relation between what they have been doing to what they would be doing. According to Elbers (2003: 80), the teacher wanted learners to "use their understanding of the mathematical means already available to them".

The teacher provided a rationale for the practical importance of linear programming and some example of contexts in which linear programming is applied. He further gave them a definition of linear programming as follows:

44	Teacher	Linear programming is about maximising the profit and minimising the loss…that whatever you are doing make it a point that you maximise the profit and minimise the losses.

The teacher then gave learners tasks written in English and learners home languages to solve first as a group and then followed by class discussion of the group's findings.

The next section will show how the teacher negotiated the meaning of the phrase 'at least' during lesson one in a teacher led whole class discussion. The task made language demands on the learners. Individuals were required to make meaning constructions from the written text and then interact with others in their group to construct shared meanings about the task. They would then transform the shared meaning into written text in English or their home languages.

Teacher deliberately using learners home languages to support learner engagement with the tasks

The section focuses on how the teacher worked with the learners to develop progressive mathematisation of the meaning of the phrase 'at least'. One way of demonstrating that the deliberate use of the learners' home languages led children to mathematising tasks is in looking at the learners' contribution during whole class discussions.

Learners engaged with the phrase 'at least', attention shifted from the informal meaning to the mathematical meanings, making a further step in the development of meaning of the concept, which is level raising (Freudenthal, 1991). The following episode shows how deeper understanding of the phrase 'at least' facilitated communication. Furthermore, learners showed understanding by introducing appropriate words like 'bonnyane', 'buncinci', 'okungenani' [minimum] in response to the following task, which was starting from real world context of borrowing to develop mathematical meaning of the phrase 'at least':

English version
a. If I say to you borrow me at least *R10* how much money do I need?

IsiZulu version
a. Uma ngithi kuwe ngiboleke okungenani amarandi alishumi, ngidinga malini?

Figure 5.1: Task on day one

The task provided means of eliciting learners' meanings of the phrase 'at least'. The teacher was accorded the opportunity to make visible what seemed to be conceptual difficulties as well as inappropriate use of mathematical language when learners were explaining the meaning of the phrase 'at least'. Explaining enabled verbalisation using mathematical language. According to Adler (2002), verbalisation can be a tool for thinking and a tool for teaching in that by verbalising, learners display what they are thinking or what they know.

Learner's responses revealed that some learners did not understand the home language meaning of the phrase 'at least' in the home language version. Lack of understanding was more pronounced when learners were using English like in the following excerpt:

Episode 2: Teacher negotiating meaning of "at least"

Excerpt 3

57	Mantombi	Any amount below R10 because at least any amount below R10.
58	Teacher	Asikhulumi I-English angithi asifuni English or Afrikaans ama foreign langauge sikhuluma ngesipedi, Uthi malini sisi [We are not speaking English because we don't want English or Afrikaans which are foreign languages we speak in Sepedi. How much do you say it is sister.]
59	Mantombi	R10 Any amount below R10, any amount below R10

It appears that Mantombi's meaning of the phrase 'at least' is less than or equal to R10. This meaning is evident in utterance 57 and 59. This suggest that the teacher was able to identify what seemed to be conceptual difficulty which led to him to encourage the learner to draw on her home language, Sepedi, instead of using the

phrase ‘at least’. However, the learner continues to use English to show that her understanding of ‘at least’ R10 is any amount below R10. In the extract below, the teacher elicited ideas from other Sepedi groups to express their understanding of ‘at least’.

66	Teacher	Akesizwe omunye weSepedi, yes [Let us hear someone who speaks Sepedi]
70	Lsi	Thishela bonnyani (*using gestures pointing downwards*)[Sir, it means minimum]
71	Teacher	Okay uthi ithi bunnyani, [okay, you say it means minimum] yes

The teacher deliberately interacts in isiZulu in utterance 66 to solicit other contributions from other Sepedi groups. According to Ndayipfukamiye (1994), a teacher uses language to seek learners’ involvement. As a result, one learner from the other Sepedi group showed understanding of the phrase ‘at least’ by introducing the word ‘bonnyane’ in utterance 70, which means minimum amount.

The teacher provided an opportunity for the other home languages, Sesotho, isiXhosa and isiZulu, to express their understanding of the phrase ‘at least’. This suggests that the teacher appreciated and recognized the language experiences children brought in the classroom. Furthermore, he wanted learners to use available language resources in the classroom. Learner’s responses showed understanding by introducing appropriate words as well as examples to support their responses as shown in the following excerpt.

Excerpt 4

85	Teacher	Okay, okay asizwe la Xhakaza [Explain Xhakaza]
86	Xhakaza	Kube ndingathi kuwe…Ngingathi ngiboleke iR10 buncinci bayo [This is what I can say to you can you lend me R10 at least.]
87	Teacher	Okay, buncinci bayo [minimum]
88	Xhakaza	Ngabe ufuna iR20, kodwa uzawuthi ngiboleke ubuncinci baloR20, iR10 [If you want R20 but you shall say lend me a minimum of R20 is R10.]
90	Teacher	All right all right asizwe la listen
92	Mkhonta	Lalomuntu lo imali ayidingayo, lomuntu lo uthi okungenani like okungenani like kube R10, ubuncane bayo kungabi R9 because makungaba iR9 angeke ngiyithathe, okungenani something uR10 ukuya phezulu. [The person needs the money and the person says at least R10, the lowest of R10 could be R9 but the person shall not accept R9 at least R10 or above.]

The above transcript shows that learners developed some understanding of ‘at least’ by using appropriate words like ‘bonnyane’, buncinci, okungenani [minimum]. Learners also gave examples to support their claim, thus showing insight. Furthemore, learners were showing the ability of logical thinking which enabled them to put ideas in precise language. Learners also appreciated the interrelation of ideas which are responsible for growth of Mathematics. I would argue that learners realised that Mathematics has its own language, which they should be able to understand and to speak.

There was continued existence of learner talk and participation encouraging learners’ verbalisation of their thoughts. In my view, verbal interaction enabled learners to share their meaning of the phrase ‘at least’. The teacher in this study gave learners an opportunity to articulate, share, discuss, reflect upon and refine their understanding of the meaning they were dealing with in their home languages.

The transcript also shows that the teacher facilitated the exchange of ideas and helped in sustaining the discussion in terms of enabling students to contribute by uttering statements like in utterance 90: “all right, all right asizwe la [what do you say] listen very carefully”. The teacher also repeated the ideas of the learners like in utterance 71 and 87 to sustain the interaction as well as encouraging the learners to use their home languages.

By establishing this pattern, the teacher was able to explore the students’ ideas in their home languages. He provided opportunities for the learners to find the meaning of the phrase ‘at least’ in their home languages. Asking learners to think about the meaning in their home languages created an opportunity for them to think about the different ways in which they could express ‘at least’ in their home languages. Learners also demonstrated their understanding of concepts through examples expressed in their home languages. I would argue that the teacher created opportunity for learners to construct knowledge which they were

responsible for, according to Freudenthal (1991) it was through guided reinvention. The use of learners' home languages in this manner supported learners' understanding and engagement with linear programming task.

Learners who did not understand the meaning of the phrase 'at least' were not ignored by the teacher. The atmosphere created by the teacher was not favouring competition and individual performance but enabled students to feel free to present their ideas. As a result learners who did not understand were not shy to express their views. Learners who did not understand the meaning of the phrase 'at least' were from one Sepedi group. The teacher encouraged the learners to use their home languages instead of English or any other home language. The following extract illustrates how the teacher drew on home language to help the Sepedi group.

Excerpt 5

109	Teacher	Awusayi-understand namanje? (You do not understand even now.)
110	Mantombi	Yes
111	Teacher	Iliphi igama elikudidayo namanje? (Which word don't you understand.)
112	Mantombi	U-at least
113	Teacher	U-at least
114	Teacher	Akesiyekele ngo at least sikhulume ngeSipedi, sithi bonnyane, [Let us forget about at least and speak Sepedi, say minimum]
117	Learner	Ngicabanga ukuthi..[I think that]
118	Teacher	ISepedi? [Is that Sepedi?]
119	Learner	Like …
120	Teacher	Ngithi mchazele kahle ezwe [explain clearly so that he can understand]
122	Teacher	Eh Eh anibachazele kahle [explain clearly to them]

Utterance 111 illustrates that the teacher wanted to make sure that the learner did not understand the phrase 'at least'. The teacher encouraged the learner to use Sepedi, bonnyane, instead of 'at least' and he further asked other learners from the other home language groups to explain to her the meaning of the phrase in Sepedi, her home language. This suggests that the teacher wanted the learner to understand the meaning in her home language. He discouraged other home languages explanations as shown by utterance 118 where one learner offered an isiZulu explanation.

During the interview, he pointed out that using learners' home languages enabled them to understand the concept.

> Teacher Because eh I think to me eh if you understand something in your home language… it becomes easy for them to interact …eh abantwana [learners] they need to understand their home language. …even in the past they use to say to me uthishela ufundisa imaths ngesiZulu [our teacher teaches mathematics in IsiZulu] because I like doing that … and I always try to explain to them in IsiZulu. And once you start doing that abantwana baya-understanda akufani noma ungakhuluma i-English waya waya [learners understand, unlike when teaching in English right through] they don't understand sometime[s]

The extract above shows that the teacher views the learners' home languages as a resource in the teaching and learning of mathematics. Furthermore, he makes an effort to ensure conceptual understanding by using learners' home languages in his teaching.

From the above discussion about the concept 'at least', using learners' home languages supported learner engagement and understanding of the task. Learners were able to draw on their home language(s) and introduced appropriate words in their home language(s). They further gave examples to support their arguments and in the process introduced the mathematical meaning, minimum. The interaction between teacher and learners shows that the teacher encouraged learners to draw on their home language(s) when explaining the meaning of the phrase 'at least' to each other. This type of interaction enabled learners to understand the mathematical meaning of the phrase 'at least'.

Furthermore, the task was encouraging student's mathematical thinking skills and it was a useful tool to identify learner's language difficulties. According to Adler (2001), linguistic discontinuities can be minimised when using learners' home languages. Learners defined 'at least' as minimum amount, the least amount or the smallest amount. Learners understood 'at least' in their home languages, as 'bonnyane' in Sepedi and Sesotho, 'buncinci' in isiXhosa and 'okungenani' in isiZulu. In between the content of the classroom talk as guided by the teacher, I

can argue that the talk went through a progression in mathematical meaning which might be summarised as follows:

- From talk about ‘at least’
- Meaning in different home languages
- To minimum in mathematical meaning
- Reflection of meaning whereby learners gave examples

Looking at this sequence, there is a sense in which the activity involved a process of mathematisation as the teacher guided the classroom talk. Learner’s responses suggest that they achieved the process of horizontal mathematisation when negotiating the meaning of the phrase ‘at least’ in their home languages. Probing by the teacher resulted in learners introducing the word ‘minimum’, resulting in learners achieving vertical mathematisation.

How did the teacher achieve progressive mathematisation? That is shown by looking at the pattern in the communicative approaches used by the teacher and the responses by the learners. The teacher interacted with the students to find the meaning in the learners’ home languages. He also encouraged learners to use their home languages. Learners gave meanings in their home languages as well as examples to show that they were engaging with the task. Then shifted to mathematical language, minimum, to show progressive mathematisation under the guidance of the teacher. Table: 5.1 summarises the above argument.

Table 5.1: Negotiation of the meaning of ‘at least’

	Horizontal mathematisation	**Vertical mathematisation**
Concept	Meaning in different home languages	Mathematical language
‘at least’	Bonnyane (Sepedi, Sesotho) buncinci (Isixhosa) okungenani (IsiZulu)	Minimum, greater than or equal to

The process of mathematisation involves the construction and manipulation of symbols. The next section will look at an analysis of how the teacher guided learners in the construction of the mathematical symbol for the phrase ‘at least’ R10’.

Teacher negotiating symbolic representation in learners’ home language

Learners were to represent ‘at least R10’ algebraically and they had the following representations shown in Excerpt 6.

Episode 3: Teacher negotiating symbolic meaning of ‘at least’

Excerpt 6

124	Teacher	'write algebraic representation of the amount I need, akesithole oyi one, awusibhalele, write algebraic [can someone come up and write an algebraic expression]
125	Learner	Wrote R10-R11…
126	Teacher	Lalelani nike ungathi anizwanga, yingako ngithi ke ake sifunde isiZulu [Listen you did not understand that is why I am saying let us read the isiZulu version]

This learner might have not understood the question as a result he thought of the amount ranging from R10 to R11 and upwards. This suggests that he could have known that it has to be greater than R10; it is not clear why he did not write an algebraic expression. The teachers’ response encouraged learners to read the home language(s) version of the task in order to understand the question (utterance 126); because he felt that they did not understand. To show understanding after reading the home language(s) version, learners produced different representations like the ones presented below:

$R \geq 10$; **$R10 > R20$;** **>10;** **$x \geq 10$.**

The teacher probed and directed learners to the responses given by other learners (utterance 146). He probed learners in order to come out with a common understanding of the mathematical symbolic representation of phrase ‘at least’ R10. In his utterances, he tried to ask learners to explain why the other solutions

are not correct instead of him telling learners the correct answer. This kind of environment encouraged learners to think.

Excerpt 7

146	teacher	Is this an algebraic expression (*teacher pointing at R10-R20*) masikhuluma ngama algebraic expression sikhuluma ngani? [When we speak of algebraic expressions what are we talking about?] ngoba iquestion iyasho nangesisuthu nangesizulu nangani iyasho.[Because even in your home languages the question is very clear]. All right akesibuye kule [Let us come back to] R>10 (*teacher circling R>10*). What was wrong kule [here]?
169	Teacher	okay, okay, yes pointing at Xhakaza
170	Xhakaza	I-algebra ingama [algebra is about] symbols and letters,
171	Teacher	Yes
172	Xhakaza	Which u-R ngingamvumela, ndingavumelana naye because is a symbol of maths. [I accept R, I can accept the letter R]
173	teacher	That is correct, It can be any symbol it can be ***a*** it can be ***b***. angeke uthi angeke uyisolve nakuthiwa solve for *a* and *b* bese uthi wena you can only solve makuna *x* or *y* kuphela as long as kuyisymbol. [You cannot say that you cannot solve for *a* and *b* if there is *x* or *y* as long as it is a symbol] Right okay now let us look at number *b*. Isikhathi sesizophela, [we are left with 10 minutes]. We are left with 10 minutes, right (teacher read next question).yes awufunde ngesizulu.

The teacher created an opportunity for learners to develop mathematical understanding of the symbolic representation by engaging them in the different representations as they participated in whole class discussions in their home languages. According to Van Den Heuvel-Panhuizen (2003: 16), "students should have the feeling of having the lead" under the guidance of the teacher. As a result, utterance 172 suggests that the learner mentioned the idea that it can be any letter. Xhakaza argues that $R \geq 10$ is correct because algebra is all about symbols. Learners were using their home languages when arguing for the symbolic meaning of the word 'at least'.

In conclusion to the negotiation in meaning of the concept 'at least' on day one, the teacher was able to help learners negotiate the meaning of the phrase 'at least' in their home languages and they introduced a mathematical meaning which is minimum as well as the symbolic representation. The teacher did not impose the meaning and symbolic representation to the learners. In RME terms, the learning process was guided reinvention of the meaning of the phrase 'at least'.

Moreover, the teacher in this study recognized and promoted the use of learners' home languages in the classroom. Research had argued that to facilitate participation and success teachers should recognize the learners' home languages as legitimate languages of communication (Khisty, 1995; Moschovich, 1999; Setati & Adler, 2000). The table below summarises the negotiation of the meaning of the phrase 'at least'.

Table 5.2: Symbolic representation of the word 'at least'

	Horizontal mathematisation	**Vertical mathematisation**
Concept	Meaning in different home languages	Mathematical language
'at least'	Bonnyane (Sepedi, Sesotho) buncinci (Isixhosa) okungenani (IsiZulu)	Minimum, greater than or equal to Symbolic representation of $x \geq 10$

The next section looks at an analysis of the concept 'at most' during the second lesson.

Episode 4: Teacher negotiating meaning of 'at most'.

This section explores and elaborates how the teacher used the learners' home languages when negotiating the meaning of the phrase 'at most'. The episode is a teacher-led class discussion. The episode is focusing on report back of the groups' findings and the interactions between learners and teacher. In this episode, the teacher allowed and encouraged learners to respond to each other's questions thus providing language as a social mode of thinking (Mercer, 1995).

The episode took place on day two where learners were given the following task to solve as a group and then to discuss the group findings with the rest of the class.

English version

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

a. Rewrite the sentence above without the words "at most".
b. If there were 39 people who bought tickets for the first show, will the show go on?

IsiZulu version

Ihhola likaMandla kungangena abantu abangu 150 noma ngaphansi ukubona isithombe esinye.

a. Bhala umusho ongenhla ngaphandle kokusebenzisa igama "at most".
b. Uma bekunabantu abangu 39 kungabe sizochubeka yini isithombe noma cha?

Figure 5.2: Task on day 2

The task caused a lot of constructive talk between students as they tried to arrive at an answer. The teacher asked students to explain their ideas therefore the discussion focused more and more on mathematical arguments. In response to part ***a*** of the above question, learners showed understanding of the task by introducing the mathematical language of 'at most' which is 'maximum'. The teacher pressed learners to give meaning in their home languages. This is illustrated in the following excerpt in which the teacher asked Maseko for the response in isiZulu, her home language.

Excerpt 8

237	Maseko	Mandla cinema can accommodate a maximum of 150 people for one show.
238	Teacher	Mandla cinema can accommodate a maximum, the word maximum of 150 ngesiZulu niyibeke kanjani? Niyibeke kanjani ngesiZulu? Ngithe bhala ukhombise ukuthi uyawuzwa lenkulumo ebeyisho la. [How did you answer the question in IsiZulu, I said write the answer to show that you understand the question]
239	Learner	Ihhola likamandla thishela ukuthi kungangena abantu abawu 150 ukuya phansi, kungabi u-150 ukuya phezulu. [Sir, Mandla cinema can accommodate 150 people or less]
240	Teacher	150 kuya phansi hhayi ku 150 kuya phezulu. Okay fine, owesibili?[150 or below and not 150 and above okay the next question]

After Maseko's response of the phrase 'at most', the teacher continued to press her thinking by asking her to link her response to the home language meaning. The exchange among Maseko and the teacher highlight the focus of the lesson on the meaning of the phrase 'at most' in learners' home languages deliberately (utterance 238). The teacher required the connection between the word maximum and the learners' understanding of the phrase 'at most' in their home languages. This suggests that the teacher managed to challenge the learners' thinking process because translating the meaning to isiZulu requires the learner to understand the meaning of the statement as a whole. Through this process, the teacher was able to encourage learners to interact meaning between mathematical language, home language and language of learning and teaching. Learners used the words "kungaba u-150 ukuya phansi, kungabi u-150 ukuya phezulu" [it is 150 or less but not 150 or more"]. The definition of 'at most' by learners can be summarised in the following table.

Table 5.3: Meaning of 'at most'

	Horizontal mathematisation	**Vertical mathematisation**
Concept	Meaning in home language	Mathematical language
At most	150 kuya phansi kungabi u-150 kuya phezulu [it is 150 or less but not 150 or more]	Maximum 150 or less than 150 $x \leq 150$

The next excerpt looks at learners' responses to question ***b*** of the task. Again the teacher deliberately asked for the home languages meaning.

Excerpt 9

241		Eyesibili… akesizwe. Nitheni lapho (second question how did you answer the question?)
242	Maseko	Sithe (We said) The show will not go on because he will not benefit profit from 39 people
253	T	Akesizwe iSipedi kucala, yes (Let us give a chance to Sepedi group first)
254	Elro	…150 kuya phansi, akanawumela 150 kuya phezulu (150 and below, cannot wait for 150 or above)
255	T	Okay, okay, alright okay akebajustifaye ipoint labo okay (Okay, let them justify their argument)
256	Mkhonza	Mawudefina iloku linear programming ithini idefinition ye linear programming. (When defining linear programming, what is the definition of linear programming?)

260	Errol	Ithi (It says) maximising the profit and minimising the loss, so nami ngiz…(I will also…)
262	Mkhonta	Wena nawubhekile lomuntu lo nakungena abantu abawu 39 kumele ucabange ukuthi le I-one show. Nakungena abantu abayi39 akusiyo nehhafo ka 150. Mara iprofit izophuma kanjani nakungasiyo nehhafu ka150. Akusiyo hehhafu, nehhafu ka 150. [When you look at this person, when 39 people get into the cinema hall, how is he going to make profit from 39 people since 39 is not even half of 150, it is not even a quarter of 150?]

The above discussion suggests that the task provoked different thoughtful reactions among learners. Some learners attached the definition of linear programming (utterance 44 on page 69) to the meaning of the phrase ‘at most’ as indicated by utterance 256 where Mkhonza justified his point by asking Errol to define linear programming. Even though they know that ‘at most’ means 150 or less than 150, [ngaphansi] as shown in utterance 239 in excerpt 8, they argued that the show will not go on. I would argue that learners were now using their knowledge of linear programming, which is the problem of finding the maximum or minimum profit. Hence, learners used their everyday experiences to justify their answers. According to Bernstein (1996) they lacked the recognition rule – they did not recognise that the question required application of the concept ‘at most’. The question wanted learners to decide whether the show will go on based on the mathematical meaning of ‘at most’.

However, other learners argued that the show will go on because ‘at most’ means 150 or less as shown in excerpt 10, utterance 263 where Errol contended, “the language of linear programming says at most 150 which is 150 or less therefore the show will go on because 39 people is less than 150”. Errol used the language of linear programming to model the task and showed a shift from informal language to mathematical language which is vertical mathematisation.

Excerpt 10

263	Errol (Sepedi)	at most ngisho imaximum angisho ilanguage ye linear programming [This is a maximum, the language of linear programming] it says equal to 150 or less than 150 so the show will go on if bebathi ba expecta [they expect] at least 150 people besizothi ishow beyingeke ichubeke ngoba babheke 150 noma phezulu kuka 150 [we were going to say the show will not go on because they expect 150 or more than 150]

265	Teacher	ake sizwe abanye nithini, nawamgroup ayi two. Ithi igroup yesiZulu ishow angeke ichubeke because there will be no profit. Laba begroup yesipedi bathi the show will go on because of the word I-maximum. imaximum it can accommodate 150 or less yes [Okay fine, let us for now leave them, let us give others a chance to make their contributions, these two groups. The Zulu group suggest that the show will not go on because there will be no profit, and the Sepedi group suggest that the show will go on because of the word maximum. Maximum can accomodate 150 or less]
266	Xhakaza	Uzochubeka umdlalo [The show will go on]
267	Teacher	Uzochubeka umdlalo [The show will go on] Xhakaza uthini nge-issue yalaba abathi angeke kube ne profit [What do you say about those who have said that there will be no profit].
268	Xhakaza	Thishela Angeke ahlala achekha ukuthi xha-kufika abantu abayi 40 everytime, uyabajikisa. Ngeke…[Sir he will not always check that when they are 40 people they shall be turned away no..]

The teacher solicited contributions from the members of the class as shown by utterance 265. The invitation by the teacher was open, "let us give others a chance to make contributions..." This shows that the teacher positioned the contribution as meaningful and he wanted learners to engage with it. According to Mercer (1995), students have to communicate their ideas and make them visible by putting them into words. Elbers (2003: 81) assert, "Participants assimilate insights expressed by others and benefit from various viewpoints and knowledge brought forward in the discussions both in the small groups and in the classroom as a whole".

Allowing learners to present arguments enabled the teacher to gain clarity on the ideas presented and learners' thinking in relation to these ideas. This treatment of a problem moves the class in a reasonable progression from the group work to building on it. The teacher maintained continuity of their inquiry by working on what the learners presented. The teacher directed the class attention to the idea presented while at the same time inviting everyone to think about how the learner had responded to the phrase (utterance 265). Joint action helped in aligning learners' participation structures with the activity of collective learning.

For example, utterance 265 suggest that verbal statements by the teacher set up the possibility for the next interaction by explicitly encouraging continued

attention to the meaning of ‘at most’ as there were two different ideas presented. In his invitation for others to contribute, the teacher positioned these ideas for continued work by the collective learners. By inviting such a particular kind of participation also contributes to maintaining continuity over time.

In response to the teacher’s invitation, learners produced mathematical arguments to support their ideas; they did not rely on the ideas from the teacher. That is shown by utterance 266 where Xhakaza supported Errol’s idea by saying that the show will go on and she further said, “If the show does not go on, it would mean the 39 people would be turned back, does that mean everyday this person would first check at the number before the movie go on”. Xhakaza continued as follows:

Excerpt 11

271	Xhakaza	Uyazi ukuthi angeke ahambe ayofunana nabantu abawu 150, uyazi ukuthi u- expecta abantu abawu 40, 50 , 60…[He knows that he is not expecting 150 all the time, he expects about 40, 50, 60 … people]
272	Mkhonta	Hha sekathini [what is she saying now?]
273	Teacher	Mani, mani asumyeke achubele [wait, wait, let her continue]
274	Xhakaza	Yes sir u-expetha lokho, uhlaeyazi ukuthieveryday kufika 150…akanawu expetha I-profit everyday [Yes Sir he does not expect to get a profit everyday]
275	Teacher	Okay ngamanye amazwi ufuna ukuthi ngelinye ilanga uzoluza, ngelinye ilanga uzowina sengikuzwa kahle ke manje. Okay okay ngizwa kahle. Nawe uvumelana negroup ethe ke the show will go on. Keep quiet [Okay, in other words you are suggesting that some day he will lose, some day he shall win. I understand your point now. Okay, okay I fully understand you also agree with the group that said the show will go on. Keep queit]
276	Learner	Ibinessman inam [A business mans has] risk if you are in a business you are going to take the risk. Even when the business… may be kune [there is])…(*learners saying yes)*

The above discussion suggest that the argument by Errol and Xhakaza was linking the solution of the task to the context of the task not on the meaning of linear programming and it was in the learners home languages. Vos (2002) argues, “The solution will only make sense when it is related to the initial question” (p. 32). Xhakaza advanced and defended Errol’s opinion. The argument was in favour of the meaning of ‘at most’ and the correct perception prevailed. I would argue that when learners ask questions and respond to various questions; it shows that

learners are active participants in the learning process and not passive listeners, which also helps in terms of managing learning in the classroom.

The teacher facilitated the discussion as shown in utterance 273 where he says to Mkhonza “let her continue” and Xhakaza continued with her example in utterance 274. The teacher invited learners to share their thinking publicly and explicitly positioning contributions as important.

The teacher could have stepped in and pointed out that ‘at most’ means less than 150 and 39 is less than 150. Instead his response is to encourage learners to explore. By engaging the entire class in thinking, he created an opportunity for all learners to engage in mathematical analysis. This suggests that the teacher is positioning learners to attend to and respond to one another’s idea. Thereby establishing certain ideas as part of the common ground and organising their exchanges directly. The teacher did not produce any of the mathematical ideas; learners were positioned as the knower and doers of mathematics. The teacher positioned himself in a supportive role by intervening to facilitate the exchange of ideas and learners thinking. In this manner he encouraged the learner’s engagement with the task and did not take over the demanding aspect of the task. The teacher fostered learners thinking about the problem and not their progression towards task completion. When learners were not clear on the task, he encouraged them to read the home language(s) version. He did not take that to mean that they needed the mathematics explained to them.

There is evidence seen by the fact that, the class operates as a mathematics community by asking each other questions and by helping to explain answers in different ways thus teaching each other. For example, as learners were arguing, they also gave interesting examples to show that they were thinking about explaining the answer to the task in different ways. These responses showed that learners were actively engaged in mathematical discussions and the teacher encouraged learners to participate during the lesson by engaging with each other’s

idea. I would argue that the deliberate use of the learners' home languages gave learners access to alternative meanings and relationships (Clarkson, 2007) as a result they were able to think of a range of real life experiences as shown in the following extract.

282	Xhakaza	Abantu nakudlala ibhola abantu baya estimate itulu zining. Kunga fika abantu abayi2 ibhola iyachubeka. [When there is a soccer match in a stadium the game continues even when they are two spectators]
284	Teacher	Okay, okay, sh.. Okay okay okay Uthini uthi ngalamanye amazwi Xhakaza uvemelane nami mangithi leyeTaxi ayifani right uthi istadium it doesn't matter ukuthi abantu bangakanani ibhola lizochubeka. Okay okay okay akesizwe la [In other word you share the same idea with me with that example of a taxi, You said in the stadium the match continues, it does not matter how many people are watching the game, okay let us get another suggestion]

Other learners had this to say:

285	Learner	Thishela, njengoba bethi [Sir because they say] there will be no profit are you telling me that like if every week and like less than 150, 40. 45 the show will not go on?
290	Learners	Mina bengifuna ukubuza thishela ukuthi a businessman is he always expecting to win,is he going to ahambe atjela bantu kuthi wozani nizobheka ncanabe fike bawu 39 sewuthola ukuthi sowuyajika. [May I ask a question Sir, Does a business person always expect to win? Is he going to go around telling people to come and watch a movie only to turn them away when there are 39 people?]
306	Learner	the show will go on, nawena the class wena the class may be a maximum of 46 people and kunabantu abayi 10 u tla ruta,…wena hhayi u tla rutisha [the show will go on because even when there are 10 students in the class instead of 46 students you will continue teaching] (*learners laughing*)

Utterances 282, 285, 290 and 306 suggest that learners constructed the meaning of 'at most' and assimilated the information individually, for producing the above examples in their home languages. These utterances show that learners brought out many everyday aspects to the discussion and therefore the use of the home languages was helpful. The learners' responses show some depth of understanding of the phrase 'at most' as they gave different examples. The language choices in their responses reflect the learners' preference and their comfort level in an environment that support norms that encourage the use of learners' home language. According to Gravemeijer (1994), the teacher created

settings in which learners renegotiate collectively the meaning of the concept ‘at most’.

Discussion

The above episodes suggest that the teacher created opportunities for learners to participate during the lesson. The nature of the task and discussion in a classroom is what shapes the classroom discourse (Mercer, 1995). According to Mercer, when learners work together and with the teacher providing opportunities for language to become a social mode of thinking, learners will have an opportunity to be immersed in the discourse of the classroom hence to fit different kinds of knowledge.

The teacher in this study gave learners enough time to engage in groups and discuss the task in their home languages. He created opportunities for learners to communicate their mathematical thinking in the class discussions. The teacher’s instructional interaction created the potential for learners to understand, respond and eventually take up one another’s idea.

During the whole class discussion, more probing by the teacher made sure that learners understood the concepts ‘at least and ‘at most’. According to Ball & Bass (2000), whole class discussions promote and extend learners mathematical understandings with a range of mathematical practices such as justifying. The teacher asked learners to justify their answers in which ever language they felt comfortable.

The task given seemed to demand more thoughtful actions as learners supported their arguments by giving examples. Learners drew on their home languages to explain their thinking. The teacher organized his instruction to support the use of the learners’ home languages. According to Van Den heuvel-Panhuizen (2003: 14) “the organizing activities that have been carried out initially in an informal

way, later, as a result of reflection, become more formal". This was evident in the examples given by learners.

Learners were focusing on the mathematics of the task and not on language as they were arguing and it enhanced learners' opportunities to communicate their thinking. Adler (2001) uses Lave & Wenger's (1991) concept of transparency to explore languages practices of teachers in multilingual classrooms. Adler asserts that:

> For talk to be a resource for mathematics learning, it needs to be transparent; learners must be able to see it and use it. They must be able to focus on language per se when necessary, but they must render it invisible while using it as a means for building mathematical knowledge (p. 133).

In my view, the tasks enabled learners to make connections, as they were able to give examples of situations that were familiar to them. This showed that when children come into the school situations they bring with them some knowledge, which they acquired, through their everyday experience.

The reasons given by the learners indicate that they had a clear understanding of what they were dealing with and it promoted understanding. The fact that learners were able to give reasons for their answers in different ways indicate that their use of home languages as a tool for communication enabled them to also use home languages for thinking. I would argue that when learners have grasped the meaning of the concepts they feel confident in using them. The confidence enabled learners to use them in the mathematical language. Lampert (2001) argues that this type of tasks open up possibilities of moving into new territory while at the same time containing tools with which learners can check the legitimacy of their assertions.

Learners have meaning of a mathematical concept if they can connect it with everyday knowledge and if they can adapt what they have learnt to new tasks (Freudenthal, 1991). In my view, the ability to connect concepts shows that

learners have understood the concept as well as its meaning in relation to real life context.

These contributions were very important because it made other learners to think of other examples. It is possible that these contributions would not have happened if the teacher did not allow learners to discuss in their home languages.

In my view, by using learners' home languages, the teacher was engaging all the learners in the classroom. It became easy for the learners to engage with the task and got an opportunity to access mathematics. I would argue that using learners' home languages enabled the teacher to give an opportunity to the learners to explain and defend their arguments when they are in discussion with other learners. The way the teacher used the learners' home languages enabled learner interaction and negotiation thus facilitating the use of language as a resource. Once pupils learn the meaning of the concepts in their home language, they can model the appropriate mathematical language.

In conclusion, it was clear that as the sequence of teacher-led questions developed, learners thought of examples to support their arguments. The teacher provided opportunities for learners to think and it led to mathematising. The tasks provided many opportunities for students to work. The opportunities created by the teacher challenged them to engage in a series of mathematical reflections, which amounted to a process of mathematising (Treffers, 1987; Freudenthal, 1991; Gravemeijer, 1994 & Van den Heizeneun, 2003). The learners showed engagement with the tasks while the teacher directed the discussion and at the same time valuing the children's contributions. Based on the above, the deliberate use of the learners' home languages did support learner understanding and engagement with the task.

5.5 CONCLUSION

In this chapter, I have presented an analysis of data collected through lesson observation. The analysis looked at how the teacher implemented the strategy of using the learners' home languages deliberately in his teaching. The analysis also looked at how the home languages were used in the negotiation of the meaning of the word 'at least' and 'at most'. The analysis suggests that the teacher used the learners' home languages to probe learners understanding of the concepts 'at least' and 'at most'. The learners' responses show that they introduced 'minimum' for 'at least' and 'maximum' for 'at most'. Therefore the use of learners' home languages supported learner's understanding and engagement with the tasks and it enabled learners to access the mathematics without loosing access to English.

The deliberate use of learners' home languages in tasks and the whole class discussion encouraged learners to write responses and verbally express their mathematical thoughts in their home languages. The learners' responses show some depth of understanding of concepts such as 'at least' and 'at most'. The depth in understanding is reflected in the learner's responses which made connections to their everyday experiences.

The next chapter looks at an analysis of data from clinical interview of one learner and focus group observation of one lesson. The analysis show how learners draw on their home language when solving linear programming task. The chapter also shows an analysis of a learner questionnaire issued after lesson observation to find out the views of the learners about the use of the strategy.

CHAPTER 6

HOW LEARNERS DRAW ON HOME LANGUGES WHEN SOLVING TASKS

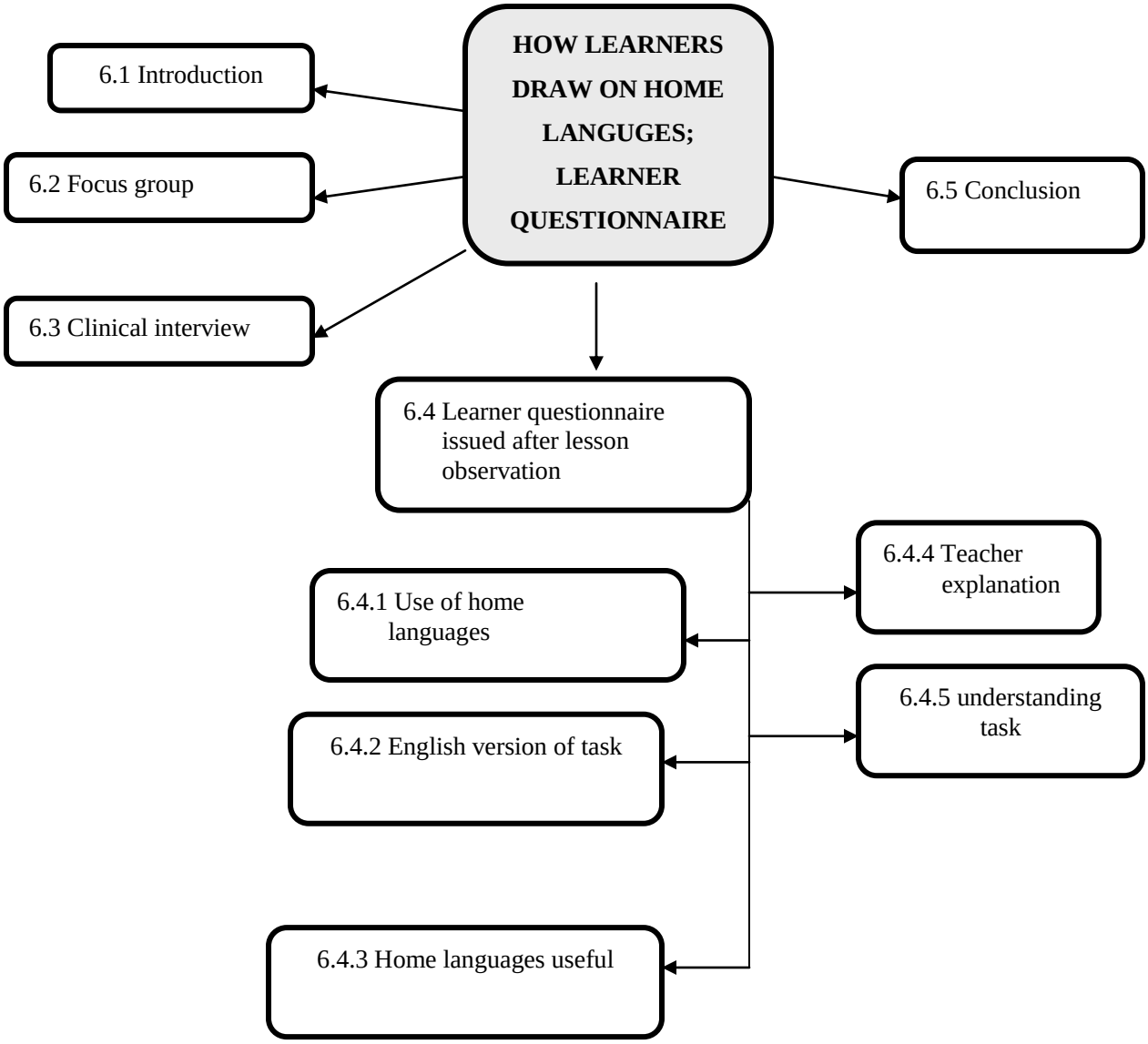

Figure 6.0: An overview of Chapter 6.

This chapter describes how learners drew on the home languages when solving linear programming tasks. It also looks at an analysis of a learner questionnaire issued after lesson observation.

6.1 INTRODUCTION

This chapter presents an analysis of data collected through focus group interaction, clinical interview and learner questionnaire issued after the five days of lesson observation. The analysis will be looking at how learners draw on their home language, isiZulu, to solve linear programming tasks. I will first present an analysis of focus group interaction on a task on day 1, followed by an analysis of a clinical interview and then analysis of a learner questionnaire issued at the end of lesson observation on day 5.

6.2 FOCUS GROUP

The analysis focuses on the task presented below given to learners on day 1. The learners read both version of the task aloud to one another and then worked collaboratively verbalizing and discussing the task.

English version

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?

IsiZulu version

Amanani amaphansi weholo akhokhelwa umsebenzi oyedwa waseNgqayizivele isikole esiphakeme yi R1 500 ngenyanga. UJohn omunye wabasebenzi kulesisikole utshele intombi yakhe ukuthi uhola i-R1 800 ngenyanga. Ngabe uJohn ukhuluma iqiniso na?

Figure 6.1: Focus group discussion task on day one

In response to the above task, the extract below shows that learners were able to identify the key word in the expression (utterance 24), which was minimum. As they participated in the discussion, learners were not grappling with the meanings

of words and phrases. They were able to come out with important ideas that may be considered when looking at people's salaries. For example, a salary depends on when you were employed. Learners used their home language to verbalize their thinking. Their utterances suggest that they justified, reflected and they critically analyzed the information in the given text using their home language as shown in the following discussion.

Horizontal mathematisation in learners' home language

Excerpt 14

24	L1	I-minimum, iminimum
25	L2	Ja! Kungenzeka ukuthi ukhuluma iciniso, lapha bethi iminimum salary, abasitjeli ukuthi wonkumsebenzi uhola malini [yes, it is possible that John is telling the truth, they say minimum salary they do not tell us the salaries of the other workers]
26	L4	Owokugcina mhlawumbe nguye uzohola okungaphezulu [the last worker might earn more]
27	L1	Kungenzeka ukuthi ufike this year, nguye ozohola R1500, owokugcina asazi ukuthi uhola malini. May be John ufika this year. [it is possible that John was employed this year]
28	L3	umazelaphi ukuthi uJohn ufike nini? [How do you know that John was employed this year?]
29	L1	Minimun salary is R1500, imaximum mara abasho. Kodwa iyakhuphuka. Akakho umuntu ohola R1400 [We are not told the maximum salary, but it increases. There is no one who earns R1 400]
30	L3	Iya iyakhuphuka, mara ukhuluma iciniso. [The salary increases, he is telling the truth]
31	Ls	ukhuluma iciniso. [He is telling the truth]

Learner's utterances show that learners discussed and developed ideas with each other. Group discussion gave them an opportunity to engage and exchange ideas on what they were thinking in their home language. They were able to express their ideas freely as well as asking each other question (utterance 28). Utterance 25 and 26 suggest that learners build on each others idea. They also evaluated each others idea (utterance 28). I would argue that learners were not taking orders from each other but were engaging about what each other had said and how it applied to the given task (utterance 28). This suggests that they were very attentive to each others comments. In their analysis and reflection, learners are mathematising subject matter in their home language. Learners are using the

results of their discussion to come out with the conclusion that John is telling the truth.

It is clear in the discussion that learners are making connections to real life situations. Such as providing information like when John was employed, salary increases, maximum salary is not given and there is no worker who earns R1400. In the process learners became active meaning makers as well as information providers that brought greater understanding of the mathematics. Grouping them according to their home language provided space in which learners used their home language freely when constructing mathematical understanding. It also enabled learners to become skilled in communicating in mathematical language their ideas.

Mathematical language

Learners demonstrated their mathematical understanding by encouraging each other to give reasons to support their solution to the task (utterance 44). According to Elbers (2003: 92) when learners work collaboratively as a group, they become aware that "it is not sufficient to have a good answer or right solution". Learners were pulling their knowledge together and building upon each other's contribution as shown in the following excerpt.

Excerpt 15

42	L3	Let us answer the question
43	L2	Kufuna sithi yes, [we say yes]
44	L3	Asibhale ne reason. [let us write a reason]
45	L1	I-reason azange basho, azange baspecify kahle kahle ukuthi uhola malini [They did not specify the John's salary]
46	L2	Bashilo, John ohola R1800 [They did, John earns R1800]
47	L4	I-reason ukuthi **iminimum salary is R1500,** yena uhola R1800. Kusho ukuthi isalary icala ku R1500, [The reason is that **the minimum salary** is R1500, John earns R1800. It means the salary is from R1500]
48	L1	Abasinikanga i-**maximum** kodwa akekho umsebenzi ohola ngaphansi kwaR1500 okusho ukuthi akekho ohola R1400. [we are not given the **maximum** salary, but there is no worker who earns **less than R1500** which means there is no worker who earns R1400.]
49	L2	Bonke bahola **R1500 kuya phezulu** ngoba bethi the **minimum salary** at Inqxayizivele. [They all earn R1500 and upwards because they say minimum salary]

The discussion in the above excerpt suggests that learners' reflection in their home language provided learners with an opportunity to participate in sense making through collaborative talk. The discussion shifted from informal talk to mathematical meaning as they encourage each other to give a reason for their answer. Mathematical language was dominating in the above excerpt (bold text). Learners were drawing on their home language as they were explaining to each other.

Learners preferring to write solution in English

The group interaction gave learners an opportunity to modify their ideas, clarify their thinking as well as refine their home language (utterance 55) as shown in the following excerpt. This type of interaction encourages better explanation as well as group participation. Utterance 53 suggests that learners choose English when writing the solution to the task. Therefore, the home language did provide support when learners were interacting with the task.

Excerpt 16

50	L4	Akekho umsebenzi ohola ngaphansi kweR1500[There is no worker who earns below R1500]
51	L1	Akekho *umsebenzi* ohola ngaphansi kweR1500 [there is no worker who earns below R1500]
52	L3	Kuyafana mara [It is the same]
53	L2	Ayifani mara, hhayi asibhale nge-english [it is not the same, let us write in English]
54	L1	Awukho umsebenzi [There is no work]
55	L3	Hhayi akekho umsebenzi, [There is no worker] the worker
56	L1	Let us write English

In the focus group, their discussion was verbalised mainly in their home language. The task required learners to go beyond the given information in order to produce the result that John is telling the truth. Learners showed confidence in their own ideas and Mathematics became an activity whereby learners think about, enquire into and communicate with others their ideas. In view of the above analysis of focus group discussion, the home language did support learner engagement with the task and it enabled learners access the mathematics.

The next section describes and discusses a learner's response in the clinical interview.

6.3 CLINICAL INTERVIEW WITH MKHONZA

In the analysis of the interview below, I use excerpts from transcripts of learners' interview to support the claims that I make about the use of the learners' home language when solving linear programming task. The analysis will look for answers to my research question:

How does the learner draw on the home language to solve linear programming tasks?

The learner was given both versions of the task below to solve as he explain his thinking.

CLINICAL INTERVIEW TASK

English version
A youth club is arranging transport for a picnic. 18 members have offered cars: 8 four seaters and 10 six seater cars. At least 64 people are expected to attend. The return trip is 100 km and the transport allowance is 50 cents per km for a four seater and 60 cents per km for a 6 seater. How many of each size should they use in order to minimize the transport cost?

IsiZulu version
Iqembu lentsha lihlela itransport yokuya epikinikini. Amalunga entsha angu-18 anikela ngezimoto zawo. Izimoto ezingu-8 zilayisha abantu abangu-4 kanti ezingu-10 zilayisha abantu abangu-6. Okungenani kufanele kuhambe abantu abangu-64. Ukuya nokubuya kungamakhilomiha angu-100. Imoto elayisha abantu abane ibekelwe imali engu-50 cents ngekhilometha kanti imoto elayisha abantu abangu-6 ibekelwe imali engu-60 cents ngekhilometha.

Figure 6.2 Clinical interview task

In the first part of the interview, I asked the learner to explain his understanding of the task. He used his home language to explain his understanding of the task and it made me conclude that the home language supported the learners' thinking process. He was able to draw on his home language and he used it as a resource as shown by the following excerpt.

Learners understanding of the task verbalised in home language

Excerpt 17

482	TN	Let us look at the question together, what is the task about?
487	Mkhonza	Wo! bathi i-youth club iphume uhambho lwepicnic, bayahamba baya kupicnic [Youth club is going for a picnic]
488	TN	yes
489	Mkhonza	And 18 members yabo, inikeze ngezimoto. Then abayi 8 banikeze imoto ezama four seater [18 members donated cars. 8 members donated four seater cars]
490	TN	yes
491	Mkhonza	Abayi 10 banike ngezimoto like ezinama six seater [10 members donated six seater cars]
492	TN	Yes
493	Mkhonza	And kwamele at least less than ah (*quickly corrected himself*), greater than or equal to 64 baye kuya kuleyo picininc leyo. And kuhamba nekubuya is 100 km. Itransport allowance for I four seater kwamele ibhadale 50 c per Km and for six seater Kwamele babhadale i-60c per Km. [At leat or greater than 64 members are going for the picnic. The return distance is 100km. The transport allowance is 60 cents for six seater car and 50 cents for four seater car]
494	TN	I-allowance kwamele ibhadalwe kubani? [Who is paid for the transport allowance?]
495	Mkhonza	Kumninimoto [The owner of the car]
496	TN	Yes, What do they want us to do?
497	Mkhonza	Bafuna ukuthi sithole ukuthi, uhlobo lwemoto abazoyisebenzisa zingakhi ukuze i-cost ibephansi. [They want us to find the number of each car in order to minimize cost]
498	TN	Good, how can you solve the task?
499	Mkhonza	I will use the method of linear programming.

In the extract above, the learner was able to see the overall picture presented by this task and he used his home language to verbalize it. The task is further represented using two sketches of cars and self-invented symbols as shown below. According to Freudenthal (1991) the learner represents relationships with a complex situation in order to make it possible to put them into a quantitative relationship with one another.

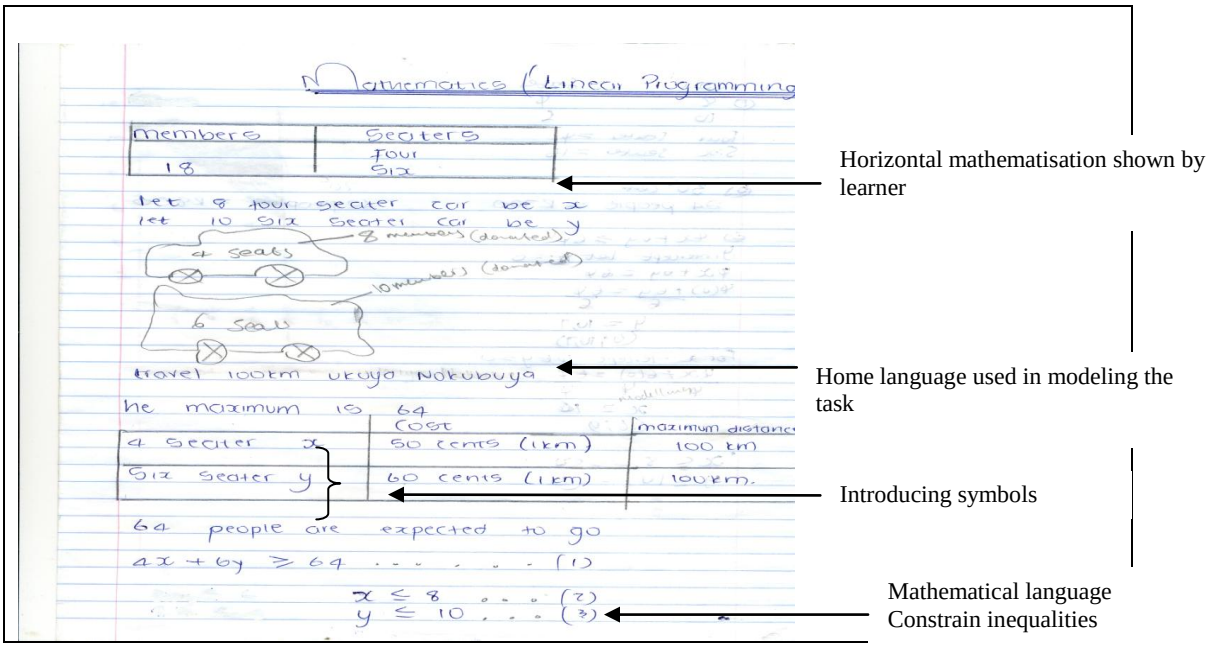

Figure 6.3: Mkhonza's solution task sheet

The learner produced conceptual tools as shown in the above solution sheet. The conceptual tools are the diagram, symbols and relationship between the symbols to make sense of his experience with the task. According to (Polya 1975), he was devising a plan to solve the task.

The learner communicated his approach by making sketches, a table, and a graph and in the process, he developed communicative skills (Freudenthal, 1991). In the table the learner introduced symbols and their relationship which led to constrain inequalities, mathematical language. The learner drew on his home language when showing the return distance. The learner's work shows that he was able to identify the central relations in the task.

Horizontal mathematisation in learners' home language

Excerpt 18

533	TN	I can see you have these models of cars, what are they representing?
534	Mkhonza	Le i-representa four seater cars, inikezwa abantu abawu 8. Le ihamba namaseat ayo. [This one represent a four-seater car donated by 8 members with seats] *(Learner pointing at the model of a four-seater car).* And le i-representa six seater cars, inikezwa abantu abawu 10 nayo ihamba nama seat ayo. [This one represents a six-seater car, donated by 10 members with six seats] (*learner pointing at the model of six-seater car)*

The above extract suggests that the learner mathematises the problem. The verbal statements and the diagram are clearly coherent. The learner is using his home language as a resource when explaining the diagrams he has drawn. The home language is also indicated in the process of solving the task as, "travel 100km ukuya nokubuya [return distance]". According to Orton (1992), the home language facilitates the thinking process.

The solution sheet of Mkhonza shows that as he was devising the plan to solve the task, it led to formation of constrain inequalities. The relationships that are important to him are the ones he has numbered (1) $4x + 6y \geq 64$; (2) $x \leq 8$; and (3) $y \leq 10$. He moved from the world of language to the world of symbols. In RME terms, it is vertical mathematisation. The task description developed into an informal language, which evolves into a more formal standardized mathematical language through a process of progressive mathematisation (Van den Heuvel-Panhuizen, 2003)

Vertical mathematisation by learner in home language

Excerpt 19

537	TN	I can see you have this inequality (*pointing at* $4x + 6y \geq 64$) what does x and y represent?
538	Mkhonza	x urepresenta the number of four seater cars
539	TN	What does y represent?
540	Mkhonza	y urepresenta the number of six seater cars
541	TN	Good. I can see you have $4x + 6y > 64$, can you tell me more about the inequality?

542	Mkhonza	Ngithole 4*x* because *x* stands for the number of four seater cars and in each car there are four members which brings the total to 4*x* members. There are *y* six seater cars and in each car there will be 6*y* members. But labo Bantu akumelanga babe bakhulu, bamele babe ncama. [Those people should be average in size.] (*All laughing*)
543	TN	Its okay continue explaining
544	Mkhonza	Bathi lapha [it says here] at least 64 people which means when I add the two like $4x + 6y$ must be greater than or equal to 64.
545	TN	Good! Continue solving the task.

In the above excerpt, concepts are explained in English. However, when he reflected on his inequality he used his home language (utterance 542) "…but labo Bantu akumelanga babe bakhulu, bamele babe ncama [in order to take four members and six members in each car they must be average in weight]. The learner is reflecting on the higher level of his activity. He carried out the plan of solving the task and then learner looked back (Polya, 1975) to see if the number of people fit in the car. Then he concluded by verbalising that these people must be average in weight. According to Freudenthal (1991) such reflection shows level-raising as it is applied to the activities of the lower level.

The above process by the learner made me conclude that the home language did support the learner to engage with the task. Furthermore, the learner was able to draw on home language, language of learning and teaching as well as mathematical language in the process of solving the task.

Below I present his feasible region and I asked him how he was going to find the minimum costs.

Feasible region

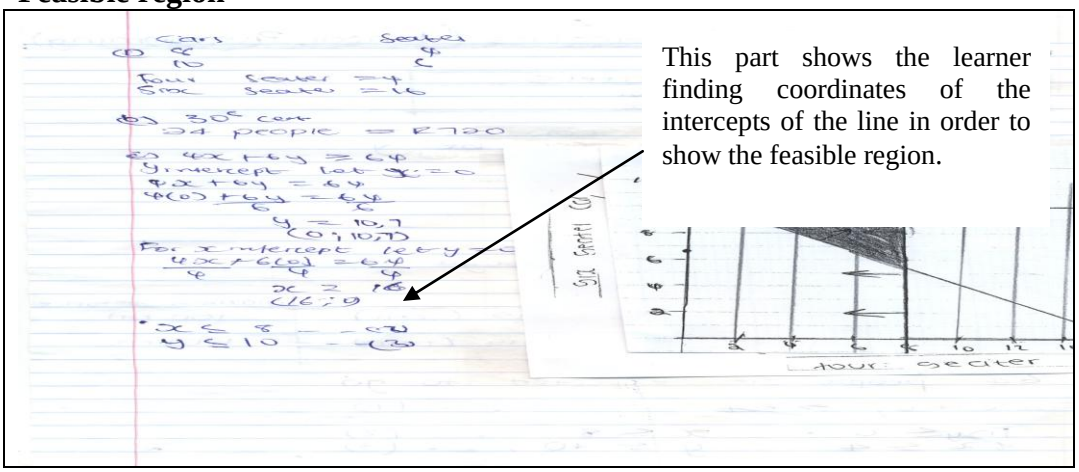

Figure 6.4: Mkhonza's feasible region

Excerpt 20

598	TN	So how are you going to calculate your minimum costs?
601	Mkhonza	I will choose points on the vertices of the feasible region and substitute in my objective function. The one that gives the minimum value shall be my solution.

The above extract shows that Mkhonza was now using English to explain how he will calculate the minimum cost. However, during the process of solving the task, he used his home language. Therefore, I argue that the home language did provide support in the learning process. It did enable the learner to access the mathematics and the skills were transferred to English, the second language.

The table below shows the learning process that Mkhonza went through.

Table 6.1: Mkhonza's mathematisation

	Horizontal mathematisation	**Vertical mathematisation**
Contextual task	- Car model with number of seats - Table with symbols - Babencama bangabi bakhulu (Average weight)	Mathematical language - Constrain inequalities -Drawing of feasible region - calculating minimum costs

Contextual task → Car model ⟶ table ⟶ mathematical language

The solution process by the learner shows that mathematics is a human activity (Freudenthal 1991). During the activity, the home language, the language of learning and teaching and the mathematical language were used interchangeably. The activity resulted in the product reflected in the formation of constrain inequalities and finally showing feasible region. Therefore the home language did provide support in the process of solving the task by this learner.

The next section will look at analysis of the questionnaire issued after the five lessons.

6.4 ANALYSIS OF QUESTIONNAIRE ISSUED AFTER THE FIVE LESSONS.

At the end of the lesson observation on day five, learners completed the questionnaire to which was to find out their views about the use of English and their home languages in the teaching of Linear Programming. The data shows the responses of learners.

6.4.1 How I used home language version of the task?

This question aimed at finding out how the learner used the two versions of the tasks.

Table 6.2: How learners used home language version of task.

	Sometimes	always	never
Number	28	18	0
Percentages (%)	61	39	0

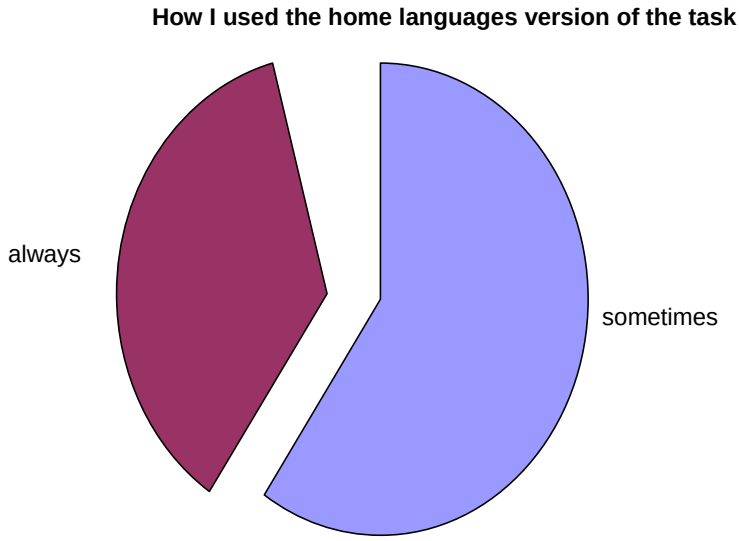

Figure 6.5: How learners used home languages version of task

The resources and material provided by the teacher promoted home languages usage as the responses by the learners shows that 61% of the learners said they sometimes used the home languages version of the task and 39% said they always used the home language version of the task. None of them indicated that they never used the home languages version of the task. Therefore, even those learners (61%) in Chapter 4 Table 4.7, who had indicated that they would like to learn mathematics in English only, did use the home languages version. In this study, the home languages were used both orally and in written form. The learning of linear programming concepts did not just use technical terms but also modes of arguing using certain phrases that constitute a register, as argued by Pimm (1981), in both English and learners home languages to support learners' understanding and engagement with linear programming tasks.

6.4.2 English language version was easy to understand

The question aimed at finding out whether learners found it easy to understand the English version of the task.

Table 6.3: English version was easy to understand

	Sometimes	Always	Never
Number	30	16	0
Percentage	65	35	0

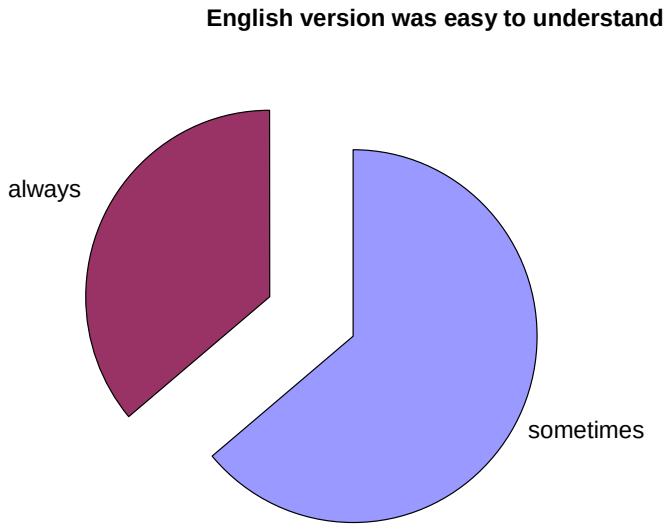

Figure 6.6: English version easy to understand

Giving learners both versions of the task enabled them to draw on both home language as well as English as the responses shows that 65% indicated that sometimes the English version was easy to understand. In my observation, learners used home language for the process of solving the task and not for translating single words. Moreover, when learners were working in groups, they were mainly interacting in their home languages; therefore, sometimes they would refer to the home language version. Furthermore, Moschkovich (1996: 30) argues that "if bilingual students have not been exposed mathematics instruction in some topics in their native language, it seems reasonable that they would talk about those topics primarily in their second language". Therefore, both versions of the task were useful.

6.4.3 Home languages version was useful

The question aimed at finding out whether the home languages version of the task was useful to the learners.

Table 6.4: Home languages version was useful

	sometimes	always	never
number	17	29	0
percentages	36	64	0

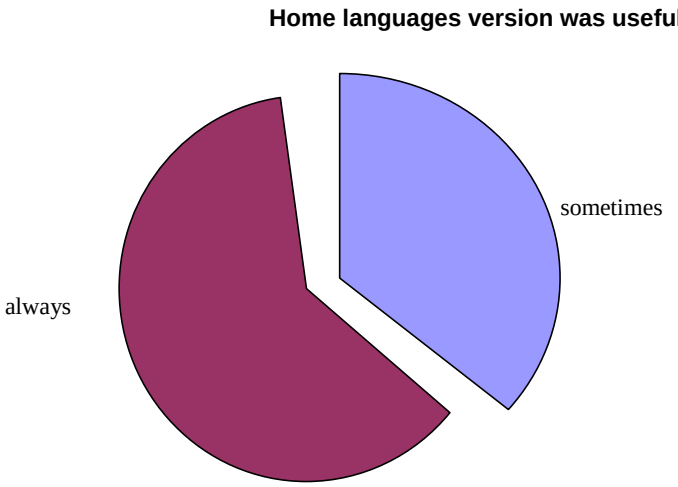

Figure 6.7: Home languages version useful

The learner's responses suggest that they used their home languages as a resource. They were afforded multiple opportunities to access the mathematics as 64% of the learners found the home language version always useful and according to Evans (2007: 147) "there is a need for young children to ensure that they have some of the basic building blocks of a mathematical register". Therefore, I would argue that the home languages provided those building blocks of a mathematics register in this study.

In the teaching and learning process, the teacher also encouraged learners to read their home languages version of the tasks when they did not understand a question. Clarkson (2007) argues that teachers who encourage the use of home

languages as well as English enhance their student's performance in mathematics. The next section looks at learners' responses when the teacher explains in their home language.

6.4.4 It helps when the teacher explains in my home language

The question aimed at finding out whether it helps when a teacher explains in the learners' home languages.

Table 6.5: Teachers explanation in home languages

	sometimes	always	never
Number	17	29	0
percentages	36	64	0

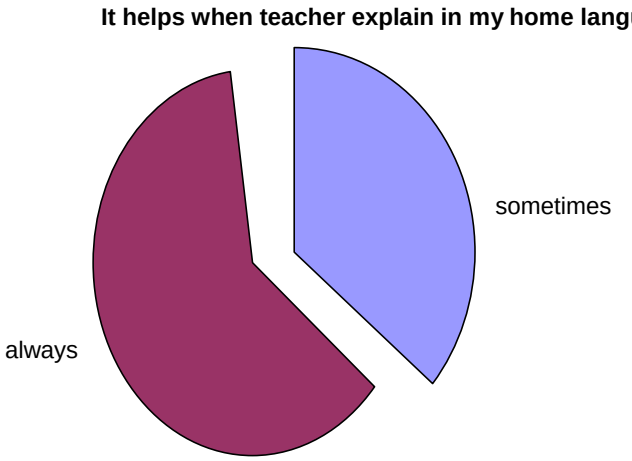

Figure 6.8: Teachers explanation in home language

The teacher recognized the home languages of the learners as resources they can draw on when responding to the tasks. The home languagse used by the teacher was helpful as 64% of the learners found the teacher's explanation in their home languages as always useful and 36% felt that sometimes it was helpful. The teacher interacted in isiZulu and most learners responded in any language that they felt comfortable. The teacher made it explicit that learners were free to communicate in whichever language they felt comfortable. Gorgorio & Planas

(2001: 14) asserts, “Teachers need to make explicit the norms that regulate the dynamics of the mathematics classroom and of mathematics practice”. The next section looks at learner’s responses in terms of understanding the tasks when written in both English and their home languages.

6.4.5 I understand the task better when written in my home language and English

The question aimed at finding out whether learners understood the task better when written in both versions.

Table 6.6: Understanding task better when written in home languages and English

	sometimes	always	never
Number	12	34	0
percentages	26	74	0

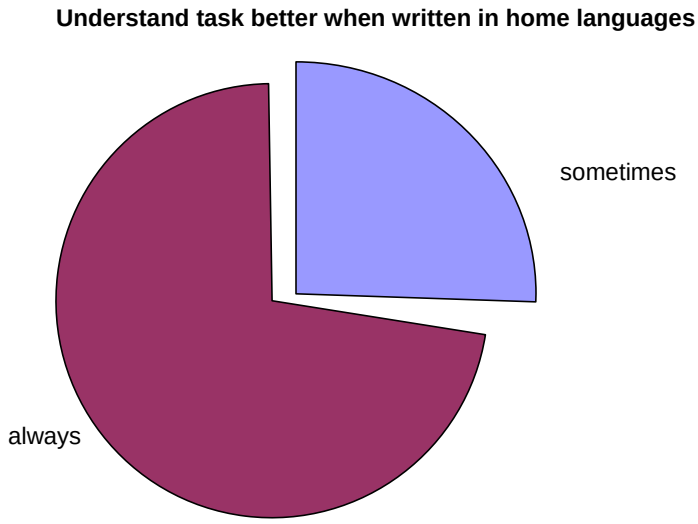

Figure 6.9: Understanding task better when written in home languages and English

Learners in this study felt that the home languages enhanced their understanding of the task. This is because 74% of the learners indicated that they always

understood the task better, while 26% sometimes understood the task better when written in both home languages and English. According to Kern (1994 cited in Clarkson, 2007) when learners think in their home languages "the concepts are likely to come alive because the learners network of associations is richer than in second language" (p. 193). Kern further argues that thinking in the learners' home languages enhances learners' confidence in the ability to understand.

In particular, the approach intended that the home languages provide the atmosphere and the tools for an exciting activity in the learning of linear programming concepts. I would argue that the material was interesting and stimulating. In my opinion interest in Mathematics grows from the stimulation one receives from teachers and material. The unusual variety of material provided an appeal for students of widely divergent interests. Interest generates creative thinking and motivates individuals in a way that a standard textbook exercise can rarely achieve. As a result throught out the questionnaire, none of the students indicated never used the home language version to any of the five questions.

6.5 CONCLUSION

The chapter presented an analysis of data collected through focus group interaction, clinical interview and a learner questionnaire issued after lesson observation. The analysis show that learners draw on their home languages when solving linear programming tasks. The home languages is mainly used in the modelling process and when explaining their understanding of the task. It made me conclude that the deliberate use of learners' home languages did support learners' engagement and understanding of linear programming concepts.

The chapter also presented an analysis of a learner questionnaire issued after lesson observations. The aim was to find learners' responses to the use of their home languages in the teaching and learning of linear programming. The learners'

responses show that they used the home languages version of the task and they indicated that it helps when the teacher explain in their home languages.

In the next chapter, I look at the knowledge I gained through the whole process of the study. I will conclude by drawing attention to the findings and limitations of the study.

CHAPTER 7

CONCLUSIONS, REFLECTIONS AND LIMITATIONS

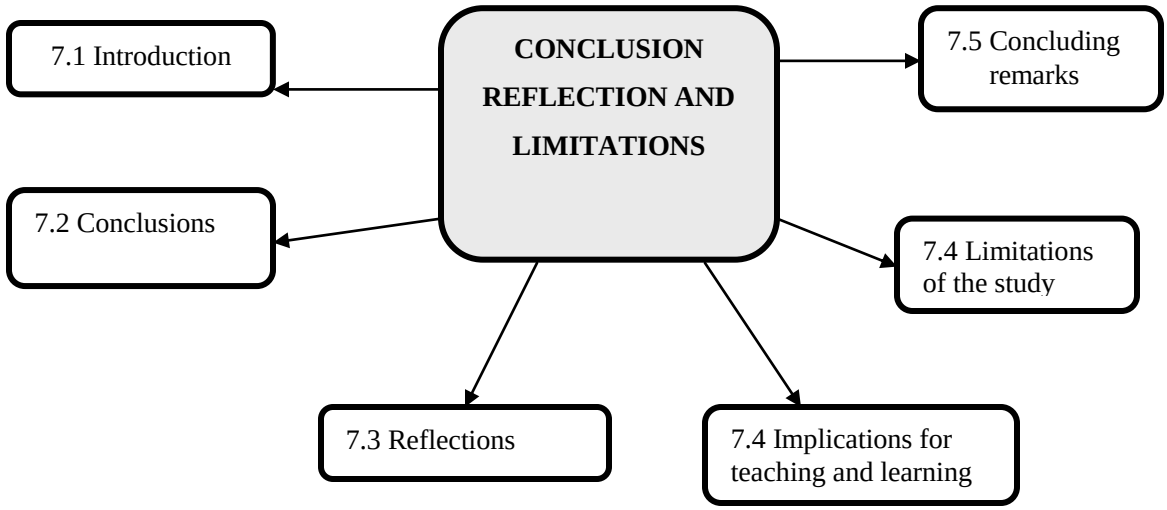

Figure7.0: An overview of Chapter 7

This chapter presents conclusions, reflections and limitations to the study

7.1 INTRODUCTION

In this chapter, I present my conclusions and reflections of the study as a whole. I discuss what I have learnt from the data collection process and the conclusions that I reached from the findings of this study. The purpose of the study was to explore how the learners' home languages can support learners understanding and engagement with linear programming concepts. To present the conclusion I use the research questions that guided my study. The research questions that guided the study are as follows:

1. How does a Grade 11 mathematics teacher in multilingual classroom use learners' home languages for teaching and learning linear programming?
2. How does the use of the learners' home languages support the learners' engagement with linear programming tasks during the lessons?
3. How do the learners draw on their home languages to solve linear programming tasks?

I will then highlight the limitations of the study. I would also mention things I would do differently if I were to repeat the study.

7.2 CONCLUSIONS

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

The teacher provided opportunities for learners to work as a group according to their home languages. The teacher grouped learners according to their home languages so that they can use their home languages in their discussions to

facilitate communication. He gave learners sufficient time to discuss the tasks in their home languages.

The approach created opportunities for learners to share understandings and verbalise their thought processes in their home languages. The analysis has shown that the teacher used learners' home languages to negotiate the mathematical meaning of linear programming concepts 'at least' and 'at most'.

Learners shared ideas through the teacher's facilitation and convinced others that their arguments were justifiable in their home languages. The analysis has shown that there was evidence of explanations in their home languages, which were followed by examples to support their arguments. Moschkovich (2002: 193) contends, "In many classrooms teachers are incorporating many forms of mathematical communication and students are expected to participate in a variety of oral and written practices such as explaining solution processes and presenting arguments".

The analysis has also shown that the teacher did not impose the meanings of 'at least' and 'at most' to the learners. The teacher used learners' home languages to probe learners' understanding of concepts in linear programming. The learners' responses showed that they introduced other English mathematical words for 'at least' as minimum and 'at most' as maximum, which indicate their understanding of the concepts. Learners further introduced the symbolic meaning of these two concepts. In my view, the teacher in this study was able to use the learners' home languages to support learner understanding and engagement in linear programming tasks. According to Ndayipfukamiye (1993), teachers meet other demands by resorting to the linguistic resources available. The use of learners' home languages was a means to foster mathematical understanding in pupils.

The teacher assisted learners who did not understand some of the concepts. He would also ask other learners to help in explaining the concepts in the learners'

home languages. The teacher also encouraged learners to read the home languages version of the task when they did not understand the question. Setati (2005) argues that the extent to which the teacher creates opportunities for learners to articulate their own thinking in their home languages facilitates the use of language as an interpersonal tool. She further argues that sometimes second language learners do not possess enough vocabulary in the language of learning to convey those meanings. In my view, the teacher allowed learners to explore meaning and developed mathematical language and understanding in the process of learning.

How do the learners draw on their home language to solve linear programming tasks?

Based on data from clinical interview and focus group, the learners drew on their home languages when modelling linear programming tasks, horizontal mathematisation, during the process of solving the task. The learners used their home languages to support the problem solving process. In the process of solving the tasks, learners verbalised their informal mathematical language in their home languages to show that the thinking process was in their home language. However, when in the world of symbols, vertical mathematisation, learners verbalised their thinking process in English. Setati *et al* (2007: 17) contends, "While learners can draw on different home languages at any time they want, language is also invisible because it does not disturb their focus on the mathematics". I would therefore argue that the deliberate use of the learners' home languages enabled learners to move from horizontal mathematisation to vertical mathematisation. In conclusion, the home languages were made available for building formal concepts.

7.3 REFLECTIONS

There is a lot that I gained by conducting the study in South Africa. The research afforded me an opportunity to view the multilingual setting (Adler, 2001) in a South African school. In the Grade 11A class that I observed, six African languages were home languages of the learners. These were IsiZulu, Isixhosa, Sepedi, Isiswati, Setswana and Sesotho. However, four home languages were used in the teaching and learning of linear programming and that did not mean that learners could not understand the other languages. The home languages that were used were IsiZulu, Isixhosa, Sepedi and Sesotho. As I was listening, observing it seemed that the learners would switch from one African language to English and learners seemed comfortable with the use of the languages.

Observation provided rich data that I used in the analysis. The teacher interview, clinical interview also helped to strengthen my observational data. The clinical interview afforded me an opportunity to listen to a learner explaining his understanding of the task in his home language. He further produced diagrams that show his understanding of the task. In the process of solving the task, he drew on his home language. However, later he communicated his understanding in English showing that the home language provided support in engaging with the task.

Conducting interviews has been the most challenging part of this study in that it demanded that I identify important points that needed to be followed up and ask potential questions that can elicit more information.

Establishing a good rapport with learners is helpful in eliciting spontaneous responses from interviews. Mkhonza's responses provided me with rich data and he was comfortable with me. Mainly because I was sitting next to him as I was observing the focus group.

As I come to the end of this study, I now realize that conducting research is not a straightforward undertaking. It demands one to interact with data, research questions as well as the literature that guided the study. The teacher's deliberate use of learners' home languages has been a revelation to me in terms of how to encourage learner's mathematical thinking.

7.4 IMPLICATIONS FOR TEACHING AND LEARNING

The teacher in this study has initiated an important role of giving learners mathematical tasks in both English and the learners' home languages. I would like to recommend that it could help teachers who teach multilingual learners if tasks in textbooks could be written in two languages.

I would also like to recommend that Mathematics teachers should make an effort to use learners' home languages as a support that is together with English in the teaching and learning of Mathematics in all Grades. In this way learners can have access to mathematical knowledge. Furtheremore, the new curriculum puts emphasis on learner-centred practice which is driven by meaningful communication. Even though a recent analysis (Setati, 2005) shows that parents, teachers and learners prefer English due to its power to give access to social goods.

The teacher in this study understood the learners' home languages, which is common to a number of teachers in South Africa. In my view, for the strategy to work, it is important that the teacher has fluency in the learners' home languages. Given the multilingual nature of South African classroom, I would recommend that teachers be encouraged to learn an additional African language while at college.

Lastly but not least, I would recommend that organising professional developmental activities around this practice might productively support teachers

reflection and development of their own practice. In my view, teachers need to be supported in order to make reform efforts successful. In reform classroom, alternative teaching materials is essential. However more research into the strategy needs to be done.

7.5 LIMITATIONS OF THE STUDY

The study is qualitative, involved a teacher and his Grade 11A learners. This implies that findings of this study cannot be generalized to all Grade 11 multilingual learners in South Africa as I observed only five lessons.

The skill of interviewing was another limitation in this study. Experience does not guarantee that interviews will be perfect. There are aspects I would do differently if I were to conduct the same interview again such as conducting interviews on a separate day because there were aspects that show that learners were tired since I did the interview immediately after their lesson on day five.

7.6 CONCLUDING REMARKS

The study has illustrated that when learners are engaged in an approach that support the use of their home languages, constrain inequalities and graph of feasible region do emerge from their mathematical activity. From the study, it is clear that the teacher's role in the involvement of learners in the classroom activities is important. The case study has shown how students contribute to their learning in an atmosphere that encourages the use of their home language.

The insight I got through the study is that the way the teacher deliberately used the learners' home languages had a greater effect on learner engagement with the tasks. The connection between home languages and mathematics reinforces the idea that "mathematics is a distinctly human activity practised by all cultures" (NCS, 2003: p. 9). Language is a carrier of culture therefore; language of the

mathematics classroom conveys the culture of the classroom as a group doing mathematics (Gorgorio & Planas, 2001). It is important therefore to regard the learners' home languages as a resource in the teaching and learning of Mathematics in order to enable learners access the Mathematics.

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APPENDIX A: TASKS

English version

Day 1

Question 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?

Question 2

The doctor advises a patient to drink at least 2 litres of water everyday.

a) What does the doctor mean by the above statement?
b) Write down the algebraic representation of the water to be taken daily.

Day 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. If there were 39 people who bought tickets for the first show, will the show go on?
c. Peter argued that if there are 39 people Mandla should not allow the show to go on because he is going to make a loss. Do you agree? Why do you agree?
d. What expenses do you think Mandla will have to pay to put up one show?
e. Use restrictions to modify the statement above in order to make sure that Mandla does not make a loss.
f. 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.

Day 3

(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

Day 4

Derrick own a hair salon. He specializes in two types of hairdo's: the dreadlocks and singles. If x represent the number of dreadlocks and y represents the number of singles. Write down the mathematics expressions to describe the following:

a) It takes 1 hour to do dreadlock hairstyle and 5 hours to do singles and Derrick can only work up 8 hours per day.
b) It costs at most R40 to do dreadlocks and a maximum of R60 to do singles.
c) Derrick has a problem: He makes a profit of R20 on dreadlocks and a profit of R35 on singles because of other commitments. Derrick still wishes to work for a maximum of 8 hours only
d) Graph the inequalities to show the feasible region in your book.
e) Use the graph above in (d) to answer this question: How many dreadlocks hairdo and singles will give Derrick the maximum profit?

Day 5

A publishing company is producing two textbooks. Textbook A costs R4 to print and R6 to bind per copy. Textbook B has a printing charge of R5 per copy while the binding costs R3 per copy. The company's budget allows for R2100 to be spent on binding and R2000 on printing (at most). Profit from book A is R2 per copy while it is R3 per copy for book B.

a) Express the production problem in terms of a system of constraints inequalities and objective function for profit.
b) Graph the system.
c) Find the production run which will maximize the profit.
d) Find the maximum profit.

ISIZULU VERSION

USUKU LOKUQALA
Umbuzo 1

a.(i) Uma ngithi kuwe ngiboleke okungenani amarandi alishumi, ngidinga malini?
(ii) Iliphi igama elisemqoka elingakunika impendulo kulombuzo ongenhla?
(iii) Bhala ngokwendlela yezibalo ukubonisa imali engiyidingayo njengoba kuboniswa n genhla.

b. Amanani amaphansi weholo akhokhelwa umsebenzi oyedwa wase Ngqayizivele isikole esiphakeme yi R1 500 ngenyanga.UJohn omunye wabasebenzi kulesisikole utshele

intombi yakhe ukuthi uhola I R1 800 ngenyanga. Ngabe uJohn ukhuluma iqiniso na?

Umbuzo 2

Udokotela weluleka isiguli ukuba siphuze okungenani amalitha amabili ngosuku,zinsuku zonke.

(a) Usho ukuthini udokotela ngalomusho ongenhla.
(b) Bhala ngokwezibalo ukuboonisa inani lamanzi okumele liphuzwe ngosuku.

USUKU LWESIBILI

Ihholo likaMandla kungangena abantu abangu 150 noma ngaphansi ukubona isithombe esinye.

(a) Bhala umusho ongenhla ngaphandle kokusebenzisa igama “at most”
(b) Uma bekunabantu abangu 39 kungabe sizoqhubeka yini isithombe noma qha?
© U Peter uthi umakunabantu abangu 39 isithombe ngeke siqhubeke ngoba ihholo likamnadla ngeke libe nenzuzo. Uyavumelana yini no Peter? Kungani uvumelana no Peter.
(d) Uma ucabanga yimalini imali engakhishwa umbukeli ngokubukela isithombe ngasinye?.
    (a) Bhala imigomo (restrictions) ongayibeka engenza ukuthi uMandla engalahlekelwa yinzuzo .
    (b) Uma ngabe uMary ubengunamba 151 emgqeni kungabe uMary uzoyithola yini indawo? Chaza impendulo yakho.

USUKU LWESITHATHU

a.
    (i) Umlimi uthenge izinkomo zenyama ezingu –x- ngemali engange R1 250 eyodwa kanye nenzinkomo zenyama ezingu –y- ngemali engange R1 000 eyodwa. Angasebenzisa ukufikela kwi R5 000.
    Chaza ukuthi lolwazi njenge “inequality in x kanye naku –y”.
    (ii) Bhala phansi amanye ama”inequalitird implicit” akulesisimo.
    (iii) Ngabe u-x- kanye no –y- kungaba izinto eziphilayo yina?

b. Bhala igrafu yama “inequalities ukutshengisa i”feasible region.

USUKU LWESINE

UDerrick ungumphathi wesikhungu sokunakekela izinwele uwuqweqwe ekwenzenzeni izinhlobo ezimbili zokucwala izinwele: Ukuophotha nokufakela izinwele. Uma u-x amele ukuphotha isibaalo esithile kanti u- y naye amele ukufakela izinwele zenani elithile.

Bhala phansi ngokwezibalo ukuthi ungachza uthini ngalokhu okulandelayo.

a. Kuthatha ihora elilodwa ukuphotha izinwele namahora amahlanu ukuqhina izinwele.Kanjalo kufanele ukuba uWillie asebenze amahora aysishiyagalombili ngosuku.

b. Kubiza amalandi angamashumi amane ukuphotha namalandi angamashumi ayisithupha ukuqhina.

c. UDerrick unenkinga : UDerrick wenza inzalo eyizinkulungwane eziyishumi nambili ngokuphotha izinwele aphinde futhi enze inzalo engamalandi angamashumi amathathu nanhlanu ngokuqhina ngezinwele zokufakelwa ngenxa yeminye imisebenzi azijubele yona, UDerrick usafisa ukusebenza amahora angeqile kuyisishagalombili kuphela. Kumele uDerrick enze izinwele ezingakhi zokuphothwa okanye zokufakelwa ukuze enze inzalo ephezulu?

USUKU LWESIHLANU

Imboni ngokukhiqiza izincwadi, ikhiqiza izincwadi zokufunda ezimbili. Incwadi A Ibiza amalandi amane ukuyishicilela kanti ukuyihlanganisa kuba amalandi ayisithupha ikhasi ngalinye. Incwadi B inesamba sokushicilela esingamalandi amahlanu ngekhasi kanti –ke ukuyihlanganisa kona kubiza nje amalandi amathathu ngekhasi elilodwa vo. Uhlelo lwezimali zemboni livumela ukuba kusetshenziswe izinkulungwane ezimbili kanye nekhulu elilodwa lamalandi ukuhlanganisa incwadi uphinde ukhiphe izinkulungwane ezimbili ukushicilela ezikhathini eziningi. Inzalo kusukela kuncwadi A amalandi amabili ngekhasi kanti amalandi amathathu ngekhasi kuncwadi B

(a) Bhala ama-equations onke kuhlangene ne equation ye profit
(b) Dweba i-feasible region
© Thola imikhiqizo engenziwa ukuze kutholakale inzuzo ephezulu.
(d) Thola inzalo ephezulu

APPENDIX B: CLINICAL INTERVIEW TASK

English version

A youth club is arranging transport for a picnic. 18 members have offered cars: 8 four seater cars and 10 six seater cars. At least 64 people are expected to attend. The return trip is 100km and the transport allowance is 50 cents per km for a four seater and 60 cents per km for a 6 seater.

a) How many of each size should they use?
b) Now considering the transport cost, find the combination that gives a minimum cost.
c) What would be the minimum costs?
d) If 8 members phone to say they are unable to attend, how can you change the plan in order to get the minimum transport cost?

Isizulu version

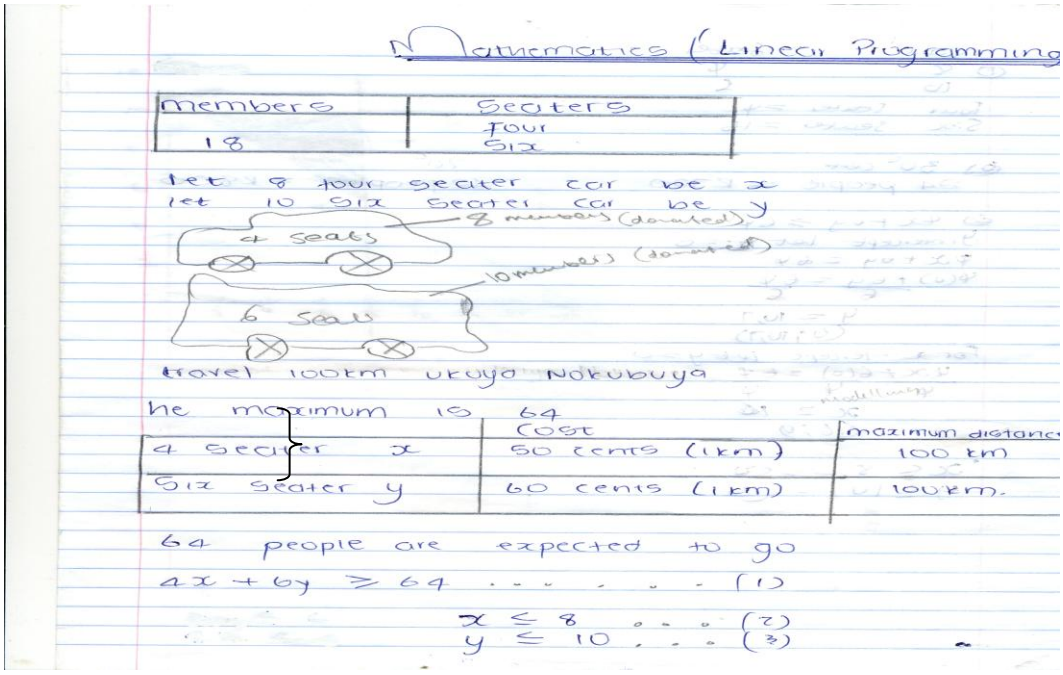
Iqembu lentsha lihlela itranspoti yokuya epiknikini. Amalungu entsha angu-18 anikela ngezimoto zawo. Izimoto ezingu-8 zilayisha abantu abangu-4 kanti ezingu-10 zilayisha abantu abangu-6. Okungenani kufanele kuhambe abantu abangu-64. Ukuya nokubuya kungamakhilomitha angu-100. Imoto elayisha abantu abane ibekelwe imali engu-50 cents ngekhilomitha kanti imoto elayisha abantu abangu-6 ibekelwe imali angu-60 cents ngekhilomitha.

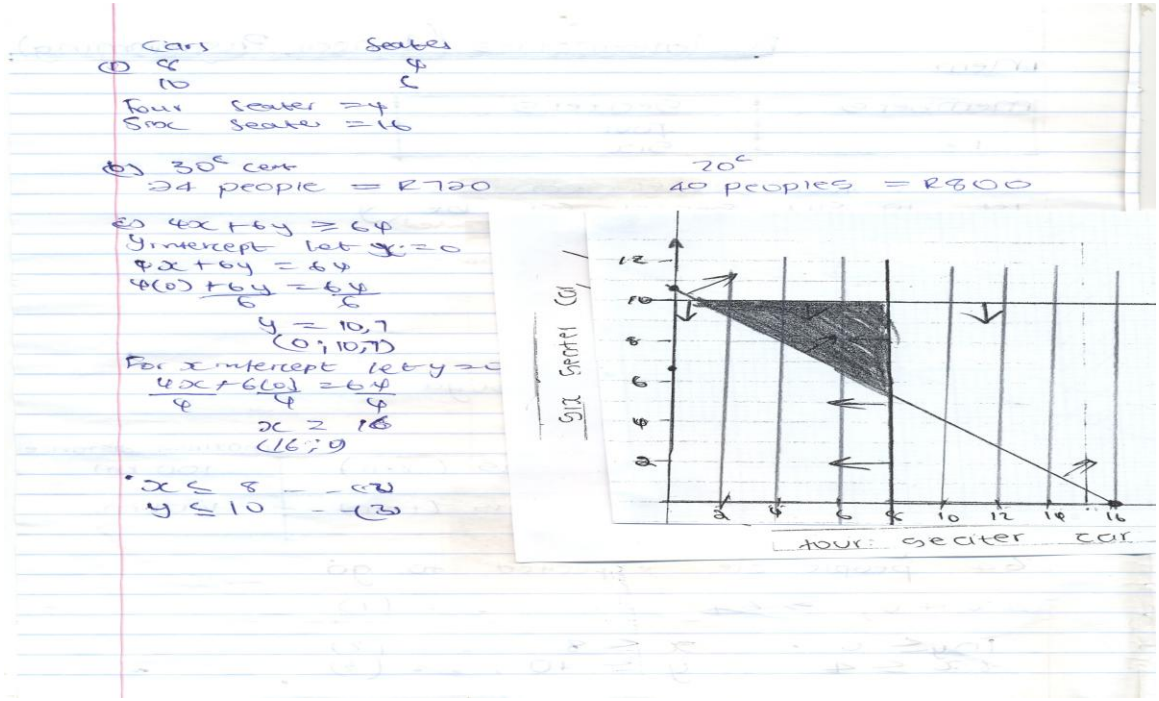
a). Kufanele basebenzise izimoto ezingaki kuhlobo ngalunye kulezi ezimbili ezinikeziwe?

b). Imalini encane kakhulu abngayikhokhela itranspoti?

c). Uma ubhekisisa izindleko zetranspoti, thola inani lohlobo ngalunye ongalusebenzisa ukuze ukhokhe kancane kakhulu.
d). Uma amalungu anu-8 efona ebika ukuthi angeke akwazi ukuhamba, ungayishintsha kanjani iplani yakho ukuze uthole izindleko ezincane kakhulu zetranspoti?

APPENDIX C: LEARNER TASK SHEET RESPONSE





APPENDIX D: RESEARCH TRANSCRIPTS

	Speaker	Utterances
1	Teacher	Give it to that one. Pass one to the next one
2	Teacher	Angazi uphi, Uphi uyambona Gijima uthi ngiyabacela abeze manje (*Teacher instructing learner to go and call three learners for the Isixhosa group)*
3	Teacher	Yeh hello yekunjani (How are you)
4	Teacher	I am still waiting for three learners from the other class to join us for the xhosa group. (*Silence*) right Ja,
5	Learner	|We need more papers
6	Teacher	Asaphelile kanjani Eh.. Eh kushukuthi bekashoda bengithi sibalile nje. Hamba uthi kubabe majola … bangakhi abashodile..one la, lapho five. [Are they finished how? It means that they were not enough but we had counted. Go to Mr Majola… How many did not get ... one here, five there.
7		Bayi six [There are six]
8		Makangenzele six six (he can make six six). Right before we can start I would like to introduce our guest for today. We have Sis Thulie, Mrs nkambule . She is doing her Masters degree final year at Wits university. We have Nathi who is also doing masters degree final year at Wits University. Si Thulie Nathi you are welcome
9	Thulie	Thank you
10	Teacher	Right okay, as you know that today we are going to look at linear programming. What is linear programming? If I am talking about linear programming because it is got that word programming. And remember one thing you are free to express in your mother tongue. Just tell me that what you understand by the word Linear programming. What is it that you understand if someone is talking about programming, LINEAR PROGRAMMING. Can you try? Linear programming what do you think is all about? Mawucabanga nje [What do you think], it is linear and it also says LINEAR PROGRAMMING. Nicabanga ukuthi ikhuluma ngani [What do you think it is all about] yes Lerato
11	Lerato	Eh progress in
12	Teacher	A what?
13	Lerato	A progress
14	Teacher	What do you mean by progress
15	Lerato	It is not constant it is progressing
16	Teacher	It is progressing that is what you think. Uma uthi iyaprogresa kanjani awuyichaze [How is it progressing, can you explain?] let it be clear. Don't just say iyaprogresa[… it progresses] use the word LINEAR PROGRAMMING. Yes Errol
17	Errol	I think linear programming is taking into account certain conditions.
18	Teacher	certain conditions. What is LINEAR PROGRAMMING mawucabanga mayithatha those certain conditions conditions kufanele ini?[(What is LINEAR PROGRAMMING when you think of it taking those certain conditions, condition is it how it should be?]
19	Errol	Like may be lets say you have a store you are selling different particulars you have to dertemine profit. And how many products are you going to use..(inaudible)
20	Teacher	Okay omunye uthini mawuzwa nje legama elithi LINEAR PROGRAMMING ucabangani nganje. Yes Xhakaza mawuzwa nje legama elithi Linear

		programming noma ungathetha sis yes Thato [Anyone with a different suggestion, when one hears the word LINEAR PROGRAMMING what comes to mind. Yes Xhakaza, any suggestion on LINEAR PROGRAMMING you can put forward your suggestion yes Thato.]
21	Thato	Thishela mabathi LINEAR PROGRAMMING…[Sir when they say]
22	Teacher	Khulumela phezulu Thato [Speak louder]
23	Thato	Ngicabanga, into engiyicabangayo thishela iLinear programming it involves inequalities and finding feasible region. [I think, what I think sir is that LINEAR PROGRAMMING involves]__
24	Teacher	Usucala ukhuluma ngezinto engangichaze kahle even before ukuthi ungakhulumi ngento ongayazi. (*Learners laugh*). [You have just begun to discuss ideas which I explained clearly even before that he should not discuss ideas which you do not know]
25	Thato	Okay thishela ngicabanga… [Yes sir]
26	Teacher	Angithi ngizama ukuthini ungakhulumi ngento ongayazi engingathi yichaze ungakwazi nokuyichaza. Ngifuna mine ukhulume ngento oyicabangayo ukuthi I think may be since it is LINEAR PROGRAMMING may be is talking about this and that that ungakhulumi ngento mhlawumbe osazoyifunda ongakayazi. [I am trying to make you aware not to discuss a concept that you do not know which you cannot explain when asked to. I want you to express a concept that you think maybe since it is LINEAR PROGRAMMING it is talking about this and that. Do not discuss a concept that we are still going to learn and you do not know.]
27	Thato	okay thishela [Okay Sir]
28	Teacher	Yes
29	Thato	mawuzothola, ILINEAR PROGRAMMING thishela mawuzothola thola mawuzothola I-area thishela [When you are to find LINEAR PROGRAMMING sir when you are to find an area sir]
30	Teacher	Ini? [What]
31	Thato	Area thishela [Area sir]
32	Teacher	Area
33	Thato	uthola I-area thishela, e-involva…ngigcina laphokuphela [You find an area sir which involves… I cannot go any further]
34	Teacher	Yes eh Mgcibelo [Yes Mgcibelo]
35	Mgcibelo	Mine I think it involves eh thisela ngicabanga ukuthi [Sir I think it is…] it is when a certain data is represented may be in a simlinear programminger way
36	teacher	Ngisaphinda futhi namanje nawuthi I-data represented in a simpler way ufuna ukuthini? [I say it once more that when you say the data, what do you mean.]
37	Mgcibelo	May be for example, eh may be a data of eh income money that may be a company has used and a compared to the eh compared to certain products in a company. For example thishela [..sir] if a company yenza thishela [.. produces sir] certain products, eh Linear programming is some where it will represent that data ya how many goods were sold and how many goods were received.
38	Teacher	Ucabanga kanjalo yes [Do you think so yes]
39	Learner	Maybe it involves ka number line eh straight line
40	Teacher	Why straight line?
41	Learner	Because linear
42	Teacher	Linear, that is what I was looking for, mawukhuluma ngelinear ukhuluma ngestraight line [.. when you talk about linear you are talking about a straight line], because you have been doing linear graphs. Ngithi uma umuntu ekhuluma nge linear leloyaziyo asikakhulumi ngen..ngekuthi nje nakunegama elithi linear [I

		am saying that if a person talks about a linear that you know we have spoken about, it is just that when there is a word that mentions linear...] you think of a ....
43	Learners	a straight line
44	Teacher	A straight line do you understand. Right But anyway u_Elroll ute wathi no may be ikhuluma ngecertain company may be ufuna certain profit njengobe ukewasho naloyo ukuthi ufuna ini nani nani. Right iLinear programming is all about maximising iprofit.like lets say you want to sell fat cakes. kuzoba nama ingredients baking powder na whatever whatever.Lawomaingredients kuzofuneka ukuthi uwenze njani, kuzofuneka ukuthi uwamixe kuze uproduce ini amafat cakes. At the same time because you want to sell those fat cakes. Uzowenzenjani, ubheke ini iprofit is in it, ubheke ini iprofit emaximum profit. akekho umuntu ofuna ukuruna ibusiness at aloss. you want to get a maximum profit and to minimise ini? amaloss, is that clear. ukuthi whatever that you are doing you must make it a point that you maximise iprofit and minimise iloss is that clear. Right njengokuthi last year if I , yes last year we were invited at Wits university because we were also complaining about that how can we see LINEAR PROGRAMMING may be outside school. There was a Prof majozi came to Wits university to explain about okay lets say may [Errol, had said no maybe it is talking about a certain company maybe you want a certain profit as he had already mentioned that he wants this and that right the LINEAR PROGRAMMING is all about maximising the profit, like let's say you want to sell fat cakes, there shall be ingredients, baking powder and whatever the ingredients, What shall you do with them? You mix them in order to produce fat cakes at the same time because you want to sell those fat cakes what shall you do. What are you expecting a profit isn't it. You are expecting to get a profit, maximum profit. Nobody wants to run a business at a loss. We want to get a maximum profit and to minimise what? The losses is that clear. that whatever you are doing make it a point that you maximise the profit and minimise the losses is that clear right. Just like last year if I yes last year we were invited at Wits University because we were also a complaining about how can we see LINEAR PROGRAMMING maybe outside school. There was Professor Majozi came to University to explain about lests say maybe you want to do LINEAR PROGRAMMING when he introduces that. LINEAR PROGRAMMING is some sort if put a house there was a house to say what is the shortest way to reach your destination to say in most cases that is used by the employees of telecommunications when they install their lines of communication. what would be the easiest way to connect all these wires so that they cannot waste their wires so maybe you are in a certain company that you should work for then you would be looking at that. You would check what would be the easiest way that shall encourage production in this company. Do you understand that? So LINEAR PROGRAMMING if you want to do it, it is not that difficult it talks about maximising profits and minimising loss. Right now I just want to give you activities that you are going to do. These activities will be written in your mother tongue and English. You shall use English and your mother tongue so that if you discover that you are having problems you use your mother tongue side by side with English. You understand that. So I shall begin with the English, I shall give it to you and then each group shall have a representative. We already have someone who shall come to the front and use the chalkboard when explaining to us in sSotho, Sepedi, Isixhosa and isiZulu. Right. This activity is in English, take one and pass the rest. One person shall record the discussions of the group. I will be moving from one group to the others. I am giving you Sesotho there and Sepedi, I should not find someone saying that his/her Sepedi is not right; isiZulu where is the isiZulu group 1,2,3,4, where is the Sepedi 1,2,...18 you take a copy and pass on to others. IsiZulu you are seven, others who are isiZulu, isiSuthu 1,2,3... Sesothu raise up your hand when you have finished. Sepedi What would

		yo like to have isiSuthu. You all remain seated. Properly understand the task you are doing. IsiXhosa 1,2, who has not received. IsiSuthu right is there anyone who has not received a copy. You are not discussing. ISepedi I have (taken out) 19, who else has not received? Here is Sepedi - who else has not received a copy. We are all having question papers.
	Teacher	Ngeye English ngininikeze yona and then igroup ne group izoba nerepresentative. Sesithole no one oza ebhodini azosi-explainela ngapha esiSuthwini iSipedi nesiXhosa, senizwile. Right leye English take one and pass the rest. Uyi one umuntu ozobhala niya discusa as a group I will be moving from one group to the other. Ngininikeza isiSuthu lapho neSipedi ngingatholi umuntu esethi iSipedi sami asikho right, isiZulu phaphi besizulu 1,2,3, 4, siphi iSipedi 1, 2,.....18 Sipedi uyathatha uyisa komunye umuntu. isiZulu you are seven ne, abanye besiZulu. IsiSuthu 1, 2, 3... nawucedile uphakamise. Sipedi la siyezi isipedi. nifuna ini isisuthu. Akekho umuntu ozosukuma la, uvisise kahle lento oyenzayo. isiXhosa 1, 2, ngubani ongakatholi. iSisuthu right ngubani omunye ongakatholi. Anidiscuse nonke lapho. iSipedi ngisikhiphile esiwu 19, ngubani omunye ongakatholi. Nasi iSipedi ngubani omunye ongakatholi, sonke sesiphethe amaquestion papers
45	Learner	yes
46	Teacher	IsiZulu isiXhosa iSipedi, right niyadiscusa nyalo. Masucedile ukuthikha letha [You can now hold discussion. When you have finished making ticks, handover your marked script.]
		GROUP Discussions
		CLASS DISCUSSIONS
47	Teacher	Right, okay, right njengoba ngishilo ukuthi ngizozikhethela because ngifuna ukuthi umuntu engabalance ngomunye. [As I have said that I shall handpick because I don't want a person to rely on someone else.]
48	Ls	yes
49	T	ngizozikhethela ukuthi kulegroup ngithatha bani, kulegroup ngithathabani azosichazela. Angithi nicale nayi-discusa as a group right asicale nge group South sesuthu okay let us have that group (*teacher pointing at the Sepedi group*) (From the different groups, I shall select one person to explain to us. You stated off in a group discuussion right we begin with the sout seSotho okay let us have that group.)
50	Teacher	Eyani le group legroup elangemuva?
51	Ls	ISipedi
52	Lsepedi	Hha!
53	Teacher	Yiza eh please uzosichazela, awuchazi the whole question ushaya le one kucala right. Mina ngizoyifunda nge English, omunye asifundele isipedi. Right okay sesphendula lamaquestion awufunde lequestion right funda [Come forward please to explain to us you do not explain the whole question you do that one first. I shall read it in English, another one shall read it in iSipedi. Right okay we are now answering the questions, read the question right, read.]
54	Leaner	Read the sepedi version question
55	Teacher	yes listen carefully, yes
56	Learner	continued reading sepedi version
57	Mantombi	Any amount below R10 because at least any amount below R10.

58	Teacher	Asikhulumi I-English angithi asifuni English or Afrikaans ama foreign langauge sikhuluma ngesipedi, Uthi malini sisi [We are not speaking English because we don't want English or Afrikaans which are foreign languages we speak in Sipedi. How much do you say it is my sister.]
59	Mantombi	R10 Any amount below R10, any amount below R10
60	Teacher	Ikhona into eng-disturbhayo ngoba uthi at least ukhuluma ngaso iSipedi bese uthi at least [I am disturbed because you said at least while speaking in iSipedi then you say at least.]
61	Learner	Explaining in Sepedi
62	Teacher	Isho njalo lento ngesipedi, [That is what it means in Sepedi]
63	Learners	Yes
64	Teacher	No angithi ngithi isho njalo yini lento ngesipedi? uzomphikisa phela uma iSipedi sesihlukana, angithi sikhuluma ngeSipedi esione. Asikhulumi ngeSipedi sithole ukuthi iSipedi sesithi, sithole sesihlukana. [No I asked if that is what the concept means in Sepedi? You shall contradict the other if the Sepedi spoken differs because we speak the same Sepedi language. Let us speak in Sepedi and identify what is stated by Sepedi and find ourselves speaking differently.]
65	Learners	in disagreement
66	Teacher	Akesizwe omunye weSipedi, yes [Let us hear someone who speaks Sepedi]
67	Learner	Sepedi
68	Learners	yes
69	Teacher	Lalelani ngithe ngithe lalelani musukukhuluma ngo at least ngoba awumunderstand khuluma nganingesipedi. That is why ngithi musakukhuluma ngento enjani? Ongayiunderstandi akesikhulume ngeSipedi kucala because naku manje seniyaphikisana. AmaPedi odwa aseyaphikisana kusho ukuthi namazulu azophikisana odwa.yes [May I have your attention. Attention do not use at least when speaking because you do not understand what at least means in sipedi. That is why I have to speak what you do not understand. Let us speak in Sipedi first because not you are contradiction each other. Sepedi speakers contradicting one another which means the isiZulu speakers will also contradict one another when speaking.]
70	Learner (si)	Thishela bunnyani [using gestures pointing downwards]
71	Teacher	Okay uthi ithi bunnyani, yes
72	Learner (si)	Sepedi
73	Teacher	R10, nangaphezu kwe R10 or R10 nangaphansi [R10 or above R10 or below R10]
74	Learners	Other learners say ngaphansi [… less than] others ngaphezulu […more than]
75	Teacher	Yes, Sepedi sengikhombe abantu baze babawuthree angitholi baphikisana bodwa right kushokuthi ispedi…(*inaudible*) yesakesitholi isiSuthu. Okay keep queit khulumani, sit down, sit down (*instructing the learner from Sepedi group*). Okay keep queit right [Yes Sepedi, I have picked on three pupils. I do not understand, they contradict one another which means isiPedi... yes let us give the Sotho an opportunity ...Express yourselves, sit down sit down. Okay keep quiet.]
76	Learner	Question
77	Teacher	Ikhona nansi iquestion, [We have the question]
78	Learner	KanasiSuthu, another learner read the Sesotho version of the task
79	Learner(seso)	Kelishumi kuya [From ten to…]

80	Teacher	Uyithathaphi leyonto, Ukuthathaphi lokho, iliphi igama elikhombisa loko lokho bunyana belirandi…[Where did you get that, which word show that the least amount.]
81	Learner	sesotho
82	Teacher	Asisamuzwa…. Awuchaze [We do not understand can you explain]
83	Errol	sepedi
84	Learners	Yes (*learners clapping hands*)
85	Teacher	Okay, okay asizwe la Xhakaza (*Explain Xhakaza*)
86	Xhakaza	Kube ndingathi kuwe…Ngingathi ngiboleke iR10 buncinci bayo [This is what I can say to you can you lend me R10 at least.]
87	Teacher	Okay, buncinci bayo [minimum]
88	Xhakaza	Ngabe ufuna iR20, kodwa uzawuthi ngiboleke ubuncinci baloR20, iR10 [If you want R20 but you shall say lend me at least R20, R10.]
89	Learners	Agreeing and clapping hands
90	Teacher	All right all right asizwe la listen
91	Thato	Read isizulu version
92	Mkhonta	Lalomuntu lo imali ayidingayo, lomuntu lo uthi okungenani like okungenani like kube R10, ubuncane bayo kungabi R9 because makungaba iR9 angeke ngiyithathe, okungenani something uR10 ukuya phezulu. [The person needs the money and the person says at least R10, the lowest of R10 could be R9 but the person shall not accept R9 at least R10 or above.]
93	Learners	(*clapping hands in agreement*)
94	Teacher	Right izandla lezi izona ezibanga umsindo manicedile singasayishayi because yizona esizobanga umsindo isikhathi phela sizohamba singasacedi, right akengithi ngesizulu ngiyayiunderstanda. Mangingathi kuwe o-ku-nge-na-ni, the least amount I want. Ngesizulu ngithi okungenani noma ngabe iyiphi but okungenani ngiphe ini? [Hands clapping makes noise, do not clap hand when you are through because we shall run out of time due to the noise of hand clapping and not finish the exercised. I do not understand in Zulu. Let me say to you at least, the least amount. In Zulu I say at least meaning anything but at least give me something.]
95	Learners	I-R10
96	Teacher	Ungangiboleka nokungiboleka kodwa okungenani ngiphe ini…[You can lend me but at least give me something.]
97	Learners	I-R10
98	Teacher	Do you understand that, well angazi may be there is ngubani longabachazela kahle laba abangakayitholi kahle, because ngiyayi-understanda manje, okay akesithi ke mangingafika kuwe ngithi because kunanaligama elithi at least. Sithi ke at least five people have been injured in a car accident. At least, uyuzwe masikhuluma ngo at least. At least mana mana, yes. [Do you understand that, well I don't know maybe there is, who can better explain to those who have not understood well because now I understand. Okay let us say if I come to you because we have the word at least. Say at least five people have been injured in a car accident. At least, you hear people talking using at least this and that.]
99	Learner	Lichaza ukuthi thishela you were expecting more but at least is a lesser number was injured. [It explains that you were…]
100	Teacher	Mangithi [When I say...] at least five people have been injured, awuchaze, yoh […explain]

101	Learner	Thishela [teacher] not less than five people from five upwards
102	Teacher	Ja baningi abantu asibazi ukuthi mangakhi, lichaza ukuthi baningi abantu abalimele at least five, kuzoba u-five ukuya phezulu but then ubani ozobachazela ngoba akufuneki sibavalele ngephandle upwards asazi ukuthi bangakhi. [There are many people we do not know how many. It explains that many people got hurt at least five, it means five or more but then who is going to explain because we must not exclude them upward we do not know how many they are.]
103	Learner	(Sepedi)… R10 is like I-maximum
104	Teacher	Okay R10 ini, okay yes lerato
105	Learner	Okay now what I understand is more like R10 is like it is compulsory….
106	Learners	Yes (Chorus)
107	Teacher	Uyayithola, your name isisuthu, are you happy iliphi igama elikudidayo [You understand your name isiSuthu, are you happy which words don't you understand.]
108	Learners	Mantombi
109	Teacher	Awusayi-understand namanje? [You do not understand even now.]
110	Mantombi	yes
111	Teacher	Iliphi igama elikudidayo namanje? [Which word don't you understand?]
112	Mantombi	u at least
113	Teacher	u at least
114		Akesiyekele ngo at least sikhulume ngesipedi, sithi bunyanne because that is why ngisho ngesiZulu ngithi okungenani, okungenani ngubani engingathi akukho umuntu okuchazela lento uyizwe kahle because nangingathi o-ku-nge-nani. Laba mabangakakuchazeli kahle kusho ukuthi abakakhulumi sona iSipedi, kusho ukuthi akekho umuntu owazi iSipedi laklasini. Mangabe nehluleka ukumchazela lento ayizwe kahle, kusho ukuthi akekho umuntu owazi iSepedi laklasini. Akufanele phela sibavumise ngenkani, akufuneki sibavumise ngenkani. Ja akufuneki sibavumise ngenkani ja akufuneki sibavumise ngenkani yes ngubani ongabachazela, [Let us forget about at least and speak Sepedi, say bunyaane because that is why in IsiZulu I said at least, at least who can explain it well in you mother tongue. Does it mean they can not explain it well? It means they do not speak Sepedi which means that there is no one who knows Sepedi in this class if you cannot explain the concept. We must not force them to agree who can explain the concept to them] yes
115	Learner	Sepedi
116	Teacher	Right okay okay, alright alright amaZulu akeme ngoba ngizama ukuthi labantu ba understande shangathi isipedi abasikhulumayo asihlangani. [The isiZulu group please excuse us, I am trying to make them understand because their Sepedi is contradicting] yes
117	Learner	Ngicabanga ukuthi.. [I think that]
118	Teacher	iSipedi
119	Learner	Like …
120	Teacher	ngithi mchazele kahle ezwe [explain clearly so that he can understand]
121	Learner	grumbling
122	Teacher	Eh Eh anibachazele kahle [explain clearly to them]
123	Brandon	Explaining concept in Sepedi and learner agreed to his explanation)

124	Teacher	Hhayi uyamfostelela [You are forcing him to understand]. Right no problem soke sibuye [we will come back], right, then teacher read next problem on 'write algebraic representation of the amount I need, akesithole oyi one, awusibhallele, write algebraic [can some one come up and write an algebraic expression]
125	Learner	Wrote R10-R11…
126	Teacher	Lalelani nike ungathi anizwanga, yingako ngithi ke ake sifunde isiZulu [Listen you did not understand that is why I am saying let us read the IsiZulu version]
127	Learner	read isizulu version
128	Teacher	Okay okay muyekeleni, awufunde lento ngesizulu [Okay do not disturb her, read the IsiZulu version of the task], write the algebraic equation of the amount I need
129	Learner	Read silently
130	Teacher	Read isiZulu version
131	Learner	*WroteR > 10*
132	Teacher	Okay okay keep queit
133	Learner	Question what does R represent?
134	Learner	I-R I representa I- rands [R represent Rands]
135	Teacher	Alright, alright okay okay ubuza iquestion asikho isidingo sokuthi nibange umsindo, right okay ubuza I question a brilliant question ukuthi this is *R* >10, ithini iquestion yakho...[He is asking a question, there is no need for you to make noise, he is asking a brilliant question that is this *R* >10, what is your question?]
136	Learner	Sesotho
137	Teacher	Come and write sizobona [so that we can see], keep queit
138	Learner	Wrote, this is incorrect kufuna ibe so [it has to be like this] *R*10 >*R*20
139	Teacher	Right ngishilo ukuthi singaphaphi, okay izandla zisaphakeme. Kwangazuthi nokuphapha kusekhona ngoba asifundi silibele ukuphapha, asifundi manje. Lento ishokahle.... [I told you not to be excited, your hands are still up. It looks like the excitement is still there because we are not reading the question, but excited we are not reading the question is straight forward]
140	Learner	*Wrote >10*
141	Teacher	Muyekeni, ngishilo ngathi ngizoyithathela noma ubani [leave him alone, I told you that I shall pick on anyone],
142	Learner	*Wrote tshelete=x; x > R10,*
143	Learners	yes and clapping hands
144	Teacher	Ngishilo ukuthi loko singasakwenzi ngoba kusibangela umsindo, right.okay iquestion besiyizwe kahle, lowokucala ngubani oyibhalile ithini iquestion ake siyibheke uyifunde kahle. [I told you to stop clapping hands because it makes noise for us. We understood the question, who was the first one to write this, What is the question, let us read it out well]
145	Learner	Read question
146	Teacher	Is this an algebraic expression [teacher pointing at *R*10-*R*20] masikhuluma ngama algebraic expression sikhuluma ngani? [When we speak of algebraic expressions what do we mean? ngoba iquestion iyasho nangesisuthu nangesizulu nagani iyasho.[Because even in your home languages the question is very clear. All right akesibuye kule [Let us come back to] (*R* >10) *(teacher circling R > 10*). What was wrong kule *(here*)?
147	Learner	Mine lomuntu lobekumele abhale u-*R* kuphela [The person was suppose to write *R* only]

148	Teacher	u-*R* kanti yini [What does *R* stand for?]
149	Learner	azangengabhale ukuthi u-*R* urepresente ini [He did not write what *R* represent]
150	Teacher	kusho ukuthi onto ewrong labekufanele enzenjani? Ikuphi okuwrong lapha awuchazekahle kahle [It means that it is incorrect, what was he suppose to do. What is not correct please explain well].
151	Learner	mine ngicabanga ukuthi I-wrong ngoba angiyi-understand ngendlela ayibhale ngayo. [It means that it not correct because I do not understand the way it is written]
152	Teacher	Ubani oyi-understandayo azosichazela kahle e-groupini yenu [Who understands the problem from your group so that he/she can explain it?]
153	Learner	Thishela mine ngicabanga ukuthi into e-wrong ukuthi asifakanga u-*R* ngaphambi kwa 10 [I think we got it wrong by not putting the *R* before the 10] because we can solve for *R*
154	Teacher	so la sekuright [so this is correct] *R* > *R*10
155	Learners	yes
156	Teacher	Sekuright, uyamvumela lo*R* [It is correct you agree with *R*]
157	Learner	Mangibheka leya [When I look at] *(meaning x> R10*) ngibona icorrect kwendlula leya [I think it is a better solution] *(meaning R > R10*
158	Teacher	Iyiphi endlula leya [Which one is better?]
159	Learner	*x* > R10
160	Teacher	Yes Errol
161	Errol	Mangabele R is greater or equals to 10, mara nawu solva for *x* or *y* and now plot kumele u plot *x* or *y*. [If R >10, when you solve for *x* or *y* and now you should plot *x* or *y*]
162	Teacher	Okay okay okay wena Errol uthi this R is because kufanele sisebenzise ubani [So Errol, we should use what?]
163	Errol	*x* no *y*
164	Teacher	u *x* or u *y* [teacher writes, *x* or *y*] yes
165	Learner	Defending my group, we can also use i-*z* ne *r* ne *x* and any other alphabet
166	Learners	Yes
167	Teacher	Right yes [*pointing at Errol*]
168	Errol	…funu zoyiplott...(*learners laugh*)
169	Teacher	okay, okay, yes pointing at Xhakaza
170	Xhakaza	I-algebra ingama [algebra is about] symbols and letters,
171	Teacher	yes
172	Xhakaza	Which u-*R* ngingamvumela, ndingavumelana naye because is a symbol of maths. [I accept R, I can accept the letter R]
173	Teacher	That is correct, It can be any symbol it can be *a* it can be *b*. Angeke uthi angeke uyisolve nakuthiwa solve for *a* and *b* bese uthi wena you can only solve makuna *x* or *y* kuphela as long as kuyisymbol. [You cannot say that you cannot solve for *a* and *b* if there is *x* or *y* as long as it is a symbol Right okay now let us look at number b. isikhathi sesizophela, we are left with 10 minutes. We are left with 10 minutes, right [*teacher read next question*]. Yes awufunde ngesiZulu.
174	Thato	NgesiZulu bathi, Umsebenzi waseNqxayizivele uhola okungenani.. Ngenyanga [Read isiZulu version]

175	Teacher	Ja, yiyo kanye engiyibhale kanjalo ngengizame ukuyibhala, ngingumZulu lowo …wathi wathi
176	Thato	Yes [continued to read the problem] U John omunye wabasebenzi utjele intombi yakhe ukuthi uhola I R1800, ngabe u-John ukhuluma iciniso na?
177	Teacher	Right akesizwe la ukuthi ngabe Ujohn ukhulumiciniso na.
178	Learner	Inaudible
179	Teacher	Why?
180	Learner	Akaholi iR1800 uhola R1500. (*Learners laughing*)
181	Teacher	Ngabe uJohn ukhuluma iciniso yini? yes
182	Learner	Yes
183	Teacher	Why?
184	Learner	Sepedi…minimum
185	Teacher	Bonnyane (*writes on the board*) right okay uJohn
186	Learner	Oh!
187	Teacher	Okay so u-John senikhuluma iSipedi kemanje yes lapho [you speak the same Sepedi now]
188	Learner	Sesotho version
189	Teacher	Why ngoba bathola R1500 why manje seyithi R1800? [Why R1800 when they earn R1500?]
190	Learner	Ubunyanni ba R1500 [R1500 is the minimum]
191		
192		end of tape
193		
194		Day 2
195	Teacher	Right eh sis Thulie and Nathi you are welcome
196	Nathi	Thank you
197	Teacher	Right yesterday we looked at eh we were using the word at least using different home languages. In Zulu by the way how we interpreted the word at least yesterday. do you still remember
198	Thato	Okungenani [minimum]
199	Teacher	Okungenani, okungenani kuchamuka kuphi? Usukhohliwe? [Minimum, how did we get minimum]
200	Learner	No
201	Teacher	okay
202	Thato	Okungenani kusho ukuthi imali ayidingayo ufuna elingana no R10 noma upwards noma imali ilingane ne R10 [Minimum means the money that he needs is R10 or above]
203	Teacher	Niyavumelana nalokho ake sizwe lapho nitheni eh [Do you agree with that?]
204	Xhakaza	Thina sithe ubuncinane u at least uthetha ubuncinane [Minimum]
205	Teacher	Kusho ukuthini lokho [What does that mean?]
206	Xhakaza	Masibuka kuleya question thina sithe ufuna imali engaphezulu kwe R10 ubuncinane bayo iR10 [With reference to that question we said he wants more than R10]
207	Teacher	Okay yes sesotho

208	Lerato	…uR10 is the minimum amount you can give
209	Teacher	Is the minimum amount, sikhulume ngokuthi uR10 [we say R10] is the minimum right amount therefore...
210	Lerato	Therefore you must give him R10 or above not less than R10.
211	Teacher	Okay one from sepedi group, that was sesothu right one from sepedi goupr yes Brandin
212	Brandon	…thishela it can be R10 or more than R10
213	Teacher	Izolo ngike ngezwa nikhuluma ngeminimum, bunyane bungasho iminimum. Okungenani nithanda ukuthi iminimum kanti yini iminimum? Ake sizwe Magudulela[(Minimum referred to in different home languages]
214	Magudulela	Thishela iminimum angithi lapha bathe eNqxayizivele bahola iminimum ka R1500, Ujohn yena utjele intombi yakhe ukuthi uhola R1800 kulabasebenzi baseNqxayizivele akekho umsebenzi ohola ngaphansi kwa R1500. Akekho umsebenzi ohola ngaphansi kwa R1500.[R1500 is the minimum amount, no worker earns less than R1500, John told his girlfriend that he earns R1800]
215	Teacher	Oh iminimum yabo R1500 okay [Their minimum salary is R1500]. So Sizochubekake namhla nje sibone ukuthi [we will continue today and see] … by the way sithe [what] is Linear programming is all about what? Who can summarise that? Yes Errol
216	Learner	Maximizing the profit and minimizing the loss
217	Teacher	Akesibone ke namhlanje ukuthi uday 2 siphetheni. Ngithe one niyadiscusa…ngizoninikeza take one and pass that nizowathola esilumbi maningi ayeza. Right nenza njengayizolo you answer all those questions. Right siza kusuku lwesibili obani labo. Isizulu or Isixhosa Eh. [Let us see what we will cover for day 2. I told you that you discuss, I will give you take one and pass that, you will get your English version I have enough copies. You follow the same procedure as yesterday. You answer all those questions. Right we are in day 2, who are those, isiZulu or isiXhosa?]
218	Learner	Isizulu
219	Teacher	Kungaba isizulu kungaba isixhosa [It can be IsiZulu or it can be Isixhosa). Sipedi (teacher distributing question papers] Sipedi. Right
220		
221		Group discussions
222	Teacher	Right okay all right okay okay okay right okay. Sengethamba ukuthi senicedile, [I hope that you have finished]
223	Learners	yes others say no
224	Teacher	Right now abangakacedi bazawuza la kudiscussion. Right oket I will start with i-group yesiZulu, I will start with isizulu group, and I will get one from isiZulu group just to come and explain and then thereafter isiSuthu siphi. IsiSuthu iSipedi, okay ake sithole one lapha egroupin yesiZulu. Maseko sishiyananawe ke namhle nje right, uthe nawufunda kelapho wathola ini? Right mawufunde before usichazele kucala. Ake usifundele iquestion a and b ngesiZulu sizwe ukuthi ithini, nalalabanye nabo bazolalela. You can also mix isiZulu iSipedi neSisuthu, angithi sihlangene la sise Gauteng.siyazungeza you can just mix anything. (Right now those who have not finished shall join the discussion. Right okay I will start with the isiZulu group. Okay let us get one from the isiZulu group. Maseko today it is your turn to present. What did you get when reading? Right read first before explaining. Read the question a, b in isiZulu so that we can know what it contains the others shall be listening. You can also mix languages because we are united. We are in Gauteng we are all rounders)

225	Thato	Thishela ngizofunda ngesizulu [I will read the isiZulu version
226	Teacher	Ja, eh eh ngesizulu hhayi ngesilungu. [Ja, in IsiZulu not in English]
227	Thato	Mistakenly read isiXhosa version
228	Teacher	hhe…(What)
229	Mkhonta	IsiXhosa, ububhanyabhanya [It is the IsiXhosa version] (*learners laugh*)
230	Teacher	Yes keep queit
231	Thato	Read
232	Teacher	Ake ufunde isiZulu wena Thato kungangena…[Read IsiZulu properly Thato]
233	Thato	Read again
234	Teacher	|Sizwile angithi read question… nayi iquestion esiyibhekise egroupin yesiZulu…[You all understood the question, it is directed to the Zulu group]
235	Mkhonta	Thishela sibhale ngesilungu yini [Should we write in English Sir?]
236	Teacher	Well it's up to you, ungabhala ngeEnglish noma ubhale ngesizulu [You can write in English or Zulu]. Mine ngizowufuna ngesizulu nange english (I want answers in both languages]. Keep quet okay keep queit yes
237	Maseko	Mandla cinema can accommodate a maximum of 150 people for one show.
238		Mandla cinema can accommodate a maximum, the word maximum of 150 ngesizulu niyibeke kanjani? Niyibeke kanjani ngesizulu? Ngithe bhala ukhombise ukuthi uyawuzwa llenkulumo ebeyisho la. [How did you answer the question in IsiZulu, I said write the answer to show that you understand the question]
239	Learner	Ihhola likamandla thishela ukuthi kungangena abantu abawu 150 ukuya phansi, kungabi u-150 ukuya phezulu. [Sir, Mandla cinema can accommodate 150 people or less]
240	Teacher	150 kuya phansi hhayi ku 150 kuya phezulu. Okay fine, owesibili? [150 or below and not 150 and above okay the next question]
241		Eyesibili… akesizwe. Nitheni lapho [second question how did you answer the question?]
242	Maseko	Sithe [We said] The show will not go on because he will not benefit profit from 39 people
243	Teacher	Nithe [you said] the show will not go on because he will not benefit from 39 people. Right, niyayizwa lendaba akengizwe ukuthi nithini [Do you hear what they are arguing] okay, ubani onenkinga nequestion a [Who has a question with a?]. Right, okay okay okay, ubani obe nequestion ku question a? (any question from a?] Ake sikhulume ngequestion a kucala [let us first discuss question a), lelethi ihhole likaMandla Cinema [The one about Mandla cinema hall). Ngubani obe neproblem yokuthi (who has a problem with that] it can accommodate a maximum of 150 people. Siyavumelana nalokho [Do you all agree with that?]
244	Learners	Yes (*chorus)*
245	Teacher	Niyavumelana nalokho, ukuthi it can accommodate a maximum of 150 people. Now nayi iquestion yesibili. uthi uma kunabantu abawu 39 ngabe sizochubeka yini isithombe nome cha. Bayaphika bathi angeke manje sengibonizandla ziphakeme, bayaphika bathi isithombe ngeke sisachubeka ireason yenu lapho yini? yes magudulela [Do you agree that it can accomodate a maximum of 150 people. Now look at the second question. If there are 39 people will the show go on or not? Some say it cannot go on this is exhibited by the raised hands. They say the show can not go on. What are you reasons for the show not to go on? Yes Magudulela]
246	Magudulela	Thishela angeke athole I-profit [He will not benefit profit Sir]

247	Teacher	Ngeke athole iprofit. Umagudulela uthi, Zulu group bathi ngeke athole iprofit. Bathi there will be no profit. Right, okay okay akesizwe abanye ukuthi bazoyibeka kanjani. Akesizwe lapho emuva, yes [He will not benefit profit, that is what Magudulela; Zulu group had said there will be no profit. They say there will be no profit. Right okay, okay. Can we get views from other groups? Those at the back yes]
248	Learner	Sepedi
249	Teacher	Nayo ayizochubeka futhi, sh... Akesimlalele [The show shall not go on.]
250	Learner	Sepedi
251	Teacher	Now igroup yesiZulu ithi [the Zulu group say] the show will not go on, and nina nithi [you are saying] the show will go on. Akesizwe... ISipedi angith...[let us hear from this group, Is that the Sepedi group] yes
252	Learners	isiSuthu [Sesotho]
253	Teacher	Akesizwe iSipedi kucala, yes [Let us give a chance to Sepedi group first]
254	Errol	…150 kuya phansi, akanawumela 150 kuya phezulu [150 and below, cannot wait for 150 or above]
255	Teacher	Okay, okay, alright okay akebajusifaye ipoint labo okay [Okay, let them justify their argument]
256	Mkhonza	Mawudefina iloku linear programming ithini idefinition ye linear programming. [When defining linear programming, what is the definition of linear programming?]
257	Errol	Before mina ngikuchazele ngitjele mina ukuthi ithini [tell me what it is before i define it to you]
258	Mkhonza	Ithini [what is the definition?]
259	Teacher	Okay, no eh masichubeka ngequestion ngequestion. muexplainele uthi ithini ilinear programming [okay, no eh let us not answer a question by a question, explain the meaning of linear programming]
260	Errol	Ithi (it says) maximising the profit and minimising the loss, so nami ngiz…[i will also…]
261	Teacher	Hhayi alright ebengakacedi, ebesebuza ukuthi ithini ilinear programming ebesezochubeka keep queit nizwe ukuthi uthini. [he was not through, he was asking for the definition of linear programming, he was going to continue, keep queit and listen to what he is going to say.
262	Mkhonta	Wena nawubhekile lomuntu lo nakungena abantu abawu 39 kumele ucabange ukuthi le i-one show. Nakungena abantu abayi39 akusiyo nehhafo ka 150. Mara iprofit izophuma kanjani nakungasiyo nehhafu ka150. Akusiyo hehhafu, nehhafu ka 150. [when you look at this person, when 39 people get into the cinema hall, how is he going to make profit from 39 people since 39 is not even half of 150, it is not even a quarter of 150?]
263	Errol	at most ngisho imaximum angisho ilanguage ye linear programming (this is a maximum, the language of linear programming) it says equal to 150 or less than 150 so the show will go on if bebathi ba expecta(they expect) at least 150 people besizothi ishow beyingeke ichubeke ngoba babheke 150 noma phezulu kuka 150 [we were going to say the show will not go on because they expect 150 or more than 150]
264	Mkhonta	Kuze leshow ichubeke kumele kuze abantu abawu 150, imali phela le akudlalwa. Yithi R10 times 150 ubheke ukuthi malini. Bese uthi R10 times 39 uphindu bheke ukuthi kuza malini [There must be a maximum of 150 people for the show to go on, jokes aside this is money. Multiply 150 by R10 and see what you get, then multiply 39 by R10 and look at the amount he receives]

265	Teacher	Okay fine, akesibayekeni labo ngoaba sebesosenzela… ake sizwe abanye nithini, nawamgroup ayi two. Ithi igroup yesizulu ishow angeke ichubeke because there will be no profit. Laba begroup yesipedi bathi the show will go on because of the word I-maximum. Imaximum it can accommodate 150 or less yes [Okay fine, let us for now leave them, let us give others a chance to make their contributions, these two groups. The Zulu group suggest that the show will not go on because there will be no profit, and the Sepedi group suggest that the show will go on because of the word maximum. Maximum can accomodate 150 or less]
266	Xhakaza	Uzochubeka umdlalo [The show will go on]
267	Teacher	Uzochubeka umdlalo [The show will go on] Xhakaza uthini nge-issue yalaba abathi angeke kube ne profit [What do you say about those who have said that there will be no profit].
268	Xhakaza	Thishela Angeke ahlala achekha ukuthi xha-kufika abantu abayi 40 everytime, uyabajikisa. Ngeke… [Sir he will not always check that when they are 40 people they shall be turned away no..]
269	Learners	yes
270	Teacher	Okay, okay. Ngihlale ngisho ke ngithi ilinear programming izoni… nakhoke isifikile. Isiphezu kwenu ke manje. Lalela yes…[Okay, okay, I have always told you that linear programming is tricky, it is now up on you, listen yes]
271	Xhakaza	Uyazi ukuthi angeke ahambe ayofunana nabantu abawu 150, uyazi ukuthi u-expecta abantu abawu 40, 50 , 60…[He knows that he is not expecting 150 all the time, he expects about 40, 50, 60 … people]
272	Mkhonta	Hha sekathini [what is she saying now?]
273	Teacher	Mani, mani asumyeke achubele [wait, wait, let her continue]
274	Xhakaza	Yes sir u-expetha lokho, uhlaeyazi ukuthieveryday kufika 150…akanawu expetha I-profit everyday [Yes Sir he does not expect to get a profit everyday]
275	Teacher	Okay ngamanye amazwi ufuna ukuthi ngelinye ilanga uzoluza, ngelinye ilanga uzowina sengikuzwa kahle ke manje. Okay okay ngizwa kahle. Nawe uvemelana negroup ethe ke the show will go on. Keep queit [Okay, in other words you are suggesting that some day he will lose, some day he shall win. i understand you rpoit now. Okay, okay I fully understand you also agree with the group that said the show will go on. Keep queit]
276	Learner	Ibinessman inam [A business mans has) risk if you are in a business you are going to take the risk. Even when the business… may be kune ([here is]…(*learners saying yes*)
277	Teacher	Okay okay, lalelani umuntu masimphikisa…[listen pay attention to someone we do not agree with] listen Grade 11, you are not using common sense here, ukuthi ngicabanga ukuthi sisebenzisa imaths la. Uthi mawenza ibizinisi at the same time you are aware of risk. Akesizwe ukuthi uthini. [I think that we are using mathematics to justify our answers. He says when you are running a business.. let us hear what he is going to say] Yes
278	Learner	*Sepedi giving an example of a taxi*

279	Teacher	Okay well etaxini okay okay lalelani etaxini angikuphikisi ngifuna sizwaneni la, but itaxi, nami ngike ngadriver (*learners laughing*) uyabona itaxi ayisuki erankini u-driver noma ngakuthiwa late kanganani sh… may be ningakhuluma ngokunye. Itaxi erankini ngeke isuke ngisho ishoda ngomuntu oyi-one. Okay okay sh okay alright, Thato, Xhakaza. Sizobabona abanye.[Okay well the minibus example okay okay listen in the minibus example, I am not saying you are wrong but I want us to understand that the minibus leaves the taxi rank when full. May be you can talk about other things. The minibus will not drive out of the taxi rank if not full even if there is just one passenger short] Okay keep queit
280	Thato	In terms of more profit angeke thishele. Angeke nawuthi uyebhayisikobhe angeke thishela uthi uyobukela imovie eyi one. Uyaboreka thishela unless nginamanga..[in terms of more profit Sir. You cannot go to watch a movie no Sir you cannot go to watch the same movie you get bored unless I am not telling the truth.]
281	Teacher	Lalelani la, angimuzwa kahle uThato okay okay keep queit, ngizama because angisamunderstand ngoba igroup leyakhe ithe there will be no profit, so i-show angeke ichubeke, and then igroup leyesipedi ithi ishow will go on negroup yesixhoza nani nishonjalo.Manje uThato angisamuzwa ungathi useyaziphikisa. Mana, ngiyeza Thato, yes akesizwe nayi iexample [Listen, I do not understand thato well okay keep queit, I am trying because I do not understand because her group had said there will be no profit, so the show will not go on and the Sepedi group suggested that the show will go on, likewise the Isixhosa group and you as well. Now i cannot understand thato. it seems like he is contradicting himself. Wait Thato; yes let us listen to this example.]
282	Xhakaza	Abantu nakudlala ibhola abantu baya estimate itulu zining. Kunga fika abantu abayi2 ibhola iyachubeka. [When there is a soccer match in a stadium the game continues even when they are two spectators]
283	Learners	Yes
284	Teacher	Okay, okay, sh.. Okay okay okay Uthini uthi ngalamanye amazwi xhakaza uvemelane nami mangithi leyeTaxi ayifani right uthi istadium it doesn't matter ukuthi abantu bangakanani ibhola lizochubeka. Okay okay okay akesizwe la [In other word you share the same idea with me with that example of a taxi, You said in the stadium the match continues, it does not matter how many people are watching the game, okay let us get another suggestion]
285	Learner	Thishela, njengoba bethi [Sir because they say) there will be no profit are you telling me that like if every week and like less than 150, 40. 45 the show will not go on?
286	Teacher	Ngizokukhomba, ubuza iquestion esimple, kufanele niphakamise isandla nimphendule ningamhhawuli yes (I will give you the opportunity to speak, raise up your hands. She is asking a simple question raise up your hands and answer the question instead of shouting at her)
287	Mkhonta	Awuthi ngicale ngaloya masesikhuluma ngerisk, ngerisk lomuntu angeke kuthi nakucala ibusiness kufika abantu abawu39 ngizishila ngibheke ukuthi kulandelani. Lomuntu lo ulethe inkinga kusho ukuthi labantu laba ngibo abahlala beza. and uyaluza lomuntu lo, hhayi ukuthi iyacala ukwenzeka lento le sekuyisikhathi yenzeka. [Let me respond to the first one about risk in business, the person will note when starting the business that there are at first 39 people and then look at the next number. This person has a problem; it means the 39 is a problem. He has brought the problem to us to solve.
288	Learners	laughing
289	Teacher	Okay okay yes

290	Learners	Mina bengifuna ukubuza thishela ukuthi a businessman is he always expecting to win,is he going to ahambe atjela bantu kuthi wozani nizobheka ncanabe fike bawu 39 sewuthola ukuthi sowuyajika. [May I ask a question Sir, Does a business person always expect to win? Is he going to go around telling people to come and watch a movie only to turn them away when there are 39 people?]
291	Teacher	Manini manini let us okay Xhakaza let us do this. Upeter uthi uma kunabantu abawu 39, uthi isithombe ngeke sichubeke. Kusho ukuthi uvemelana negroup yabo Mkhonta, the Zulu group usho njalo uPeter. ..Ngoba ihhola likaMandla ngeke libe nenzuzo, uyavumelana yini no peter kungani uvumelana no Peter. Okay, sesiyiyekile manje indaba yegroup yesizulu we are now talking about UPeter eyimele lapha uthi hhayi angeke ishow ichubeke. [Wait wait Peter suggest that the show should not go on because there will be no profit with 39 people. Which means that he support the Zulu group] yes
292	Lerato	We said yes because the 39 is not I-representative of 50% of the 150 peoplewe mean yes.
293	Teacher	Now I am having a problem, because the very same group ebeyithi [which said] the show will go on seyithi [is now saying] the show will not go on.
294	Zulu group	Seyinathi manje! [They are saying the same thing as our group]
295	Teacher	Ngiyeza kini. Okay ngiyeza kini, Igroup yesisuthu ithi kunumber 2 the show will go on, yafika kunumber 3 yathi the show will not go on. All right seyiyazi phikisa manje. Yes shh. Alright okay. Into engiyaziyo ukuthi le group isazosuphotha ipoint layo ake ngizwe igroup yesi Xhoza. I will give you the chance; Okay I will give you the chance. The Sesotho group had stated that the show will go on but in part b they are saying the show will not go on. They are now contradicting themselves. Yes sh... Alright okay. What I know is that the Zulu group is still going to support their suggestion. May I give the Isixhosa group the opportunity?] Okay
296	Learner	Akazawuphulela imali yokungena, izohlala injalo ngalawo mazwi asivumelani no Peter. [We do not agree with Peter because the price of the ticket will not be reduced]
297	Teacher	Anivumelani noPeter? [You disagree with Peter?]
298	Learner	Asivumelani [We disagree]
299	Teacher	Lalela kwangathi animuzwa ukuthi uthini. Uthi Upeter uma kunabantu abawu 39, isithombe ngekesichubeke ngoba ihhola likaMandla angeke libe nenzuzo. Kusho yena. [You seem not to understand Peter's argument, Peter said if there are 39 people the show should not go on because there will be no profit. That is what he said] Yes
300	Learner	Iside lakhe, namhlanje wazi kahle ukuthi kunabantu abawu 39 uzabafaka idiscount ayikho imali ihleli injalo yokinto ikhona ukudla, bayangena..[That is his suggestion, Today he knows that there are 39 people he will not give them a discount, the price of the ticket is the same, and everything is available food the people will buy....
301	Teacher	Kodwa (but), what was interesting, what was interesting la wena [here] Xhakaza amagroup ayithree bebephikisa legroup yesizulu kodwa [the three groups said the show will go on] when it goes to the next question the three igroup yesisuthu seyishintjile [the show will not go on]. Okay, alright yes.
302	Learner	Because he is always expecting 150 people or less..., the show must go on even if …
303	Teacher	Okay, yes
304	Learner	I do agree for b I say no because he will be minimising the profit and maximising the loss. Since it is 22% of 150..

305	Teacher	Senidivided manje ngoba group yesisuthu, iyabuya manje ithi kunumber b. no profit the show will not go on. Okay okay okay ake sizwe wena
306	Learner	the show will go on, nawena the class wena the class may be a maximum of 46 people and kunabantu abayi 10, wena hhayi u tla ruta [the show will go on because even when there are 10 students in the class instead of 46 students you will continue teaching] *(learners laughing*)
307	Teacher	alright, okay okay okay okay akesizwe la [let us move on to the next question]
308	Learners	complaining, thishela [Sir]
309	Teacher	Wo..wo.wo wo okay yiziphi izindleko…yiziphi izindleko, angithi ngizama ukutholi answer angithi niyabona, sizama ukuthola I-answer nasilokhu sichubeka namaquestions, hhayi ukuthi ngiyabaleka sizama ukuthi sithole inswer hhayi kuthi ngijake ukuceda, sizama ukuthola inswer yes
310	Learner	Ukudla
311	Teacher	Ukudla yes
312	Learner	Electricity
313	Teacher	Electricity, indleko zonke u-Mandla cinema abhekene nazo, ishow kuze kuthi ichubeke kufuneka kube khona ukudla yes
314	Learner	I-rent
315	Teacher	I-rent, I-rent yes
316	Learner	Entertainment
317	Teacher	Entertainment, yes
318	Learner	Nabasebenzi,
319	Teacher	Nabasebenzi bakhe amaworkers, abantu azobacasha yes
320	Learner	Proper furniture
321	Teacher	Ini?
322	Learner	Proper furniture
323	Teacher	Kumele abe ne proper furniture, yizo zonke izindleko u-mandla cinema abhekene nazoyes
324	Learner	Kumele abhadale irent kunabantu abawu 39 akatholanga iprofit
325	Teacher	Akesithole yes
326	Learnerr	Kunekuthi amanye amalanga enze iprofit, ngamanye amalanga enze I loss
327	Teacher	Okay okay but bengisabuze izindleko, nibale I rent nabala I-electricity nabalabsebenzi. Okay keep queit yes
328	Learner	Thishela kusho …
329	Teacher	Ja kusho ukuthi nakangayitholi iprofit uzoyivala
330	Learners	inaudible
331	Teacher	Let me tell you one thing, let me tell you one thing, are you aware that may be when there is an increase in petrol ngishilo ngathi ilinear programming you think of maximising the profit and minimising the loss. Does it necessarily mean that because wena you want the profit bese iservice kubantu kumele ibe poor. Does it necessarily mean that because wena you want profit the only thing that you are concerned about with is your profit you dont care about the people. that is where phela igovernment comes in. Angeke uzosilethela ipetrol engenavalue. just becaus wena ubheke iprofit. Ngako akesiye ku question number b. Uma bekunabantu abawu 39, ngabe sizochubeka yini isithombe noma cha? Because onke lamaquestion besizama ukuthola ianswer yes

332	Learner	Yes the show will go on.
333	Teacher	The show will go on yes
334	Learner	The show will go on because Peter an ordinary person and then they are not specific whether eh in a month may be is just for this specific day, so bear in mind that the show will go on
335	Teacher	Okay right an argument kaPhumzile ithi, kubese kuthathwa uPeter an ordinary person from the street kwathiwa aka-commente. Okay, ake sizwe labantu abadifenda lendaba kaPeter yes
336	Thato	What if Peter ey Boss.
337	Teacher	Okay, Okay, Okay right. Phumzile nangim-analaza kahle uthi Peter is just an ordinary person. Akayiphiki uThato leyo it is an ordinary person but he is the boss. Yes
338	Learner	inaudible
339	Teacher	WO..
340	Teacher	Hhayi hhayi.. Yes
341	Teacher	Ake simuphe ichance ajustifaye ipoint lakhe
342	Thato	Ngicela ufunde iquestion kahle, Ake ufundi question kahle, fundi question kahle lomuntu loakathi eh, akathi eh uthi uyalwa uthi angeke kube
343	Teacher	Alright, alright okay asesiyifinalyzeni, Bhala imigomo ongayibeka ukuthi uMandla angayibeka, ukuthi yimiphi imigomo ongayibeka engenza ukuthi Mandla angalahlekelwa yinzuzo, akesiyeni lapho. *(learners confused*) number e. akesiyeni lapho amarestrictions, angithi uPeter uthe ishow will not go on because ke sekuthiwa manje bhala imigomo ongayibeka engenza ukuthi uMandla angalahlekelwa yinzuzo. Yimiphi imigomo ongayibeka yes
344	Learner	Change accomodation because he was aiming high
345	Teacher	Uthi he must change what,
346	Learner	Change accomodation because he was aiming high
347	Teacher	Yes kufuneka achange athini
348	Learner	Ashintje lapha athi at least 50, iminimum 50. For one show iminimum must be 50
349	Teacher	Ashintje lapha athi atleast 50, hhe..remember okay okay, khumbulani masesithi at least. Lalelani, lalelani angithi u-atleast izolo sikhulumile sathi kusho kuthi usho 50 or more. Still.. Akesizwe abanye ukuthi bathini yes. Okay akusho ukuthi siyaniphikisa, asiniphikisi, sisazothola eminye, yes
350		
351	Learner	Mina I say, the main restriction mina I can say that people should be greater than 75
352	Teacher	Listen very carefully asisho ukuthi inswer iright sisezowabona asewonke. Wena uthi abantu kumele babe bangakhi? Yes
353	Learner	|Should be greater than 75, at least 75 people
354	Teacher	Wena uthi at least kufuna kube hehhafu, from 75 upwards but less than…phela ungalkhohlwa ihhola likaMandla ukuthi liaccomodata 150. Ngeke uthi nawenza irestriction bese ubheke iside eli-one. Kufuneka ubheke neside lehhola ukuthi ihhola liaccomodate how many people per show. Yes...
355		end of tape
356		
357		DAY 3

358		
359	Teacher	Right okay the day before yesterdat we looked at the word at least isn't. which simply means what?
360	Learners	Minimum at the same time
361	Teacher	One person at a time, yes Winile
362	Winile	Minimum
363	Teacher	What else, yes
364	Learner	The smallest amount
365	Teacher	The smallest amount, you can say the smallest amount because we said borrow me at least R10, borrow me at least R10. How did we write borrow me at least R10? Yes borrow me at least R10, how did you write if some one says to you borrow me at least R10.
366	Learner	R is greater than 10
367	Teacher	R >10 or you can say x > 10 or *y* > 10. In most cases we use *x* and *y*. But is there any thing wrong in using R. Why? Yes
368	Learner	Mina ngineproblem no *R*,
369	Teacher	Yes
370	Mkhonta	Lo R lo masimtransposa these are like terms…
371	Teacher	Yini I-problem no R
372	Mkhonta	…because u R lo masimtransposa kuzosal u R9
373	Learner	Kuya ukuthi as long as u... Ukuthi u R u representa ini, if that R urepresenta…
374	Mkhonta	Angazi mine mfowethu ngicela ungi...ukuthi urepresenta ini, that's why…that'why lomuntu wenzi maths, uyabheka ukuthi kwenzeka ini
375	Brendan	As long as uyobheka ukuthi lo R urepresenta ini which means … kwasala ilike terms. If R arepresenta bread kala…
376	Mkhonta	Mara akarepresentanga…
377	Teachre	Thankyou very much Brendan
378	Learner	Mina kufinancial maths uR urepresenta imali, thina masibona uR…
379	Teacher	Kufanele nenzenjani
380	Learner	U R u representa imali…
381	Teacher	Cishe uBrendan uyiphendule kahle, akekho umuntu uzoyispoila ukuthi thats R represent this. Angeke kube ngama like terms ngoba that R represents something else no R ka R10 is money. So lezinto eziyitwo azihlangani. These are two different things. R that represents something, you are saying something. You are saying suppose R is equal to that. so how can that R be like terms nale R10. Right and then yesterday we looked at the word at most. which other word do you think also fit with at most
382	Learner	Maximum
383	Teacher	Maximum, right yes.
384	Learner	Highest amount
385	Teacher	Can it be highest amount, yes
386	Learner	Largest amount
387	Teacher	Largest amount, highest amount now it is the matter of language, now its language, highest amount largest amount yes
388	Learner	greatest amount

389	Teacher	Right okay okay, what we are going to do today. I am going to give you a statement. Transform it or write down that statement in a mathematical form. And thereafter plot a graph. I will be giving you a statement in both languages. In isizulu and English, Isixhosa and English j onust take one and pass it
390	Learner	If they say angiplote igraph u R ngizomplota kanjani?
391	Teacher	What do you mean when you say uR simplota kanjani?
392	Learner	inaudible
393	Teacher	Take one and pass it on, sizobona which means that mangingakupha I-graph eka so may be wena uzuskethca I graph ethi $y = ax + b$
394	|Errol	..inema like terms
395	Teacher	$P = ax + b$, ngeke uyisketche leyo
396	Learner	silent
397	Teacher	English version aphi amaquestions, maningi kabi amacopies. Nankha la
398	Learner	Asikho isiXhosa
399	Teacher	English version (distributing question papers to learners) Right siphelele sonkhe. Right remember that you use only one when you are a group
400		
401		GROUP DISCUSSIONS
402		
403	Teacher	Right okay right okay okay okay, we are left with only 35 minutes. And in this 35 minutes we will be discussing. Now stop writing, remember one thing that you cannot sketch a graph if you did not answer (I), (ii) and (iii). That is (I), (ii) and (iii). That will help linear programming us to sketch a graph. Do you understand? Now before you can sketch a graph, I will start with the Zulu group to find out what did you get for the first equation. How did you write that inequality? for number (i) and then you must also explain to us how did you get that yesMkhonza
404	Mkhonza	One thousand….
405	Thato	Hamba uyobhala
406	Teacher	Woza, then you must explain. You explain everything you don't just write you explain everything. I said you talk and explain. Mkhonza explain please.
407	Mkhonza	Then iequation yethu ithi, njengoba la bashilo bathi ke inkomo eyi one like amadairy icosta 1250 and asazi ukuthi yingakhi, that is why sith u x and plus inkomo le abayithengele inyama ibiza R1000 nayo asazi ukuthi yingakhi. Mara eyi one icosta R1000 then lomuntu lo uphethe R5000.Angeke akhone ukuthi asebenzise imal e-more tha R5000. That's why sithi must be less than or equal to R5000. Angeke kube R5010 akanamali. Then mangabe lomuntu uthenga inkomo eziwu two, mhlawumbe uthenga two kumabeef then athenge one kuma dairy sizosubstitutha kuy y, bese sisubstitha kux sibone lokuthi lomuntu uspenda malini. any question
408	Teacher	Right, I have a question. Yini nidecided to say $1250x + 1000y < 5000$ and why not $1250x + 1000y > 5000$. Why you decided to say that yes.
409	Learner	Inaudible
410	Teacher	Yini ewu-maximum
411	Teacher	Awuchaze khona omunye azoyiunderstanda kahle
412	Learner	… basebenzise I-maximum which means less than or equal to
413	Teacher	Uthini lapho, yes

414	Learner	Sir yingoba imali ayiphethe ilingene u-R5000, angakwazi ukusebenzisa imali engaphezulu kwaleyo
415	Teachre	Oh that is why because imali azoyisebenzisa
416	Learner	imali ayiphethe izabaless than R5000
417	Teacher	Oh siyavumelana ukuthi it should not be $1250x + 1000y$ it should not be greater than or equal to 5000 that one is wrong okay. Right that was the first question. Then you mark your work if your equation and that is how we mark it at the end of the year. What is important here is to get those equations. To sketch a straight line graph is simple because this is a straight line graph.But now that is how we mark. Just to get this equation I might give you one or two marks. Let's say its two marks. Now we move to number two. What is number two? What is number two It says write down any other inequalities implicit in this equation. What does it mean? Who can explain to us what does that means. Write down any other implicit any other iequalities implicit in the situation.
418	Learner	Thishela bathe maximum is greater than or equal to
419	Teacher	Xhakaza niyayizwa, awuyichaze.
420	Xhakaza	Thishela, ngingathi uyakwazi ukufumana amvalue ka x ngaphandle….(*inaudible*
421	Thato	Ithibhala ialgebraic equations mayelana nalengcogco engenhla.
422	Teacher	we are not referring to this
423	Thato	bhala iequation, bhala iquation
424	Teacher	Bhala any other inequality implicit constrain
425	Thato	$xX > 1$, $y > 1$, sure mfana. Usuppothe usaphothe
426	Teacher	Uthi $x > 1$ or $y > 1$ yes Xhakaza
427	Xhakaza	Thishela nawuthi $x > 1$ or $y > 1$ because thishela bathe maximum 5
428	Teacher	Ngikho ngithi asizwanga at least wena kumele ubuze iquestion about this. You must question them. Is there anything wrong about that? Yes
429	Learner	x is greater or equal to one what?
430	Teacher	Your question is not clear again
431	Learner	Singamphendula thishela
432	Teacher	Okay, Vilkazi your question is not clear mawuzawuthi one what. Kusho kuthi kwawena awukawuunderstand leqeustion. Ngubani omunye ongangibuzela iquestion kulabantu ababhale lento leya ukuthi $x > 1$ $y > 1$. Who can ask a brilliant question based on this yes?
433	Learner	Ukuthi u-y ureprenta ini?
434	Teacher	Yes
435	Learner	Is it possible to write eh $x < 1250$, no $y < 1000$
436	Teacher	Inkinga I-one nangu usebhalile ukuthi $x>1$, y >1, then if you do not understand what is on the board then it means you are also confused. Yes
437	Errol	Mine bengicela ukubuza ukuthi why ebhale greater or equal to one ngoba on the question angiboni lapho kuthi at least?
438	Teacher	Bathi ababoni lapho kuno at least, yes Thato
439		Ukuthi thishela u x masthi greater than or equal to u x umele inkomo
440	Teacher	Is greater or equal to not less
441	Thato	Greater or equal to one, ux umele inyama zenkomo. Lomuntu lo angeke athenge inkomo eziwunegative two futhi lomuntu angeke athenge inkomo eziwuzero. Angathenginkomo eziwuone nama ngaphezulu

442	Errol	Kungabanjani x is greater than zero or *y* gretare than zero. Will I be wrong?
443	Zulu	Ayikho inkinga [There is no problem]
444	Teacher	But anikabuyi la. Anikacabangi iquestion kucala.You don't want to reason grade 11 A. My question is simple, ukuthi question is $x > 1$ $y > 1$. How can you question that? You must question that. $x > 1$, $y > 1$ you must question that, how can you question that Yes Brandon, yes Errol
445	Brandon	silent
446	Teacher	yes
447	Errol	...From the equation, we can see that both x and y are less or equal to R5000, if they say $x > 1$ and $y > 1$ it means he can buy more from that R5000 which is not real but.
448	Teacher	Abantu bathula nje ake sikhulumeni phela. Asibuzeni asikhulumi ngemhlahlo eyione. Nithini? Yes
449	Learner	Okay thishela mina bengibuza ukuthi, our equation thishela sithole as is like, 1250 ecorrect, but when it come to after I equal sign angithi ..inaudible. Why did they use any other since sikhuluma ngo R5000 we have u 5000 instead of u-one.
450	Teacher	Angiyizwa I-question yakho, uthi since sikhuluma ngo R5000 okay fine
451	Learner	Since sikhuluma nge R5000.
452	Teacher	Okay fine, uthi why Thato have you decided at least ubuza lento engiyifunayo ukuthi all of a sudden usechamuka nokuthi $x > 1$ where does that one come from. That is what I was expecting from you. Ukuthi nimbuze ukuthi u-one usechamuka kuphi, nimthathaphi ngoba la akukho lapho kukhona lapho kubhalwe khona u-1?
453	Learner	Each one
454	Teacher	Okay. Oh uthi bakhulume ngokuthi each
455	Learner	The reason babhale u-one its because lababhale each
456		Now that's the language. Angithi besishilo ukuthi eyi one ngitjele ukuthi eyi-one ibiza malini? How many cows? At each cows how many cows. A beef cow and dairy cow, how many? You don't know but each costs
457	Learner	eyi one 1250
458	Teacher	And the beef cow each cost
459	Learners	R 1,000
460	Teacher	R1000 isn't, but how many; because this one it means that they know exactly. Now it means this one they know exactly that you have one or more. One at a time please yes
461	Thato	Lana thishela asazi ukuthi kumele athenge inkomo ezingakhi. Mara esikwaziyo ukuthi angazithenga inkomo eziwu one, angazithenga eziwutwo kwazi bani asazi.
462	Teacher	Lalelani la kwangathi anisitholi istory, anisitholi istory. This is a farmer. A farmer wants to know ukuthi by the way let me give you an example. A very simple example khona nizisi-understanda istory. Nangu umuntu owenza amadreadlocks, namasingles esaloon. Idreadlocks may be let's say that person can work a maximum of 8 hours a day. Do you understand that, usebenza how many hours a day?
463	Learners	8 hours
464	Teacher	Ukuthi ngifuna uku addresa le issue ka one. Mhlawumbe sizoyizwa kahle mase sibuke le. right, right each dreadlock, amasingles will take five hours, imagine isingle eli-one
465	Learners	*Grumbling*

466	Teacher	Inhloko eyi-one hhayi ukuthi isingle eliyi one right, okay that is not an issue right. Each single ithatha for how long?
467	Learners	five hours
468	Teacher	And I dreadlock may be it takes two hours, do you understand that.
469	Learners	yes
470	Teacher	Ngathi iLinear programming is to maximise the profit and minimise the loss.That is why, right before that and then amasingles kune profit ye R30 and againhear kune profit ye R30. Is that clear. Will that person go for singles or dreadlocks?
471	Learners	Dreadlocks
472	Teacher	He will go for what?
473	Learner	Dreadlocks
474	Teacher	Why?
475	Learner	Because the profit...
476	Teacher	Uzowenza amasingles. What will be singles? Angithi uzowenza ama-dreadlocks. Angithi uzo opt for dreadlocks, uzothi uyafika the following day uthole sekubhalwe hhayi asisawenzi amasingles. Why? Angeke athi no profit uzawuthi amacustomer akasawathandi something like that. Amasingles ezobe ewubani ngaleso sikhathi if angenza ama dreadlocks only. What will happen with the singles?
477	Learner	Price
478	Errol	Ngeke asewenza
479	Teacher	Neke asewenza kuchaza ukuthini lokho
480	Learners	Zero
481	Teacher	Zero hhayi u-one loya. Where does that one come from? But any way you said uyajabula manje you said each. You said that one represent each
482	Learner	Angithi lclasini siyadefendana
483	Teacher	Niyadefendana ini you said that one stands for each cow. We donn't know, This farmer wants whats to know what ever that will give him amaximum profit. Will he goes for beef cows or will he go for dairy cows? That is why I am corncerned about this one. Where does that one come from? Is that one correct?
484	Learners	No
485	Teacher	Forget about 1, but let us think about any other implicit constrain. Yes
486	Learner	$x + y > 0$ is it right
487	Teacher	Is not a question of right or wrong, is a question of how do you justify you answer. If it is correct you can still say your answer is correct. I maths is like English. Mawubheda nje uyayibonela ukuthi ngiyabheda nyalo. Yes
488	Learner	Asikwazi ngoba amavalue ka x asiwazi.
489	Teacher	Asiwazi amavalue kabani?
490	Learners	ka x no y
491	Teacher	Kanti iyasho kahle la ithi write down any other constrain, any other restriction. What would be any other restriction that they are talking about here? Any other restriction.
492	Learner	x can not be a negative number.
493	Teacher	What is x can be any negative numbers, this is any other restriction? Yes
494	Errol	x is greater than and y greater than

495	Teacher	Can only be x greater than zero, what will happen if *x* is greater than zero?
496	Learner	If *x* is greater than zero that means *y* is greater than zero
497	Teacher	Can only be *x* greater than zero only? What will happen when *x* is equal to zero? What will happen if *y* is equal to zero
498	Errol	Uzoyiyeka if $x = 0$
499	Teacher	what will happen when *x* is equal to zero and *y* is equal to zero
500	Learner	Yo!
501	Teacher	That is a good question, because it goes back to that issue ysaloon
502	Errol	Uzocabanga ukuthi angathenga ini, except lawa ayi few because azamenzela I-loss, uzocabanga lawa azomenzela I-profit. Uzoyiyekela ngoba ingeke imenzele iprofit
503	Teacher	So useshilo u-Taki ukuthi *x* should not be negative wathi u-*y* should not be negative less than zero and wathi u y should not be negative asiworry ngendaba yegraph everybody can sketch a straight line graph. What is important in linear programming is to get those equations. You can sketch a graph. Asinandaba ngendaba ye graph I can give you a graph to sketch it can take you more or less a second. But now let us get all this restrictions. Eyokucala i-restriction esiyithole from Taki ithi x should not be negative, and u -*y* should not be negative, ($x > 0$, $y > 0$). What other restriction because we want to modify this restriction mase siwabeke together. Uthi wena u-*x* should be greater than zero. U-*x* should be greater than zero. Is nt is that all? yes
504	Learner	Lomuntu akufanelanga aspende more than R5000
505	Teacher	Sithe any other, leyo siyikhulumile, sithe any other inequalities, any other. Lawa sesikhulumile ngawo. $1250x + 1000y < 5000$. Any Other amanye that is why they are coming with these, $x > 0$ and $y > 0$. What else? What else
506	Errol	x should not be a rational number.
507	Teacher	Should not be a rational number, what do you mean by a rational number? But siceda ukwenza I example sathi nangu umuntu wenza amadreadlocks kanye nama singles. There is a possibility that lomuntu angagcina angasawenzi ini?
508	Learners	Amasingles
509	Teacher	Amasingles, esewubani amasinlges
510	Learners	Zero
511	Teacher	zero sekuyiwona amadreadlocks yes
512	Learner	Ulo u-*x* ne Imali akumelanga indlule ku 1250, ngoba lomuntu lo uzoloza
513	Teacher	Okay ake sibuye la, akesikhulume ngo *x* kemanjebecause sebasinikezile idirection. U *x* should not be negative siyazi we are not going to look at negatives x is not negative yis not negative which means our graph is on the first quadrant. That one is clear. What else we want to modify this restriction. Sesishilo ukuthi nangu umuntu ugcina angasawenzi amasingles, aba yini amasingles
514	learners	Aba wu zero
515	Teacher	yes
516	Learner	Kuzoba u-*x* greater than zero kanye no-*x* greater than 1

517	Teacher	Sesiphumile kundaba, ya1 ngesisaphindela egibhitha ku-one, asisaphindeli egibitha ku-1. Ngishilo ngathi I graph asinandaba nayo noma singa-sketchanga because even in an exam there is no mark for sketching because they know is a straight line graph oyenze kwa grade eight, all what is important is to get all these constrains. hhayi ngamkhumbula ke u- .. Kemanje. Ja ja Ngamkhumbula ke u... because asisafuni ukucabanga ke manje But I gave you an example ngathi nangu umuntu who is specialising ngamadreadlocks nangamasingles… yes. To modify this *x* can be greater or equal to zero and y can be greater than or can to zero. Not that it can be strictly greater than zero. And *y* can be greater than or equal to zero but not less than that. Yes a question. Yes a question, but not less than zero. yes.
518	learner	silence
519	Teacher	Awazi ukuthi uzobuzani. Right what is question number three, I hope now we can answer question number three after we have come up with this a … (*inaudible*). Can *x* and *y* take any real number? One at a time please. Can *x* and *y* take any real number?
520	Learner	Yes, mine I say yes because any…
521	Teacher	Do you know what is a real number?
522	Errol	Yes
523	Teacher	What is a real number?
524	Errol	Kulukhuni ukuyidefina…
525	Teacher	Oh ake look at, is 1 a real number
526	Errol	Yes
527	Teacher	Is minus one a real number
528	Errol	No
529	Teacher	Ah
530	Teacher	Is minus one a real number?
531	Learners	yes
532	Thato	Thishela mine I equatrion yami ithi…
533	Teacher	Angikubuzi ngequestion yakho. But before leyakho is one a real number
534	Thato	Yes
535	Teacher	Is minus one a real number
536	Thato	Yes
537	Teacher	Yes
538	Thato	Thishela nayi ianswer thishela ianswer ithi asiphikisi u-*x* can be any real number but excluding any negative numbers.
539	Teacher	Pho uzoyibhala kanjani lento if you say x can be any excluding amanegative numbers. How can you write that mathematically yes.
540	Thato	*y* and $x > 0$ hhi.. Sizawubona.
541	Teacher	Right, ithini inumber 3, can *x* and *y* what take any real value. Any real value. What is your answer. Can *x* and no-*y* take any real value. Yes Xhakaza
542	Learner	yes
543	Teacher	Can you justify your answer yes
544	Xhakaza	…inaudible
545	Teacher	is an element of

546	Xhakaza	*x* and *y* is an element of real number
547	Teacher	*x* and *y* is an element of R, but uTakiso usebekile la ukuthi u-*x* kumarestrictions ethu cannot be zero, I mean can not be negative and u-y can also not be negative. Akumbuze utakiso, why takiso uthi u-*x* no *y* can not be negative.
548	Takiso	Thishela, first of all we are talking about cows here
549	Teacher	Yes very good we are talking about cows here. Case closed.
550	Takiso	so…(nooiing her head)
551	Teacher	Yes, very good. We are talking about living things here. Do you have negative cow? Okay okay yes
552	Learner	For answer number one thishela I think…
553	Teacher	Mana sizobuye sikubone sesindlulile kelapho okay kulungile we will come back to that, ngizokubona masiceda lapha hhayi ukuthi ngikuvalela ekoneni, ngale answer ka number one ngizabuye ngikubone ngoba may be usune misconception, right. Nayi Iquestion yethu, can x and y take any real value. Yes Brandon
554	Brandon	No because our restriction says *x* must greater than zero
555	Teacher	Its no because u-*x* angaba yini, it can be any real value except negative numbers. Do you understand that, as long as x is positive and as long as y is positive because minus one is a real number. (*Learner from Zulu group*) okay for your home just go and sketch this graph. This is what you need to do in an exam. What is important in an exam is to write all those equations correctly. because to sketch this is just a straight line graph you know how to sketch a straight line graph, how can you sketch a straight line graph it has got twoo features, yes
556	Learner	The *x* and *y* intercept
557	Teacher	the *x* and *y* intercept, if you want *y* intercept what do you do
558	Learner	You make *x* equal to zero
559	Teacher	So if you want y-intercept you make *x* equal to zero. So there is nothing so what you have to do just go and sketch this tomorrow morning we will start here. I want it yes
560	Learner	We have done it
561	Teacher	Hha, I will take it tomorrow, that is your home work. how did you get it because you did not get number two correctly
562	Learners	Siyitholile, alright see you tomorrow, right
563		
564		End of tape
565		
566		DAY 4
567	Teacher	I gave you some work to do yesterday for homework. Can we quickly sketch that graph. Yes any one, right before we can sketch that graph. What was our first conhstrain? It was…
568	Learner	One thousand and….
569	Thato	Twelve fifty *x*
570	Teacher	What is twelve fifty *x*
571	Learner	One thousand two hundred and fifty
572	Teacher	Awu naba abantu bengibhedela $1250x + 1000y < 5000$, that was number 1, number 2?

573	Learners	$x > 0$ or $y > 0$
574	Teacher	You can sketch the graph here are coloured chalk, use different colors
575	Thato	Ngi explain sometime thishela
576	Teacher	Yes
577	Thato	The equation sizoyidivida ngo 250, lozongena ku-1250 and 1000, which is 1250 divide by 250 gives us 5*x*..
578	Teacher	Okay okay fine Thato, before you continue what are you doing?
579	Thato	Ngiyeza ibe simpler thishela khona ngizokwazi ukusketch
580	Teacher	Remember that a straight line graph has got only two features, don't waste time Thato. What is it that you are looking for? Don't waste time.
581	Thato	The factors thishela
582	Teacher	We are looking for?
583	Thato	The factors
584	Teacher	Not the factors..
585	Teacher	Okay okay what are we looking for? Yes
586	Learner	*y*-intercept
587	Teacher	*y*-intercept and *x*-intercept so don't waste time Thato, go straight to *y*-intercept. Forget about what you are doing.forget what you are doing. Don't waste time.
588	Thato	Oh thishela
589	Teacher	Don't waste time
590	Thato	For *y*-intercept , $x = 0$
591	Teacher	Case closed
592	Thato	Case closed
593		*Learners laugh*
594	Thato	$1250x + 1000(0) >$
595	Teacher	You just, just changes the inequality to equals to (*learner erases equal sign and writes equal to sign)*
596	Thato	$1250x + 1000(0) = 5000$
597	Teacher	Yes just equal to good
598	Thato	$1250\ x = 5000$ divides both sides by 1250
599	Teacher	What is an answer?
600	Learners	four (*chorus)*
601	Thato	*x*-intercept is equal to 4 meaning that the point is (4; 0), [*Thato marking the point (4;0) on the graph.]*
602	Teacher	Good.
603	Thato	For *y*-intercept $x = 0$, which means that $1250(0) + 1000y = 5000$, and you know zero any number multiplied by zero is zero
604	Teacher	Good
605	Thato	Then you divide both sides by 1000
606	Learners	Hhi
607	Thato	Yini (*turning back to the learners*) yes
608	Teachers	Keep qiet and listen

609	Thato	Awuthi ke ngibone.
610	Teacher	Hhayi kulungile Thato
611	Thato	Let me continue Sir, then I will get 5 then (0;5), eh (*marking the point (0;5) on the graph and then drawing the straight line*
612	Teacher	(helping learner to draw stright line with board ruler) Pressing it here
613	Thato	ehu, umgababa thishela,
614	Teacher	Press it here, press it here yes, then draw a line
615	Thato	(draws line okay. From my equation, I am going to make my *y*, the subject of the formula, from my equation
616	Teacher	Hhayi Thato now it seems now as if you are confused
617	Thato	Angithi ngifuna ukuthola kahle, thishela ukuthi I-*y* thishela angikwazi ukuyi-explain ngamagama thishela ngikwazi ukuyi explain ngezanlda Sir
618	Teacher	Okay
619	Thato	Which means kuzoba so thishela 1000*y* < 5000 - 1250 *x*
620	Teacher	yes
621	Thato	divide 1000 *y*
622	Learners	1000*y*
623	Thato	Ja 1000*y*
624	Magudulela	1000 kuphela
625	Thato	Ja 1000 (*learner erasing the y)*, which give me *y* < 5 - 2/3 *x*, 1.25 angithi and erasing 2/3 and writing 5/4 meaning that nakathi *y* is less than 5 - *x*, (*erasing The minus sign*) 5 - 5/4 *x* meaning that all the values of including the value of *y*, meaning that nakathi *y* < 5 - 5/4 *x* meaning that all the value all the value of including the value of *y* meaning that sizo shada lapha,
626	Teacher	Use a different color to shade.Thato,
627	Thato	Sizoshada ngenzansi (*learner using gestures*)
628	Teacher	Use a brigther color Thato, yellow or orange or something like that, yes (*Thato taking a colored chalk and shading)*
629	Thato	Okay
630	Teacher	Okay, okay any comment? Any comment no comment yes
631	Learner	Mine ngifuna ukubuza mine why amashading akhe aphelela ku equal value only?
632	Teacher	Aphelela kuphi?
633	Learner	The shading kayiside, this side (*using gestures poiting downwards*)
634	Teacher	Which one
635	Learner	This side (*pointing downwards*)
636	Teacher	Before that is this graph correct?
637	Learners	Yes
638	Teacher	Just before that, yes
639	Brandon	It is not complete because he didn't shade *x* > 0 and *y* > 0, thishele its like akire our *x* I-line ya-*x* is
640	Teacher	Can you explain
641	Learner	Akire our *x*…line ka *x* they say, roman figure (ii) they say *x* is greater than zero it means our line must go up. That side must go to the right

642	Teacher	Yes
643	Mgcibelo	I think the graph is not complete because the lines are not are not labelled. They should be labelled a or b on the y-axis
644	Teacher	We said *x* must be greater or equals to …
645	Learners	Zero
646	Teacher	And *y* must be greater or equals to zero. This is what we said; now I am looking at this graph. Is this graph correct? Yes
647	Learner	Inaudible
648	Teacher	My question, you are not answering my question
649	Learner	It is not complete
650	Teacher	Why is it not complete?
651	Learner	Because he hasn't sketch the equation $x > 0$
652	Teacher	Hawu, that one is already there, that one is already there. Ngithi lento awumchazele Errol,
653	Errol	We have..sepedi
654	Learner	Ale line eliso….
655	Teacher	Kusho ukuthi asi-understandi asivume ukuthi asiundersatndi ukuthi kuchaza ukuthini. asivume ukuthi we do not understand that Yes
656	Mkhonza	Mine into engicabanga ukuthi uzama ukuyichaza ukuthi kumele kube ne-equation ethi $y > 0$, kube ne line, ku $x = 0$, amaline onke ayephezulu its greater.
657	Teacher	Usho kona u- Errol kuthi already lento its here
658	Mkhonza	But kwamele siyi-indicate its greater than zero
659	Teacher	Ukuthi siyi-indicate la?
660	Mkhonza	Eh, kwamele
661	Teacher	Besides that akesiyekeni. Ukuphi oku wrong? There is something wrong about this graph akengisho njalo. Looking at this restriction, there is something wrong about this graph. Yes
662	Errol	Mine I think the the region engaphansi kwegraph, yiyo bekufanele ingashadwa
663	Teacher	Kuphela nje, suseni lento. Sukuma ususe leline.
664	Magudulela	Ngishilo ngathi yinto encane…
665	Teacher	Isho ukuthini, u-*x* must be greater than zero, once u-x is less than that part must not be allowed. Awukacedi phela.
666	Learners	laugh
667	Teacher	On that part we have a very wrong x here.isn't that a negative. The values of *x* that are negative are not included, that is why we removed that. The values of y here that are negative are not included here. That is why you must erase that. Now our graph is found on the first quadrant. That question was answered yesterday by Takiso to say why it is greater it should not be less than zero. it was answered that one. Right okay what do we call this the shaded region?
668	Errol	Feasible region
669	Teacher	Feasible region. How did you know that this is the feasible region. Where did you get that?
670	Brandon	Because thishela (standing up pointing at the boundary of the region) when this, between this three lines our region is called the feasible region.

671	Teacher	Iquestion yami mhlawumbe awuyizwanga. Ngithi utjelwe ubani ukuthi this is the feasible region? Kusho ukuthi awukangizwa
672	Learners	Laugh ufundile
673	Teacher	Okay. Now our feasible region.Lets say may be here lets say we've got the point A, this is the point on the feasible region is point A. That other point is point what point B. And this shaded region, where we find our solutions. Where all these lines intersect because sometimes you might find that there are more than three lines that intersect at a certain area we call that feasible feasible region. Do you understand?
674	Learners	Yes
675	Teacher	Good, As I have said yesterday that what is important is not to sketch the straight line graph because a straight line graph we did that in grade, actually sicala ka-standard bani?
676	Learners	five
677	Teacher	Lapho ko four, standard four akekho umuntu ongeza a-sketch I straight line graph because if you want to sketch a straight line graph you know that I need to find only two things. That is the *y*-intercept and *x*-intercept. Except that this straight line graphs sinama restrictions. Your *x* must always be greater or equals to zero, your y must always be greater than or equals to zero. But the fact remains the same that this is in a straight line graph. Now I want to give you something for today. For 15 minutes and then at exactly eleven oclock we will be starting our discussion from eleveb until half past eleven
678	Learners	Sibhala itest ye English
679	Teacher	Alright no problem ungaworry. Okay okay
680	Learners	Grumbling
681	Teacher	Lalela mina angikhulumi nani. Mina nginganigcina la until lilanga lishone. Angikhulumi nani. Mina angikhulumi nabantana besikolo, ngikhuluma no-maam, angikhulumi nabantana besikolwa ngikhuluma nobani?
682	Learners	Nomaam
683	Teacher	Esengisho ukuthi wena just keep queit please just keep queit please, umuntu engikhuluma naye ubani? Umaam not wena.(Learners laughing) Why should I talk to you, ungumntana wesikolo. Ngikhuluma no-maam mina hhayi nani. Okwenu is to just keep queit senizongitjela ukuthi ebenithethisa kwenzenjani ngoba izolo azange anithethisa. (Teacher distributing question papers), take one and pass the others. Right one. You know why ngishonjalo? Because nangingena esikolweni ngithola ukuthi amagrade 11, nama grade 12 mangikhanda awekho angikaze angikaze ngize ngizo shout abantwana. Okwenu is to listen, nina okwenu nje.. isipedi sikuphi? Isipedi one two...
684	Learner	Thishela use klasini hhayi e-staff room
685	Teacher	Sipedi sikuphi, Sipedi sipedi isipedi siright, Sisuthu…Yini eshodayo?
686	Learner	English
687	Teacher	English, Sisuthu, right Isizulu, Zulu 1, 2, 3, 4, right. English? Niright nge English. Khuluma ukuthi nishoda ngani.
688	Learners	Ngesizulu thishela
689	Teacher	Okay, Anguthi uyazazi, nawenza isixhosa ufunda isixhosa nawungumzulu ufunda isiZulu. Ungazitholi usufunda into ongayazi. Isipedi nibangakhi?
690		
691		
692		Group discussions

693		
694	Teacher	Right, okay okay okay now let us start, Remember what I said yesterday is that what is important here is to extract amamathematical equations from that statement that you are given. To sketch a straight line graph that one is not important. You must first get the equations that are very important. Anyone can sketch a straight line, you can give it to standard six, youcan give to grade seven and to Grade four.But now what is important here is to get all the equations. Right, I will start with that group, Isixhosa group. What was your first equation? Awuzosibhalela i-first equation. Woza Xhakaza and you must also explain. That group has a problem, that group. Leya group iseneproblem naleya group iseneproblem. Mawunga explainela yona kakhulu. Leya group iseneproblem naleya gropu iseneproblem. Right explain
695	Learner	Ya, nawufunda lapha phezulu ne!
696	Teacher	IsiZulu uphethe ini?
697	Learner	Ishi bathi write down the mathematical expression to desribe the following angithi. Bese bakunikeza I-information bathi it takes one hour to do dreadlockshairstyle and take five hours to do single and Derrick can only work for 8 hours per day ne. So lana uzowenzani, angithi bathe amanto amadreadlocks uzowarepresenta ngo-x angithi bese amasingles sizowa representa ngo y, so lana uzothini, ngoba sebakunikezile ukuthi amadreadlocks athatha how many hours eli-one angithi sizothi one x + five y is less than or equal to eight hours ngoba la sesikhuluma ngehour zonke angithi for amadreadlocks eli-one usebenza one hour for ama singles usebenza five hours, so amahours awasebenza nge langa mangakhi ayi eight, so thats why sithi $x + 5y < 8$.
698	Teacher	Right, is there any question specifically kulama group lawa ayitwo because ngibona ungazuthi baseneproblem. Onke lamagroup amanye awasenankinga cishe this two groups ane-problem. Yes
699	Mgcibelo	Asinaproblem thina kusho ukuthi, yiconflict eyenzakalayo
700	Teacher	Okay, asizwe la
701	Learner	I-right ayinankinga, but nangiza lapho ngithole ingekho correct
702	Teacher	But nangiza lapho beyingasicorrect
703	Learner	Beyicorrect
704	Teacher	Oh eyokucala was correct, its number two enibe ne problem ngayo alright. What is your problem lapho
705	Learner	Ayi thishela it is correct
706	Teacher	Oh unumber one was not correct, yes unumber two ongekho rights. All right fine, thank you very much for number one. Now let us get one from that group or from this group for number b.
707	Learner	Number b,
708	Teacher	Listen carefully
709	Learner	Number b say eh it costs at most R40 to do dreadlocks, a maximum of R60 of singles so write down a mathematical expression to describe the following, as (referring to previous learner) has defined x therefore x is less than or equals to 40 and y is less than or equal to 60.
710	Teacher	Yilawo amagroup angakayitholi kahle ngibheke I-question lapho, nala ngibheke I-question lapho, right akesizwe lapho yes.
711	Learner	Why is *x* less than or equals to 40?
712	Learner	Okay,

713	Teacher	Ake ayifunde kucala ngesisuthu sakubo khona azoyi-understanda kahle, ake uyifunde kucala yini isipedi lapho? Mhlawumbe because I-English mayi I-problem ake uyifunde kahle ngesipedi uzwe ukuthi bathini ngesipedi
714	Learner	read home language version
715	Teacher	Uyithola kanjani awuyichaze sizwe. Please keep queit Takiso lapho Daniel, right awuchaze sizwe
716	Learner	ungathi sengiyibonile ngoba ithi bunnyane bekumele ibe ngaphansi
717	Teacher	Uyitholekahle ngesisuthu or nge English?
718	Learner	Inaudible
719	Teacher	Question uyithole kahle ngani ngesisuthu or ngesilungu?
720	Learner	Ngesisuthu
721	Teacher	Right, kulegroup la ngoba nayo nike naba neproblem seniyayizwa nani?
722	Learners	yes
723	Teacher	Awuyichaze
724	Learner	Mara it cost at most R40 ..
725	Teacher	Khulumela phezulu
726	Learner	Mara it costs at most R40 isho kuthi from 40 downwards kusho kuthi less or equal to zero.
727	Teacher	Mara bekuyini inkinga lapho , inkinga yenu bekuyini kuthi ningayitholi I-answer because besiyibeke nge-English sayibeka ngesipedi what was your problem? Ake ngithole kahle, because besiyibeke ngelanguage eziyitwo, besiyibeke ngapha nge-English ngapha senzela ukuthi mawungayitholi then you jumptoo isipedi. Then what was your problem? yes what was your problem?
728	Learner	It was not easy how…
729	Teacher	Kanjani
730	Learner	Like sithi sithi x is less than or is equal to 8 hours
731	Teacher	Lalelani Grade 11, I-problem ungathi sizoyibona, kanti nawunikezwa I-question uye ufune ukuyi drivela lawuyicabangela ngakhona. Or u-understanda istatement osunikezwe sona. That is my question, because ngithi lapha inikeziwe kwathiwa funda la ngesipedi, funda la nge English. Kuzothi nawungaunderstandi ngeEnglish may be kuzothi nawungaunderstandi nge English may be isipedi will helinear programming you. Mawungaunderstandi ngesiZulu may be English will helinear programming you. Not the question. Iquestion asikhulumi... Sifunda lesostatement, uthe mawufunda statement sathini, sathi 8 hours in your own mother tongue. sathi is it 8 hours or sikhuluma ngokuthi lomuntu engenza amdreadlocks ukusuka lapha ukuya lapha or besithini isistatement? that is my question, because masizobheka kanjalo it means that nawunikezwe iquestio ku-exam wena uzowuthi i want this formula. I must get this formula. I must calculate 8 hours. That is not the issue. Yingakho ngibuza ngoba yilamagroup angazange ayithole kalula, what was your problem? Bekuyini inkinga ukuthi ningayitholi the second equation? Yes.
732	Learner	Mine sir bekuneconflict kule group
733	Teacher	Sengisho wena uyi-one. Asiyekele indaba yegroup manje sengisho wena uyi-one lets forget about indaba yegroup, sengisho wena uyi-one njengoba ngiyithole iwrong why?
734	Learner	inaudible
735	Teacher	Ubunga-understand I-English nesisuthu at the same time.

736	Learner	Yebo
737	Teacher	zoyi two awu-understandi isisuthu sakini nesipedi
738	Learner	Yebo
739	Teacher	Now that is a problem, now that is a problem phela Philani.Sizokufundisa ngani ngoba nawungaunderstandi ienglish, nawungaunderstandi I-english nesipedi, |English nesisuthu sakini
740	Learner	Sesotho
741	Teacher	Kanti besithini istatement
742	Learner	Sesotho
743	Teacher	Yes
744	L earner	Read Sesotho version
745	Teacher	Does it mean ngoba lawomagama phela besikhuluma ngawo Monday, natuesday besikhulumangawo ngobunnyane na Wednesday sike sakhuluma ngayo lento leyo
746	Learner	Kubeyimistake thishela
747	Teacdher	Next time ungasayenzike leyo mistake. Right asitholeni ke igroup c yes
748	Learner	For number b, is it right to put units?
749	Teacher	Okay, singawafaka amaunits, R40 to indicate that this is money. Because nase sidrawa I-graph asiwasebenzisi, uyaunderstanda that. You don't use that rands when you sketch a graph.
750	Learner	Yebo
751	Teacher	C, Amantombazane yiwo asolo eza ebhodini, since woza inyanga yawomama le (learners laughing). Bomake kufuneka kube yibo. Okay keep queit.
752	Learner	Read sesotho vesrion and the as we represented the dreadlocks as x- then kuzoba P as our profit that is going to be P= profit ya dreadlocks plus profit ya singles (P= and then as we represented dreadlocks ka P = profit ye dreadlocks plus profit ya singlesx
753	Teacher	Is there any question or may be you want to add something? Is ther any one who wants to add something la kule group. Anyone
754	Learnerr	That P stands for profit
755	Teacher	That p stands for profit, how much profit abayithola ngamasingles nangamadreadlocks. Iprofit iR20 for what
756	Learners	Dreadlocks
757	Teacher	And R30 is for
758	Learners	Singles
759	Teacher	Right,okay but when you sketch your graph, when you look at this (referring to $P = 20x + 35y$) you canot sketch a graph using this. But when do you use your profit. Because I-profit you can find I-profit in two ways, number one by using this objective sometimes in an exam a terminology that is used in an exam they can say find an objective function. Do you understand that.In an exam they will say find an objective function? By an objective function they are talking about a profit. What is a profit, objective eh write down an equation for an objective function. Do you understand that? Right just that we do not have enough time I just want to show you so that I can give you that as home work. read the last question it will be question number last. it means it is used there to say find an objective function.
760	Learner	..maximum profit

761	Teacher	Remember that uDerrick is specialising with two things, sinles nani namdreadlocks. Uderrick wants to know at the end of the day ukuthi will I go for singles or will I go for amadreadlocks. Leyo answer yini enizomtjelA yona tomorroe morning, but now I just want to give you some tools to get to an answer. i am not going to give you an answer, I just want to give you some tools ukuthi nizoyithola kanjani i-answer right. All you have to do hear akeze omunye azosketcha le graph so that I can show you how you can get the answer, come and sketch one two graphs so tha i will show you so that I can show you whether Derrick will go for singles or derrick will go for dreadlocks. Alright, okay Nginikeza bani i-chance. Xhakaza ngikukhombile wakhomba owakho woza uzodrawa
762	Xhakaza	Thishela
763	Teacher	Yes, woza uzodweba, right nizomceda ngescale u-Xhakaza, ukuthi yisiphi iscale enizosisebenzisa. Because our scale must be correct
764	Learners	1:10
765	Teacher	What do you mean by 1:10, let her understand woza nizomceda, nisho ukuthini ukuthi 1:10, one what is to 10 what? Animcede ngescale
766	Learners	One group showing Xhakaza (Zulu group)
767	Xhakaza	*Learner wrote:* $x < 40$ $x = 40$, 1:10, then $x : 40$; $10x = 40$ then $x = 4$… for y, $y : 60$; 1:10, $y = 6$
768	Teacher	I hope scale senu sisebenza kuko konke, akusho ukuthi sisebenza ngapha ngapha sibese singasasebenzi.
769	Learners	sisebenza kuko konkhe,
770	Teacher	Ngisho kona lokho, phela sizobe singekho accurate, mawuzothola ukuthi for number one, it works but for number two it does not work. Or may be it only works for number one and not for number two. That scale must accommodate everything that is on the chalkboard. is that clear
771	Learners	yes
772	Teacher	Good
773	Xhakaza	drawing line
774	Teacher	Okay, okay How did you get that 4 and 6.
775	Thato	*Y*-intercept
776	Teacher	Ama-intercept kanjani, we want to start with this graph. We want to start with this graph aand then after that we want to move into these two graphs and then to this one.
777	Mkhonza	For leyo kucala $x = 0$,
778	Teacher	For $x = 0$, what will be the value of y?
779	Mkhonza	y is 1.6
780	Teacher	yitholeni
781	Xhakaza	substituting values of $x = 0$ to find intercept, $5y = 8$, $y = 1.6$
782	Teacher	Okay sketch that, you join
783	Teacher	Sketch that, join them, right bese ngi challenge uMkhonza, nguyiphi ke legraph le, because you said it doesn't matter, this one is the graph of x and this one is the graph of y. You said we can start with anyone that is fine. Ngiyiphi ke legraph because le ayishoyo it $x = 0$, $y = 1.6$ and then if $y = 0$ $x = 8$
784	Mkhonza	Ingcondo iyakhathala, ziningi indaba, le siyibukile lapha like masithi $x = 6$ yiyo leya, yi-mistake lencane.

785	Teacher	Oh
786	Mkhonza	Bengitesta ukuthi babhekile na
787	Learners	Laughing
788	Teacher	Right then now we have to sketch the next graph $x = 40$, $x = 40$ how did you yes
789	Errol	Ngingeza ngizobhala
790	Teacher	Yes, right
791	Errol	Mine ngicela ukucala lapha, lento abayenzile,
792	Teacher	Musukuyisusa, susa leside elingapha
793	Errol	*[Learner writes]* $x > 40$
794	Teacher	Ayi why?
795	Errol	Erased greater than symbol and wrote $x < 40$, then $x = 40$ into eyi one kodwa, wrote (40;0) and (0;60) then drew the line
796	Teacher	Look at the highest value of *y*, you see, what is the highest value of *y*? Your value of *y* is 60 and your what is your highest value of *x* is 40 accommodate 40 and 60. Okay I-question,
797	Learner	Why draw a dotted line?
798	Learner	Okay because it is not part of this, if may be if may be ayiyona part of this feasible region, Uyayithola
799	Teacher	I have a question here, I have a question here. Let us first address the issue of a scale, to accommodate 40 and to accomodate that 60. Before siye lapha kuyodebate kuthi where do we shade, we shade below we shade above bla...bla. Let us accommodate that 40 that is on the *x*-axis. Here we've got 40 on the *x*-axis and we've got *y* which is 60, the highest value should be 60 on the *y*-axis and the highest value on the *x*-axis should be 40. Let us try and accomodate that one first before we can jump into that. That is what I was asking from you to say I want to get 60 here, I must see 60 here. It must go up until 60, so that, think of a scale how can you put that? So that you can get 60.
800	Learner	Reworking a scale
801	Teacher	You said 2, 4, 6… iright, iright. Mara wenzani that is wrong, it's wrong, you must count angeke besu decide. I decided to do ten here here I decided to put 8 that would be wrong. Angithi wenzi science abakutjeli labakascience that would be wrong. Aniwenzi yini amascale kascience? What is your problem? You can think of anything maybe you can say here, may be you can say one unit is to 3, 3,6,9,... but we want to see it hear so that omunye nomunye azoba clear ungathi ngoba wena uyayibona, besucabanga ukuthi nalo uyayibona nalo uyayibona nalo oyayibona. Sifuna ukwenza into wonkumuntu ozoyibona.
802	Learners	Yes thishela yayibona naloyayibona
803	Teacher	Mana mana Errol yes, is that the right scale? Nakho engifuna ukukwazi, phela nescale nawusosenza kufanele usitjele ukuthi will it fit into my information, into that data. Uyabona that is why I am saying to you, you must think mawuzowenza I-scale, ithini manje we want to get 40 hear let say may be your scale will take how many units 3. Will you get 40? Or let's say 2, 4, 5...20, but that side it will be 5, 210, 15.
804		
805		End of tape
806		
807		DAY 5

808		
809	Teacher	(Teacher distributing question papers) sesuthu, Sesuthu Sesuthu right seniyacala njalo niya-discuss ngifuna ni-answere lawo ma-question, a, b, c and d. For today angizuninikeza more minutes I will give you only ten minutes. Sesijwayele phela akufani nayizolo. Right isiXhosa 1, 2, 3, 4. right Zulu, Sipedi, nibangakhi lapho
810	Learners	Four
811	Teacher	IsiXhosa, English nibangakhi? Nibangakhi kule-group. 1, 2, 3, …10, Nibangakhi kule-group
812	Learner	inaudible
813	Teacher	Eh
814	Learner	
815	Teacher	Akufani, yes
816		
817		GROUP DISCUSSION
818	Teacher	Okay, okay, okay, okay, right okay you stop writing.
819	Learners	Ja sir
820	Teacher	Ja you stop writing, fine. A publishing company is producing two textbooks, textbook A cost R4 to print and R6 to bind for text book B has a printing charge of R5 per copy while the binding costs R3 per copy. The company's budget allows for R2500 to be spent for binding and R2000 at printing at most. Profit from book A is R2 per copy while it is R3 from book B. Right Smangele azosi explainela azosibhalela our first equation. Smangele, and then Smangele uzosi-explainela kahle usichazele kahle kuthi how did you get that equation. And rememberukuthi what is important is to find those equations. To sketch a graph is not a problem although yesterday it was a problem. Aniwazi amascale kahle.
821	Smangele	Wrote let x be textbook A and let y be textbook B.
822	Teacher	Okay before Smangele, kufuneka sibone ukuthi do you agree? Awubachazele kuthi why kuthi wenze kanjalo. Do you agree
823	Smangele	Do you agree
824	Learners	Yes (*chorus*)
825	Smangele	Okay, the reason why I did it's to make it simpler for me to write it algebraically.
826	Teacher	Okay. Kune question
827	Errol	Does it matter which one is x and which one is y?
828	Teacher	No it doesn't
829	Smangele	writes $4x + 5y < 2100$ and $4x + 5y = 2100$
830	Teacher	Uconfused, ubani o-confused yes.
831	Learner	Thishela, …
832	Thishela	Awuyisuse, lento iya-confuza, u right sisi? Can you just explain |Smangele how did you get this? Right keep queit sh…
833	Smangele	It says here textbook A costs R4 to print and then R6 to bind and there it says the company budget allows the budget to spent at most R2100, so this is for printing and this binding (pointing at equation)
834	Learners	Dissatisfied
835	Smangele	Okay, this is for binding and this is binding and this is the minimum amount
836	Learners	Printing printing, printing

837	Teacher	Mana no okufanele nikwenze ukubuza amaquestions you must ask questions, makukhona into ongayi-understandi yes.
838	Teacher	mana ulalele I-question
839	Smangele	Mana Ulalele I-question yes
840	Learner	Thishela mosi lena R2100 angithi iprinting lona uthe R2000 yathi ye printing
841	Smangele	Oh no this is for printing, this is my mistake I am sorry about that
842	Teacher	Right okay, but what were you suppose to do? Ukuthi siphakamise isandla sithi we think you have made a mistake la. More especially mawubona imistake angithi? Not ukuthi ke let me do it. You understand that , the best way is to say I think angazathi there is a mistake somewhere thereyou understand
843	Learners	Yes
844	Teacher	In future if there is any mistake, you just raise up you hand and point where there is a mistake.just to say ngibona angazuthi these things azihlangani. Ngapha the way ayibeka ngakhona athi ke ucabanga ukuthi this 2100 is for what is for binding yet yena uyisebenzisele i-printing. So do you agree with this this statement?
845	Learners	Yes
846	Teacher	Good, right the next one, quickly
847	Smangele	Write $6x + 3y < 2100$, do you agree with that?
848	Learners	Yes
849	Teacher	What else? Is that all,
850	Learners	No
851	Teacher	Can you please add
852	Learners	Profit
853	Smangele	Oh, then writes $P = 2x + 3y$
854	Teacher	Right, yes
855	Mkhonza	Amarestrictions
856	Teacher	Restrictions okay
857	Mkhonza	y must be greater than or equals to zero
858	Teacher	Good
859	Mkhonza	And x must be greater than or equals to zero
860	Teacher	That's good is there anything left
861	Learners	No
862	Teacher	Sesiyayibona kancane iLinear programming
863	Learners	Yes
864	Teacher	Because then u-Smangele uthe let textbook A be x and let textbook B be y. And then this is for textbook A(pointing at $4x$) and this is for textbook (pointing at $5y$) Isn't
865	Learners	Yes
866	Teacher	But for printing, is that clear
867	Learners	Yes
868	Teacher	And textbook B that represents textbook B for binding I mean that represents textbook A and textbook B for binding because the available budget for binding is how much?

869	Learners & Teacher	R2100 Available budget for printing is how much?
870	Learners & Teacher	R 2,000
871	Teacher	But this is confusing niyabona obani abayitholi abangayi itholanga that equation, ababeneproblem to get those equations at first? Yes!
872	Learner	Azange siyithola
873	Teacher	Azange niyithole, But now you get it
874	Learner	Ja
875	Teacher	That group was having e-problem Which other group was having a problem yes! That group ibine problem, Le group le ibine-problem yes
876	Learner	Ibineproblem yekuthola u x
877	Teacher	La
878	Teacher	Bengingayiboni kahle, okay fine
879	Teacher	Kadungayiboni kahle bonke laba bebeyibona ukuthi ihamba kanjani okay, but ngizwile I-problem yaleya group nayizolo. Yes Vincent
880	Vincent	Its Fine sir,
881	Teacher	Alright fine and after this is to sketch a graph, let's quickly sketch a graph. Just to save time let me do this for you, (Teacher drawing the axis)
882	Learner	Writes $6x + 3y < 2100$, for xinterceot let $y = 0$, $6x = 2100$,
883	Teacher	Write ucala ngayiphi igraph, ucala ngo number one
884	Thato	Number one
885	Teacher	Kuyafana noma ucala ngayiphi.
886	Smangele	Continue writing for y-intercept $x = 0$, $y = 700$, Learner mark the scale and plot the points
887	Teacher	I hope nonke nibheke ebhodini kuthi ubhala zona.
888	Smangele	Writing $6(0) + 3y < 2100$; $3y < 2100$
889	Teacher	We ignore that inequality sign when we
890	Thato	Is equal to
891	Smangele	Erasing inequality sign and writing equal to sign, $3y = 2100$ $y = 700$
892	Teacher	
893	Smangele	Marking and plotting points
894	Teacher	Good where do you shade,
895	Learner	Shade phansi, below
896	Teacher	Is that correct
897	Learner	Yes
898	Teacher	Right, the next group. Yes group 1, right keep queit
899		
900	Teacher	Did you all get that
901		Learner writes for x-intercept let $y = 0$,$4x + 5(0) = 2000$, $4x = 2000$, $x = 500$… for y-intercept let $x = 0$, $4(0) + 5y = 2000$; $x = 400$
902	Teacher	Plota it here, nawa amacoordinates
903	Learner	Then writes, $y = 400$ in line 918

904	Teacher	Right keep quet and listen, teacher and learner drew graph, where do you find the feasible region, use another color. Where do we find the feasible region, anyone who can come and show us yes come and show us use this ruler to show us where we find a feasible region, use a ruler,to get where we will find a feasible region
905	Learner	Learner drew boundary of feasible region.
906	Teacher	Is that correct?
907	Learners	Yes
908	Teacher	That's good, now what do we do this is what we must do so let say this is our point A on a feasible region and this is our point B and this point C on a feasible region. And what are the coordinates? Okay so now it means now we erase this isn't. What are the coordinates of A?
909	Learner	(0; 400)
910	Teacher	Writes (0; 400) right what are the coordinates of C
911	Learner	(350; 0)
912	Teacher	Eh (350;0) You must also find the corodinates of B that is very important right,
913	Learner	(250; 0)
914	Teacher	Do you know how to find the coordinates of B
915		No
916		Because it is very important to know also know the coordinates of B because these are the point on a feasible region. We look at this point, this point and that point (pointing at the points on the board). How can we find, what is happening at that point B? yes
917	Learner	Ngulapho point AB kune intersection kune intersection ye AC
918	Teacher	At point of B we find the point of intersection of line A, I mean of this line and this line Isn't. Its where this line intersect that line. At the point of intersection what is happening? Yes
919	Learner	It means that line AB meet that line AC
920	Teacher	That is not mathematics, what is happening at the point of intersection?
921	Mgcibelo	Eh there is the midpoint eh…
922	Teacher	What is happening at the point of intersection? If this graph intersects with that graph, at that point of intersection my point B, what is happening between these two graphs? We have this graph and that graph; they intersect at A. what is happening at the point of intersection? But how did you you find the coordinates of B if you don't know what is happening at the point of intersection? Kushukuthi siya gesa la sivele silandele i-procedure ongayi-understandi nokuthi ukuthini. You just follow the procedure equate this to that equate that to that, how can you find the coordinates of B if you don't know what is happening at point B. What is taking place at point B? yes Lerato
923	Lerato	I think the coordinates (inaudible)
924	Teacher	The coordinates are what?
925	Lerato	Are decreasing
926	Teacher	Are decreasing, why they are decreasing? Why do you say the coordinates are decreasing?
927	Lerato	Inaudible

928	Teacher	No, what is taking place at B? Ngiyezwa nithi niwatholile amacoordinates of B but now what is happening at that point? You said this is a point of intersection. So what is happening at the point of intersection? Yes.
929	Learner	Inaudible
930	Teacher	Now sesikhuluma I-English ke-siyayihlukanisa, listen very careful, when two lines intersect siyazi ukuthi ayahlangana what I want to know is what will happen if those two lines intersect? Siyazi ukuthi masikhuluma nge intersection is when two lines intersect. yes
931	Learner	The gradient will be the same
932	Teacher	What?
933	Learner	The gradient will be the same
934	Teacher	Uyithathaphi lento ethi the gradient will be the same?
935	Errol	I think thishela the graph
936	Teacher	Hha, wawuyitjelwe ubani lento? Yes
937	Mgcibelo	Mine I think the gradient will change
938	Teacher	Niyayithanda indaba yegradient, igradient njelapha niyithathaphi indaba ye-gradient. I want to know what will happen at that point of intersection because you cannot find the coordinates B if you don't know what is happening at point B. Not unless nje u-cramile nje ucrame into ongayazi ukuthi wenzani. yes
939	Learner	Sesotho
940	Teacher	What do you mean by stationary? Ngangishilo ngathi umuntu angasebenzisi igama angaliunderstand. What do you mean by stationary?
941	Learner	a constant thishela
942	Teacher	What do you mean by constant?
943	Learner	Ayishintji thishela
944	Teacher	Ayishintji ini?
945	Learner	Ayishintji
946	Teacher	Yini engashintji? Listen we are saying, this line asithi u-A, sithi-B, sithi u-C sithi la u-D sithi la u-E. Sithi line CE intersects with line AD at this point. So what will happen at point B, at the point of intersection between uline CE and line B line AD? What is going on there? Kwenzekalani lapha at point B? Ngekengininikeze i-answer, angeke ngininikeze i-answer. Okay I am not going to give you an answer, but that will be your homework. Remember that what is the next question? It says find the production run which will maximize the profit. Do you understand that? Who can explain to us number c. Find the production run which will maximize the profit? who can explain that yes
947	Learner	I think sir it means that we have to find the production of textbook A and textbook B which will make the profit a maximum.
948	Teacher	Very good. Asithole I-production ukuthi will (*pause*) a maximum profit sizoyithola if this is not produced and that one is produced. Or this one is produced and that one is not produced or both when this one and that are produced at which point they will give us a maximum profit. Do you understand that? Right what did I say yesterday about finding the maximum profit? Sithe senzenjani?
949	Learner	Thishela wana formula ye objective
950	Teacher	Awuyibhale sizoyibona
951	Learner	writes $P=2x + 3y$

952	Teacher	yes
953	Brandon	Learner writes
954	Teacher	Abanye sebezosinikeza I calculation ukuthi ke..
955	Brandon	What is 3 times 400?
956	Learners	1200
957	Tteacher	Asicheckhe enye. Awuyichecckhi into eyi-one, kusho ukuthi kuseyi-profit yakho leyo?
958	Learner	Hhayi thishela (learner writes coordinates of D) ngiyayiampa le
959	Teacher	uyayijampa le ngoba phela aniyazi
960	Learner	Hhi
961	Teacher	Inaudible… usazoyi-explain
962	Learner	Writes P = 2(350) + 3(0) = 700
963	Teacher	Okay bathi ubala what are the coordinates of B noma ningawazi ukuthi niwathole kanjani?
964	Teacher	Nithe 200 (erases 200)
965	Learners	(250; 200)
966	Teacher	Two fifty is to two hundred (writes (250; 200). Okay awuyithole ke nayo
967	Learner	Writes P =2(250) + 3(200)
968	T eacher	Right
969	Learners	500 + 600 = 1100
970	Learner	
971	Teacher	Okay thank you very much, so now you check, 1, 2, 3 (pointing using board ruler), by the way remember that this one is not finalised (pointing at point B) up until you tell me how did you get the coordinates of B which is (250; 200), lets assume, for now we assuming that this answer is 250, this coordinate is (250; 200) but will continue we'll summarise everything tomorrow. But now let us assume that this is (250; 200) up until you tell me what is happening at point B? Is that clear. right, now now can we answer number *c* and *d*.Can you answer number c and d. Say what answer for number *c* and *d*
972	Learner	Saying what sir
973	Teacher	|Saying what answer for number c, write down the answer for number *c*. Anyone who can write down an answer for number c and one of you write an answer for number *d*.
974	Learner	Writes 1200
975	Teacher	Is that answer for or *d*?
976	Learners	*d*
977	Teacher	Is that answer for *c* or *d*?
978	Learners	is for *d*
979	Teacher	Yes
980	Learner	inaudible
981	Teacher	My question, is that answer for d or is for d
982	Learners	Is for *d*
983	Teacher	Write an answer for d, ubonile ukuthi wenzi phutha lapho weMkhonza? Awuyi-understand I question

984	Mkhonza	u-number d
985	Teacher	Angizange ngith u-number d ngithe unumber c
986	Mkhonza	Angibonanga
987	Teacher	Awubonanga, now you are defending yourself, uyazidefenda
988	Learners	*laugh*
989	Teacher	Write answer to on top of d right
990	Errol writes	This company will
991	Teacher	Just write an answer, remember in an exam it will be two marks you just write an answer that will give us a maximum profit and then you must explain what does tha zero stands for.
992	Errol	Writes (0;400) where *x* is textbook A and 400 is for *y* which is for texbook B.
993	Teacher	So that it will mean that zero is to 400, right there is another way of finding yes
994	Mkhonza	Mawubhale textbook B
995	Teacher	Uthini
996	Mkhonza	Mawubhale textbook B
997	Teacher	What do you mean by textbook B I question ithini Mkhonza
998	Mkhonza	Ithi find the production run will maximize the profit. And u-textbook B uye ..
999	Teacher	Find the maximum run which would maximize the profit. Kufuna u-explain ukuthi if sizosebenzisa only I-textbook B and no textbook A.
1000	Mkhonza	Kwamele ngibhal amacoordinates
1001	Teacher	Yes wabhale oyi two uthi (0; 400) you can say zero for textbook A and 400 for textbook B. This run will give us a what. A maximum profit is that clear good. Right there are two ways in which you can find profit. This one it is by calculation. There is another way of finding this graphically. Do you understand? We will see that one on Monday. Kuthi how can we find by using another method which we call a search line.Do you understand that so we will look into that on monday i don't want to confuse you. For now let's stick to this one unless there are any questions.
1002		
1003	Errol	Monday asibhali thishela, Monday asibhali?
1004	Teacher	For
1005	Errol	Monday asibhali I-test
1006	Teacher	Siyabhala
1007	Errol	Manje thishela uzosikhomba nini
1008	Teacher	Ja, angithi le niyayazi nizosebenzisa yona.
1009	Thato	Thishela
1010	Teacher	I-graph yenu injani
1011	Learner	For number B
1012	Teacher	What
1013	Thato	U-number b
1014	Learners	Showing teacher their point

1015	Teacher	Seniyaphika manje senithi (325; 125) Bengishilo kuthi lama-point ka B asiwasebenzisi. Siya-assuma ngoba anazi kuthi how did you get the coordinates of B. Sishilo sathi we are assuming
1016	Learner	Sithole ku graph thishela
1017	Teacher	Hhe
1018	Learner	Sithole graphically
1019	Teacher	What do you mean graphically
1020	Learner	Hha thishela sithole nge-graph
1021	Teacher	Kanjani
1022	Learners	Ngegraph thishela, nawe uyazibonela
1023	Teacher	I-graph yenza njani?
1024	Teacher	Okay
1025	Thato	Nay-point thishela
1026	Teacher	How do you know that this is 125
1027	Thato	Naku thishela I-scale
1028	Teacher	Okay, Alright alright scale senu if you have drawn to scale. Alright alright how can you find it algebraically
1029	Learners	Hhayi
1030	Teacher	Yes you have found it graphically but how can you find it algebraically. So lena ngekengininikeze ukuthi what is going on at point B, ngini enizongitjela? UThato uthi ama-coordinates ala is not (250; 200) uthini Thato is what?
1031	Thato	(325; 125) iscale siwrong
1032	Brandon	Le-point is between 250 and 290
1033	Thato	Hhayi iscale senu si-wrong mfowethu
1034	Learner	Thishela thishela ungayishintji, thina sina 50, 50 and then 100 ,100 Yes thishela
1035	Teacher	No kufanele isinikeze I-answer efanayo. Whether you have fifty fifty or hundred hundred, We need to get this one, that is why ngisho kuthi how did you get this?
1036	Learners	Yes thishela
1037	Learner	Thishela we got it graphically
1038	Teacher	Graphically when you get it nithola bani?
1039	Learners	(325; 125)
1040	Teacher	(325; 125) no problem, but how can you find it algebraically. I would agree ngoba I-graph paper will give you a clear
1041	Thato	Yes
1042	Teacher	But it took you for how long, ukuthi nizoyibona lento ukuthi e-graphini you just map the value of *x* that side and the value of *y* that side. It took you for how long ukuyibona lento?
1043	Learners	Two minutes, sesiyenzile...
1044	Teacher	Ngishilo Daniel ngathi asiyeke ukuphapha, serious ukuphapha asikuyekeni. Ukuphapha singayenza yonke into but ukuphapha asikuyekeni. Daniel awusiye uthishela. Awusuyu thishela. Because masingabuyela nje back ngoba ngazi ukuthi masisuka manje siya kuperiod kabani. Iperiod lika maam ubani… yingako ngithi asiyekeni ukwenzenjani?
1045	Learner	Ukuphapha

1046	Teacher	Ukuphapha. Because I can not just take you i-period lika thishela without …That is all. Sesizothatha labo be interview, emuva kwaloko ngizonitjela ukuthi obani nobani. Ngoba i-period le Biology ngilicelile, but for now it will only be those engibadingayo, they will go back to eclasini. Sizoyikhethela ke thina ukuthi nguabani nobani nobani esimthathayo. Sis Thulie, ngulaba besiZulu.

APPENDIX E: FOCUS GROUP (ISIZULU GROUP) TRANSCRIPTS

1	L1	Uma ngithi kuwe ngiboleke okungenani I R10, ngidinga malini? Ingumalini? [If I say to you borrow me at least R10, how much money do I need?]
2	L2	Mine engiyiunderstanda ngayo, ngicabanga ukuthi lomuntu lo udinga iR10 or more
		as they were discussing the teacher gave them the following instructions
	Teacher	Niyacala niphendula onke lama questions. Oyi-one uzohamba ayo describe e boadini, omunye anibhalele amasolutions
3	L2	Sizobona khona ukuthi ubani ozopresenta kodwa L5 ozosibhalela amasolutions
4	L1	Let us continue with the question.
5	L2	Lomuntu lo ufuna uR10, kuthi at least R10, kusho ukuthi udinga I R10 or more than R10
6	L4	$X > 10$
7	L3	A more than R10 or indlule ku R10
8	L1	Umbuzo 1.1, lomuntu udinga imali engange R10 noma endlula uR10
9	L2	Noma asithi engaphezu kwe R10 ungathi endlula uR10
10	L3	Laughs, kuyafana engaphezu kwe R10 noma endlula R10
11	L1	Nguliphi igama elisemcokwa
12	L2	Okungenani [pointing at okungenani]
13	L3	English at least
14	L1	Read question, bhala ialgebraic equation ebonisa imali engiyidingako, sizothini?
15	L2	Sizothi u *x*, $x > 10$, *x* is greater than or less than equals to 10
16	L3	Sibhale greater than or less than?
17	L1	$x > 10$, or less than
18	L4	Mabathi expression basho ukuthini?. Abasho u-*x* and *y*?
19	L2	When they give an expression like two companies, we would say le icompany *x* and le icompany *y*, mara le istraight forward it is *x* only
20	L3	Lapho senza mabasinike lecompany e produca loku kanye necompany e produca okunye kwehlukile kulena
21	L1	Kusho ukuthi le company i-one
22	L1	Read English version for question (b). Minimum salary worker…
23	L3	No
24	L1	I-minimum, iminimum
25	L2	Ja! Kungenzeka ukuthi ukhuluma iciniso, lapha bethi iminimum salary, abasitjeli ukuthi wonkumsebenzi uhola malini
26		Owokugcina mhlawumbe nguye uzohola okungaphezulu
27	L1	Kungenzeka ukuthi ufike this year, nguye ozohola R1500, owokugcina asazi ukuthi uhola malini. May be John ufika this year.
28	L3	Umazelaphi ukuthi uJohn ufike nini?
29	L1	Minimun salary is R1500, imaximum mara abasho. Kodwa iyakhuphuka. Akakho umuntu ohola R1400
30	L3	Iya iyakhuphuka, mara ukhuluma iciniso

31	Learners	Ukhuluma iciniso
32	L3	Bashilo, John uhola R1800
33	L2	Mara baspecifyile, John uhola R1800
34	L1	*x* is more than R1500, *y* is more than 1800
35	L2	Yithi *x* no *y*, why singenzi u-*x* no *y*?
36	L3	*x* amele ini?
37	L4	*x* amele u R1500 bese *y* amele R1800
38	L2	La aicalculate imaximum salary,
39	L1	*x* is average salary, $x > 1500$
40	L4	What if John uhola R1700?
41	L2	John uhola R1800, but iminimum salary is R1500, akekho umuntu ohola less than R1500
42	L3	Let us answer the question
43	L2	Kufuna sithi yes,
44	L3	Asibhale ne reason
45	L1	I-reason azange basho, azange baspecify kahle kahle ukuthi uhola malini
46	L2	bashilo, John ohola R1800
47	L4	I-reason ukuthi iminimum salary is R1500, yena uhola R1800. Kusho ukuthi isalary icala ku R1500,
48	L1	Abasinikanga I maximum kodwa akekho umsebenzi ohola ngaphansi kwaR1500 okusho ukuthi akekho ohola R1400.
49	L2	Bonkhe bahola R1500 kuya phezulu ngoba bethi the minimum salary at Inqxayizivele
50	L4	Akekho umsebenzi ohola ngaphansi kweR1500
51	L1	Akekho *umsebenzi* ohola ngaphansi kweR1500
52	L3	Kuyafana mara
53	L2	Ayifani mara, hhayi asibhale nge-english
54	L1	Awukho umsebenzi
55	L3	Hhayi akekho umsebenzi, the worker
56	L1	Let us write English
57	L4	There is no worker ohola ngaphezu kwa R1500
58	L2	Umholo wemsebenzi ucala ku R1500 ayicali phakathi
59	L1	Abasinikanga I maximum.
60	L3	There is no worker ohola ngaphansi kwa R1500
61		**Question 2**
62	L2	At least
63	L1	at least 2L
64		Ngelanga eli-one unatha 2L kuya phezulu
65	L3	Read the English version
66	L2	The doctor advises
67	L4	Lesigulane kufuna siphuze 2L kuya phezulu, not less than

68	L1	Isiguli sakhe
69	L2	Yoyo! Uthini manje! Senzeni
70	L1	Uyabona la ngelanga eli-one kumele aphuze 2L upwards, at least
71	L3	I-patient kufuna iphuze 2L ngelanga
72	L1	A week?
73	L2	Kwamele aphuze 14L kuya phezulu. At least 14 L
74	L3	14 L kuya phezulu
75	L4	What does the doctor mean by the above statement?
76	L1	Kusho ukuthi isiguli masiphuze amalitre amabili
77	L2	2L kuyaphezulu not less than,
78	L4	Asibhale isiguli sakhe noma ipatient yakhe
79		
80	L1	Amalanga awu seven sizothi $2x + 7y > 14$ lapha u-x umele litres kanti u-y umele amalanga
81	L2	U-4 urepresentani?
82	L3	Amanzi awaphuza evikini
83	L1	14 liters a week
84	L2	Kuyafana neviki
85	L1	Amalanga sinawo
86	L2	Ababuzanga a week, ungabheki into abangakayibuzi, why calculate when not asked?
87	L4	Let us say u aplayele i-job bese bethi what is your name? Uzothini?
88	L1	Ngizosho igama lami
89	L2	Yebo, nala asiphendule abakubuzile
90		
91	L3	2l to be taken daily, let x be number of days so $2x > 4$L
92	L1	asith $2x > 2$
93	L2	but that means 2x can be 3L
94	L1	Angisho njalo
95	L2	iya yinto oyishoyo leyo, uma uthi $2x>2$, usho ukuthi u-x can be from 2 upwards
96	L1	ngelanga kumele aphuze amalitre amangakhi,
97	L3	Kumele aphuze 2l, akumelanga ufake u 2
98	L2	kumele ngithi $x > 2$
99	L1	No! $x > 2$L, do you remember a number line, x can be 3 and not $2x > 2$L
100	Teacher	Uma ngithi kuwe ngiboleke okungenani R10 ngidinga malini?
101	Learners	Udinga R10 kuya phezulu
102	Teacher	Why?
103	Learners	$x >10$
104	Teacher	Ngithi why?
105	Learners	Bathi okungenani? At least?

106	Teacher	Uyangizwa ukuthi ngithini, umuntu mayecela kuwe ukuthi umboleke at least R10
107	L1	Usho ukuthini?
108	Teacher	Uma kuzothiwa at least two people have been killed in a car accident
109	L2	Uyabona lapho sedifferent story
110	Teacher	What do you mean by different story, u at least kanti ushoni
111	L1	Lapho mhlawumbe kufe abantu, let us say mhlawumbe kushaye ibomb
112	L2	Then bazothi at least abantu abashonile bayi five. Kusho ukuthi lapho kushone abantu abayi hundred.
113	L1	Uma ufunda lequestion ithi at least R10, kusho ukuthi mawumnika R9, angeke ayithathe.
114	Teacher	Okungenani kuchazani lokho?
115	L2	Kusho ukuthi lomuntu uke wamcela ngaphambilini?
116	Teacher	Asikhulumi ngokumcela, okungenani kuchazani loku
117	Learners	At least R10, at least R10, okungenani R10
118	L2	Ma umamele izindaba bathi kushaye ibomb but at least kushone abantu abaningi, at least 6.
119	L2	Uma umnika R10, uzoyithatha, kodwa R9 ngeke ayithathe.
120		
121	L1	ContinUe with doctors question
122		
123		DAY 2
124	L1	Read the English version of day 2
125	L2	At least minimum therefore at most is maximum
126	L3	Read home language version, noma ngaphansi
127	L2	Noma ngaphansi
128	L1	Then x meaning noma ngaphansi, which is less than or equals to 150 so $x < 150$
	L2	Bathi bhala umusho ngendlela ekhombisayo ukuthi uyayizwa lengcogco
129	L1	Singayibhali ngamagama, siyibhale algebraically.
130	L2	Sizibhala ngesilungu, write in English
131	L5	Mandla cinema hall can accommodate a maximum of 150 people for one show
132	L3	A maximum
133	L2	… can accommodate a maximum of 150 people for one show
134	L1	Yes, people
135	L3	Can accommodate people
	L2	Eh Ena Can accommodate a maximum of 150 people
	L1	Um, for one show (learners laugh)
136	L1	Read part b)
137	L3	Yes
138	L2	Read home language version
139	Learners	Sizochubeka

140	L2	Ya!
141	L4	Remember idefinition ye Linear programming, mamela idefinition yelinear programming
142	L1	Minimizing loss and maximizing profit
143	L2	Uma ubheka, u 39 akusiyo ne hhafu ka 150, akusiyo nehhafu nehhafu ka 150, not even a quarter of 150
144	L4	Chake ngeke ichubeke
145	L3	Ayikho into azoyizuza, angeke kube neprofit
	L1	Yithi ubhale ne-English,
146	L2	Yithi no
147	L1	Ngeke azuze lutho
148	L3	Ayikho iprofit
149	L5	The show will not go on because he will not benefit profit from 39 people
150	Learners	Ngesizulu sithi cha ngesizulu
151	L1	Read part c)
	L2	Yebo siyavumelana,
	L1	Minimizing the loss maximising the profit
	L2	Minimizing the profit, maximising the profit
	L3	Minimizing the profit, maximising the loss, mara niyayitjintja,
	L2	Mamela phela uma echubeka he will be minimising the profit and maximizing the loss.
152	Ls	Yebo siyavumelana, because he will minimize the profit, maximize the loss
153	L2	That is uma echubeka ne-show, he will be minimizing the profit and maximizing the loss
154	Ls	Ja!
155	L5	maximize loss, minimize profit akukho azokuzuza, ulahle imali
	L2	Ah ena, ya akukho azokuzuza
156	L4	Ja maximizing the loss, minimizing profit akukho azokuzuza
157	L1	Read d
158	L1	Number one electricity, food
159	L4	Environment kumele ibe clean
160	L3	Ne-rent, toilet nani futhi
161	L2	Kuthenga movie tapes
162	L1	Projector
163	L5	Sesibala nama chairs, lento le uyenza nge computers
	L2	Ihhola
164	L3	Advertisement ziningi lezinto, uwa letha ngani amamovie kanye nendwangu yakhona (Banners)
165	L1	Read part e
166	L1	Restrictions
167	L3	Kumele a advertise azothola iattention yabantu
168	L2	Use I media, athole isponsor umuntu ozomnika itulo

169	L4	Asebenzise ne radio station, TV
170	L3	Abe nesponsor sizokhokha ini ini
		Ane bathi la angalahlekelwa yinzuzo, enze nama sales, sometimes kube nama sales kuzoba nabantu
171	L4	Abe na more movies, abalekele icompetition
172	L3	Avoid competition ngekuthi abe namasale
173	L1	Let us say umuntu oyione i-R40 and e Carlton Centre i-R12 uzothola ukuthi baye carlton centre abantu
	L4	La kumele abheke i-competition phela.
174	L2	Akumele enze eyi one, after an hour kumele ashinjte kube nam action movie
175	L1	I-movie nemovie nge hora, kanjalo kanjalo, ngoba iyabora eyi-one suyazi kuthi kwenzekalani?
	L2	Kumele a-divide lehhola
176	L3	Kumele ama services akhe abe right
177	L4	Let us say amaservices akhe a-right, but the thing is something to do with the number?
178	L3	Kumele kube ne discount khona kuzogcwala
179	L4	What happens?
180	L3	There will be more people
181	L4	In terms of restriction, how many people
182	L3	Minimum has to be 100 people
183	L2	60 people, at least 60 people
184	L1	Besingathola iminimum kube basinike imali leticket
185	L2	Kumele athengise ama popcorn kanye ne lunch
186	L2	Kube 49 bese uthola I %, 39 divide by 150
187	L3	Ku 150 sekuneprofit, sifuna i% ezosinika 50%
188	L1	Lets say umuntu ungena nge-R40, kuba u R2000 per show, uyayithola iprofit
189	L4	Ulahlekelwa imali lomuntu, sifuna i-profit phela
190	L2	Iminimum yabantu abawu 60
191		
192	L1	Read part f)
193	Ls	Angeke angene because i-maximum is 150
197		DAY 3
198	L2	Read the english version of the task, (but before finishing) lapha sebasigayile..
199	L3	Chubeka ne question
200	L2	Continued to read the question
201	Ls	State inequality in x and y
202	L2	Sino x, sino y
203	Learners	Sino x, sino y
204	L1	Imali anayo, imali anayo
205	L2	A farmer buys dairy cows nge rands, imali esispendayo

206	L3	U-*x* is R1000, uma *y* is R1250
207	L1	Imali okufanele aspende uR5000, then
208	L2	Sizothi uma siyibhala ngamainequality 1250 x + 1000y < 5000
209	L4	Besesiyisa ku simpler form
210	L2	State this information as an inequality
211	L1	Yayi ikaso
212	L2	Read the next question
213	L3	Read home language version, siyibhalile
214	L4	Sibhalile, um nayi
215	L1	Sibhalile
216	L2	Kusho kuthi inumber one vele ikaso
217	L3	Angisho inumber 2 leyo
218	L1	I-number 2 into e-one
219	L2	Read English version, uyayizwa leyo
220	L4	Funda leyesizulu
221	L1	Read home language version
222	L3	Ngesizulu nange English akuhambiselani
223	L4	Implicit angiyiunderstand
224	L2	Unumber 3 lo
225	Learners	Thishela isizulu ne English akuhambelani
226	Teacher	Read both version, iquestion la ekugcineni ithi state this information as inequality, la bese iyabuya ithi write down any other inequality implicit in the situation
227	L1	Lakusizulu kuthi bhala i-algebraic representationngandaba engenhla, yinto e-one
228	Teacher	Yini into e-one
229	L2	Naku, ux-umeleni u-y umeleni
230	Teacher	Mhlawumbeke asizwani, bhala amanye ama algebraic equations ngendaba engenhla
231	Learners	Amanye!
232	Teacher	Yes, ngifuna amanye
233	Learners	Hhayi le
234	Teacher	Seningincedile nje seningikhombisile kuthi kune mistake
235	L1	Mara leyesizulu ayinawo umbuzo ekugcineni, kodwa leyesilungu inawo umbuzo
236	Teacher	Read home language
237	L1	Ngisho kunumber ,1ekugcineni akunambuzo
238	Teacher	Kuphi ekugcineni lapho kungenambuzo
239	L1	Lapha akubahlwanga mbuzo
240	Teacher	Read home language version together with learners
241	Teacher	Oh, ucinisile
242	Learners	Asithathe I English

243	Teacher	Yangiyaunderstanda, kufanele sisho kuthi bhala i-algebraic what expression ngale nkulumo engenhla, lasesifuna amnye
244	L3	Amanye futhi
245	Teacher	Yes
246	Learners	Siyabonga, sibonga ukusishayisa ngomoya [learners laughs]
247	L1	Ezinye senze amanye amavalue
248	L4	Ja, angithi uyabona lapha sithi 1250, imaximum yale nyama yangaphakathi then sizothi..
249	L2	Bese iminimum
250	L3	x< 1250, y = 1000 nawa amanye, nawa amnye
251	L4	Less than or equal to
252	L1	y less than or equal to R1000
253	L4	Akumelanga ehle, akumelanga ibe 999 angisho, ingaya phezulu
254	L1	Lena iminimum amount,
255	L2	Usho mara kufuna kube igreater than, greater than or equal to
256	L4	Uright akumelanga yehle, y is less than R1000, akumelanga bathengise inyama ye beef nge 999
257	L3	Bazoyithengisa.
258	L2	Hhi! Bazoyithengisa?
259	L1	Masingathi greater than phela yo kusho kuthi manje izondlula i-R1250
260	L4	Angithi bathi he can spend a maximum of R5000
261	L2	Ja nayileyo sesiyenzile, lezi ezinye
262	L1	Lomuntu lo angeke avume ukuthenga inyama e-more than 1250, mara angayithenga e less than 1250
263	L4	Ha ha uright akumelanga yehle, y is less than R1000, akumelanga bathengise inyama ye beef nge 999
264	L2	Nale iright
265	L3	Number one nayi, unumber 2 le
266	L2	Bhala le, number one
267	L1	Mabasibuza sizothi sibheke i-profit, angeke afune ukuluza imali, angeke athenge ngemali e-more
268	L3	Mabasibuza yiphi iquestion
269	L2	Mabawsibuza ukuthi why less than 1250 sizawuthi sibheke iprofit lomuntu ngeke athenge e-more than R1250, angeke athenge nge R1300 mara anangazithenga eziwu 900 ngoba uzobheka i-profit. Angithi labasitjela ngokuthi e-farmer buys what what...
270	L1	Dairy, cows
271		Interview with learners
272	TN	What does y stands for
273	Learners	Inyama ye beef
274	TN	I mean the y, what does y stands for
275	Learners	y beef cows
276	TN	Yet u x- umele…

277	Learners	*y* stands for the number
278	TN	*y* stands for the number yama beef, inkomo
279	L1	But wena sowutse imali, can you see, you have *y* and 1000, what does 1000 stands for
280	L2	Imali ya each beef, ye beef eyi one, masithi 2 sisubstitute this sithi 2000
281	TN	Mine angiva kahle, *y* stands for the number of cows, its *y* is the number of cows, now you are saying that the number of cows is less R1000
282	L1	Ayi thine sithi u *y*.
283	L3	What is *y*?
284	L1	Urepresenta inkomo ze beef
285	L4	Ehe, so what you are saying is
286	L3	*y* urepresenta i-beef
287	L2	Ene e beef eyi one icosta R1000, or less
288	TN	Yes mine ngifuna, just read this thing for me, what does it mean. Awuyifundze as you have written it inkomo ze beef ziless than 1000. Does it make any sense?
289	L1	Kwamele zicost-1000
290	TN	Uyabo sowufaka icost and number, which are two different things. Do you get my point?
291	L2	Read roman figure 3
292	L1	Angiyi understand, asifunde nge vernacular
293	L3	Eyesilungu ayisho kanjalo
294	L2	Ja, any real value
295	L1	Thina sesicabanga ngenumber
296	L3	Sesicabanga inumber
297	L2	Ziyaphila noma
298	L1	Lapha bathi dairy cows and beef
299	L4	Uthenginkomo eziphilayo noma ezingaphili?he uthenga ezifile
300	L2	Uthenginyama
301	L4	Inyama
302	L3	Idairy ubisi
303	L2	Uthenga ubisi, ubisi aluphili, luyaphila ubisi?
304	L4	Bathi inkomo
305	L1	Uthenga inkomo zobisi
306	L3	Uthenga inkomo zobisi, lezinye uzozihlaba bese kuba inyama
307	L4	Kusho ukuthi ziyaphila
308	L2	Kusho ukuthi uthenge inyama nobisi
309	L4	Hhayi uthenege inkomo zobisi,
310	L1	And mind you, malini inkomo ngempela
311	L2	R5000
312	L1	R5000 upwards

313	L2	And lomuntu lo uphethe malini? R5000, uthenga inyama uthenga nobisi
314	L1	Angeke uthenge inkomo ephilayo bese uthenga nobisi, hhayi bo
315	L3	Angeke, uzophuma nangakhi
316	L4	Lapha ngesizulu kuthi uthenge inkom zobisi hhayi ubisi lwenkomo
317	L1	Mara masesiya ku reality inkomo ibiza malini,
318	L2	Ireality
319	L3	Iyadura, iyadura
320	L1	Mara ireality, sikhuluma ngemaximizing profit, inkomo ibiza R5000 upwards angeke inkomo ibe R1000
321	L2	Mara why bathi la iyodwa ibiza? Angeke uthi ibisi iyodwa (*laughs*)
322	L4	Lomuntu uthenge inkomo
323	L3	Inkomo, uthenge inkomo
324	L4	Inkomo azoyihlaba athole ibeef
325	L1	Lomuntu uphethe i-R5000
326	L2	Ayikho leyo asiyiyekeleni
327	L3	Why angabhalanga inyama yenkomo?
328	L4	Inyama yenkomo, kusho ukuthi akuthengwanga inyama, kuthengwe inkom ezohlatjwa kube inyama yenkomo.
329	TN	There are two different things, ungathenga yelubisi, tyou know dairy cows
330	Learners	Yes
331	TN	You buy beef cows and you buy dairy cows
332	L2	Angeke, kusho ukuthi lezamabeef aziphili lezi ezinye ziyaphila
333	L1	Zamadoda
334	L2	What do you mean
335	LS	Ask teacher
336	Teacher	Ja
337	L1	Lapha bathi each beef cow and each dairy cow and inkomo ibiza R5000 kuya phezulu. Nawe thishela uyazi
338	L2	Lomuntu lo uphethe R5000
339	Teacher	Kwangathi anisizwa isizulu, read the problem home language version
340	L2	Ho uthenga inkomo
341	Learners	Chubeka thishela, chubeka thishel
342	Teacher	Nenkomo zenyama
343	L1	Thishela ibeef cows le
344	L2	Wo! inkomo zenyama (*laughs*) like leziazosisebenzisa nakazibulala, ezenyama
345	L4	Kunini nginitjela ukuhthi inkomo eziphilayo nangangilaleli
346	Ls	Ziyaphila, ziyaphila
347	L3	Inkomo zenyama
348	L1	Okay number 2
349	L3	Angeke simenze
350	L2	Hhayi sizomenza

351	TN	Can he buy negative cows
352	Learners	No, *x* must be greater than 1
353	TN	That's exactly what they want
354	L1	Sizothi yes but excluding negative values
355	TN	How can you represent it using an algebraic expression
356	L1	Write it down
357	L2	You mean restrictions
358	L1	Negative values or zero
359	L2	*x* is equal to 1 or upwards
360	L3	*x* is greater than or equal to 1
361	L2	No *y* is greater or equal to 1
362	L1	No zero futhi
363	L4	Angeke athenge inkomo eziwuzero
364	L2	Number two zizomexplain ngama gama
365	L1	Into encane leyo
366	L2	Ungajaki
367	L1	Asisimplify, sizokwazi ukurepresenta lento le $5x + 2y < 80$ sesinagyidrawa
368	L3	Masenze u-*y* abe yi something something. $y = 0$ for intercept and $x = 0$ for intercept
369	L1	Mabenze isketch, bafake amacorordinates kucala
370	L4	Try another one
371	L2	Angithi sishintja iscale
372	L4	Try $x = 1$
373		
374		Day 4
375		
376	L1	Read task in English. Now what next?
377	L2	Kanti abasifundeli ngesizulu
378	L3	Read task in Isizulu [did not finish reading question]
379	L4	Read the last part of the question
380	L2	U-*x* umele ini?
381	L1	u-*x* umele amadreadlocks
382	L3	U-*y* umele amasingles
383	L1	Kuzoba u $x + 5y$
384	L1	5*y* ngoba 5 hours
385	L4	$x + 5y < 8$ hrs
386	L3	Read part b English version
387	L1	Sibhala ama expression
388	L4	Ngoba bethi at most kusho ukuthi i-maximum, ya bethi at most
389	L1	$y < 60$

390	L4	Siphelile kanjalo?
391	L3	Ja, number 2
392	L1	Sino equation 1, sinoequation 2 kanye no equation 3
393	L4	Read part c, English version
394	L1	Kumele sishaye enye imathematical expression
395	L1	Number4 u-out asimthathi
396	L3	Asicede le, number 4 kucala
397	L4	Awuthi ngibone ukuthi wenza i-profit engakhi ngale 8 hours
398	L2	Le inayo yiniprofit
399	L4	Yazi yini into esingenayo? Yazi yini into esinganayo?
400	L1	Sifuna itotal profit yamadreads nama singles
401	L4	Angithi iprofit ye hour eli one basinikezile, iprofit yamadreads R35 and iprofit yamasingles R20, so nge 5 hours iprofit u-R100, then basitjele ukuthi usebenza ama-hour awu 8…
402	L3	La abakhulumi ngama hour basiphi imali
403	Learners	8hours esinaye, u-x = 8, so u Derrick has to work for a maximum of 8 hours
404	L1	Sifuna u y futhi
405	L4	Sifuna iprofit
406	Teacher	Ngifuna kubona ama equations kucala
407	Learners	Nawa amaequations
408	Teacher	Okay, okay
409	L1	Lapha sisadiscuss thishela
410	Teacher	Nithole amangakhi amaequations?
411	L2	Sithole awu four
412	Teacher	Angithi kusho wena ukuthi iprofi, bathimalini iprofit?
413	Learners	R20 for singles and R35 for dreadlocks
414	Teacher	R20 for dreadlocks and R35 for singles
415	L1	Lapha kusho ukuthini…
416	Teacher	Lapha bebegcizelela ukuthi Uderrick can make a maximum…
417	L1	Kusho ukuthi sinama unknown eyi one, u-P
418	L2	Kusho ukuthi sinama unknown ayi three
419	L2	Sifuna u-*x*,
420	L3	U-*x* kodwa owani
421	L2	U-*x* ngulowemasingles
422	L1	
423	L3	P = 20*x* + 35*y* I-profit
424	Teacher	Ayingeni la!
425	L4	Iprofit sizoyithola kugraph
426	L1	Lapha kuzoba u-*x* = 4
427	L3	*x* = 4?

428	L2	Asimbuze uthishela
429	L1	Thishela (silence)
430	Teacher	Lapha kusketch I graph kufuneka iscale
431	L1	Asithole i-scale
432	L3	Kufuna sicale sibhale I ratio, *x*:10
433	L1	Masisubstitue
434	L2	Angithi sitimes nge scale, manje masi-tmes ngo 10 kuba kanjani?
435	L2	Kusipha i-number enkulu
436	L2	Or singenza so, x = 10, then *x* = 40
437	L3	Ja!
438	L2	Mara bheka phela, asith 1 : 10
439	L4	1 unit is 10, every one usinika u-10
440	L3	asazi,
441	L1	sabuyelemuva for every 10 ione unit,
442	L2	Ja, la sithi 1, lasithi 1..
443	L3	I1-unit is equal to 10, and x is equal to 40
444	L2	marking scales
445	L1	For every 1 is equal to 10, 1 block is 10 units, *x* is equal to 40 units, then bese siya cross multiply, u *x* is going to be 4
446	L4	*y* equals to hm..
447	L3	*y* = 35
448	L1	*y* is equal to 6 units sho, sho..
449	L3	Sitheni, for every one block is 10 units,
450	L1	for i-number b, scale sethu
451	L2	u-number b lo
452	L3	Laso grapha khona
453	L2	Sobhali e-graphini lento leyo, asibhaleni yonke lento leyo la
454	L1	Asiplotheni I graph kucala
455	Teacher	Okay, okay let us start.
458		Day 5
459	L1	Read the English version of task
460	L2	Isizulu
461	L4	Read home language version
462	L1	Let textbook A be equal to *x* and let textbook B be equal to y then satholukuthi for i-printing satholukuthi I textbook A ibiza R4 angithi. Itextbook B ibiza R5 and kumele ingandluli ku R2000 I printing what what cost, ukuprinta. Ne
463	L2	Lena
464	L1	I at most 2000, then uma iyakubinding I textbook A kumele ingandluli ku R6 and I textbook B kumele ingandluli R3 ukubinda and kumele ingandluli ku R2100. Equation yethu kuzoba $4x + 5y < 2000$.
465	L3	Bese ukuyihlanganisa kuba $6x + 3y < 2100$

466	L1	Bese siza nama restrictions
467	L3	Ama restrictions le kanti yini
468	L1	I-profit, sesishaya ngama objectives once bese sishaya ngamarestrictions okay kuzoba…
469	L3	Sibize le abathi u $2x + 3y = P$
470	L2	Eyiwena ngeke uzwakale awukhulumi
471	L3	Why wena ungakhulumi
472	L1	Sesishaya ngamarestrictions,
473	L3	Write down restrictions
474	L1	$x > 0$, and $y > 0$
475	L2	Sizoyenza njengothishela sizosubstitutha,
476	L1	Awusitjele sizowenza kanjani, amapoint awuthree, 1, 2, 3.
477	L2	(0, 70) mangabe sizosubstitutha, Abayibhalnaga kahle le….silence
480		Clinical interview
482	TN	Let us look at the question together, what is the task about?
483	Mkhonza	Kuphi la?
484	TN	Yes, What is the problem about?
485	Mkhonza	i-problem lapha bathi 8 …
486	Tn	No just tell me what is what is happening in this problem?
487	Mkhonza	Wo! bathi i-youth club iphume uhambho lwepicnic, bayahamba baya kupicnic
488	TN	Yes
489	Mkhonza	And 18 members yabo, inikeze ngezimoto. Then abayi 8 banikeze imoto ezama four seater [Youth club is going for a picnic, 18 members donated cars. 8 members donted four seater cars]
490	TN	Yes
491	Mkhonza	Abayi 10 banike ngezimoto like ezinama six seater [10 members donated six seater cars]
492	TN	Yes
493	Mkhonza	And kwamele at least less than ah (*quickly corrected himself*), greater than or equal to 64 baye kuya kuleyo picininc leyo. And kuhamba nekubuya is 100 km. Itransport allowance for I four seater kwamele ibhadale 50 c per Km and for six seater Kwamele babhadale i-60c per Km.
494	TN	I-allowance kwamele ibhadalwe kubani
495	Mkhonza	Kumninimoto
496	TN	Yes, What do they want us to do?
497	Mkhonza	Bafuna ukuthi sithole ukuthi, uhlobo lwemoto abazoyisebenzisa zingakhi ukuze i-cost ibephansi.
498	TN	Good, how can you solve the task?
499	Mkhonza	I will use the method of linear programming.
500	TN	Good, how can you solve the problem then. Just go on and solve the problem.
501	Mkhonza	I will use the method of linear prgramming.
502	TN	Continue solving the task.
503	Mkhonza	The number will be in the feasible region

504	TN	Continue solving the problem
505		
506		*learner left to solve the problem for about 10 minutes*
507		
508	TN	This is your equation 1 and how many four seaters,
509	Mkhonza	Bawu eight abantu abacontributhako
510	TN	Can you write that as an equation
511	Mkhonza	Then singathi let four seater cars be *x*
512	TN	Let four seater cars be *x* yes, how many four seater cars are there?
513	Mkhonza	Bayi eight abantu abacontributhakhofour seater cars.
514	TN	So how many four seater cars?
515	Mkhonza	Bayi eight abantu abacontributhakho kush ukuthi 8 times 4 equals to 32
516	TN	No you said bayi eight bantu labacontributha ema four seater cars, how many four seater cars are there?
517	Mkhonza	Oyi one ucontribhutha four sithi 4 time 8, bayi 32
518	TN	32 is the number of people that will be in 8-four seater cars
519	Mkhonza	Angithi bay eight abantu abacontribhutha four seater cars
520	TN	Oh Bayi eight labacontribhutha…
521	Mkhonza	Four seater cars oyi one ucontribhutha four.
522	TN	Oh! Bayi eight labacontribhutha, there are eight people who are contributing cars where four, can sit
523	Mkhonza	Kusho ukuthi angiyiunderstandanga, mina ngithi bathi abantu abayi eight, oyi one wabo per person, ucontribhutha, ukhipha four cars,
524	TN	Oh but this is fine, the way you have written your equation is fine, this is correct. So how many four seater cars can there be in this question?
525	Mkhonza	There can be 8
526	TN	Good. How many six seater cars can there be?
527	Mkhonza	There can be 10
528	TN	So how many people can fit in 10 six-seater cars Offered by some of the 18 members
529	Mkhonza	there can be 60
530	TN	Good. Continue again solving the problem
531		
532		*Learner drawing the model of the cars*
533	TN	I can see you have these cars, what are they representin?
534	Mkhonza	Le i-representa four seater cars, inikezwa abantu abawu 8. Le ihamba namaseat ayo. And le irepresenta six seater cars, inikezwa abantu abawu 10 nayo ihamba nam seat ayo.
535	TN	Yes yes now you understand it,
536	Mkhonza	kancane
537	TN	I can see you have this inequality (*pointing at* $4x + 6y \geq 64$) what does x and y represent?
538	Mkhonza	*x* urepresenta the number of four seater cars

539	TN	What does *y* represent?
540	Mkhonza	*y* urepresenta the number of six seater cars
541	TN	Good. I can see you have $4x + 6y > 64$; can you tell me more about the inequality?
542	Mkhonza	Ngithole 4*x* because *x* stands for the number of four seater cars and in each car there are four members which brings the total to 4*x* members. There are *y* six seater cars and in each car there will be 6*y* members. But labo Bantu akumelanga babe bakhulu, bamele babe ncama. [Those people should be average in size.] (*All laughing*)
543	TN	Its okay continue explaining
544	Mkhonza	Bathi lapha at least 64 people which means when I add the two like $4x + 6y$ must be greater than or equal to 64.
545	TN	Good! Continue solving the task.
546	Mkhonza	$x + y < 18$
547	TN	Yes, why less than or equal to 18?
548	Mkhonza	Because amameber azonikela ngemoto awu 18 angeke abe ngapehezulu. Kushukuthi at most 18 members.
549	TN	You are now talking i-language ye linear programming, good. Go on solve the problem.
552	TN	How many restrictions have you got
553	Mkhonza	Four
554	TN	How did you get this one?
555	Mkhonza	Labathi 18 members have offered seater cars, 8 four seater cars, kusho kuthi kuzohlala abantu abawufour, then ngathi 4*x*, and 10 six seater cars. Kusho ukuthi Kungangena abantu abayi six.
556	TN	Its okay, just write it nicely, these are your equations.
557	Mkhonza	Yes
558	TN	So what is your minimum costs?
566		Second learner
568	TN	What does the 4*x* and 6*y* stands for
569	Magudulela	It means kunemoto eziwu *x* kuhla abantu abawu 4, kanye nemoto eziwuten kuhla abantu abwu six
570	TN	Yes
571	Magudulela	Bese ngathi, le 4 ngiyirepresente nge *x* bese le six seater ngiyirepresente ngo *y*.
572	TN	Yes
573	Magudulela	Bese ngathi kuhlala abantu abawu 4, ngath $4x + 6y$ must be less than 64, ngoba at least four people must attend
574	TN	Okay, at least. What does at least stand for?
575	Magudulela	It means the minimum.
576	TN	Minimum, is this representing a minimum
577	Magudulela	It must be greater than or equal to.
578	TN	Okay fine. So this is your first equation.
579	Magudulela	Yes
580	TN	Then you have got here..

581	Magudulela	Ukuthi kumele basebenzise izimoto ezingakhi uhlobo ngalunye ngalunye kulezi ezinikeziwe.
582	TN	Good
583	Magudulela	Kufour seaters kumele basebenzise imoto eziwu four, bese kuthi kusix-seaters kumele basebenzise imoto eziwu ten. Ngoba ngithe ba expetha kuhambe abantu abayi-64. Bangathatha abantu abayi 40, babafake ku ten seaters, bese sithi 40 divide by 10, sithi 4. Besengabuya kulemoto eziwu 8. Bahlalisa abantu abawu four. Angisho kule 64 ngithathe abantu abawu 40 lakuzongena abantu abawuten khona, kwasala u 24. Bese ku24 ku four seaters, mangathi 24 divide by 4 kungipha u six.
584	TN	So what does the six mean,
585	Magudulela	Kufour seaters bazodinga imoto eziwusix.
586	TN	You've got 24 divided by 6
587	Magudulela	Angithi abantu abayi 24, bese kuhlala abantu abayi-six
588	TN	How did you get the six
589	Magudulela	The six, bengithe ku 10 cars there are six chairs
590	TN	You say yove got four tens
591	Magudulela	Yes
592	TN	These are your four seaters
593	Magudulela	Yes
594	TN	Okay is that all
595	Magudulela	Yes
596	TN	That is the only combination you can think of
597	Magudulela	Solve for x
598	TN	So how are you going to calculate your minimum costs?
601	Mkhonza	I will choose points on the vertices of the feasible region and substitute in my objective function. The one that gives the minimum value shall be my solution.
602	TN	That one what does it say, the return trip is 100 and the transport allowance is 50 cents which means if they use your car. They are going to give you 100 wabo 50cents. And if they use the other type, that is going to be 60 cents per km which is 60 times 100. So how can you write the objective function?
603	Mkhonza	Lomuntu lo uyabatjela…
604	TN	Ukuthi if we use your car we are going to pay you 60 cents per km so if there are 100km so in other words we do not know the number of cars. You have to find the number of cars. And then what will be the minimum costs. Once you have got the number of cars you then time. Say there were two... she got 64 so what would be the cost. It is going to be 6 times the charge, what is the charge
605	Mkhonza	U-x
606	TN	This is x
607	Mkhonza	6 times 100 times 50 cents
608	TN	Exactly, this is 4 times 100 times 60. Yes.
609	Mkhonza	The exact number
610	TN	Iya, you have to find the feasible region if I can say that, You have got your equation plot your graph.

APPENDIX F: TEACHER INTERVIEW TRANSCRIPT

Speaker	Utterances
TN	Thank you very much for allowing me to observe your lessons and also learn from what you were doing. You are a good teacher Sir congratulationss. I learnt a lot from you and you interact very well with your learners. I really enjoyed your lessons. I would like to ask you a few questions from the video clips i have selected. Feel free to say whatever tyou want to say. If my question is not clear you can ask me to rephrase it. What went well in your lessons?
Teacher	Thank you very much; what went well was their participation when grouped according to their home languages. As you remember all the groups were interacting very well with each other. They were expressing themselves in the way they express themselves even when not in a mathematics class. Like when they were outside using any language they feel like. To me that was important because it enabled them to talk while doing the task i had given them.
TN	Linear programming is a challenging concept, challenges with its languge how does the use of home languge helinear programming you
Teacher	The use of home languge work because learners as you know were able to come out with words like okungenani, buncinc and bonyanne in their home language. This showed that they understood the problem and can interact with it to come out with the mathematical language. Because what is important is the mathematics Once learners understand what the question wants them to do, once they understand the problem they can do the mathematics. They can also explain to each other, they can ask question. Our learners have a problem if they dont understand they dont know what to ask, so the home language enabled them to interact, to tell each other what they are thinking and more especially they refer to the version they feel they understand. As a teacher i can tell that now it is not the English but the mathematics that they do not know what to do.
TN	The task that was given to the learners was very interesting, learner's wer enjoying the lessons. They seemed to work very well. I remember clapping hands when one of them had made a good point. Language seemed not to be a problem it showed that they understood each home language.
Teacher	The task were really challenging, learners were involved in the thinking process because they would give interesting examples. Especially the task on day two, mandla cinema learners really engaged with the concept at most. Eh because what is important is for them to understand the concept and engage with it. As you remeber they gave interesting examples, like fans in a stadium something they are familiar with they related to at most. Other one said i would teach even when the majority of students are absent. that showed they engaged with the task. in the process they all understood the concept at most, a very difficult concept.
TN	I observed that even the task for day three, four and five they never had a problem with the concept at most what can you say about that?
Teacher	Ja I think giving learners enough time to engage with the concept helinear programminged them a lot, in most cases you find that we give learners the answer and they forget yet if we allow them to engage, they benefit from each other. Because you find that may be the example is an eye opener for that learner. it make him or her understand better hence he or she will be able to access the mathematics. Because what is importan is the amthematics. i really think giving tehm enough time to engage helinear programminged them a lot. That's why they never had problems with those terms, their problem was minimized. They had to do the mathematics.
TN	Who helinear programminged you with the translation?

Teacher	I asked the home language teachers, for isiXhosa I asked Mrs Moyo, For Sepedi I asked Mr Dilomo, for Sesoth I asked diketso and isiZulu I asked Mr Nkomo and we did it together and we agreed that we will not translate technical terms. My supervosor also helinear programminged in checkingthetranslated version. Really, the task was translated accurately. So learners did understand what the problem was all about.
TN	Ja I agree with you because they were all actively involved, in the discussion.
Teacher	That is what I like with using learners home languages even the passive one does interact with the task, but the problem is in reading properly the version.
TN	I can see in this clip you are saying Read proper Zulu wena thato,
Teacher	Yes because if you don't read proper zulu you don't understand that's why I said read proper zulu, they tend to mix the languages such that they don't speak proper Zulu
TN	In the questionnaire that I gave them, I asked them to indicate the languages they are fluent in reading, some said they cannot read their home language. And now you are insisting that the learner read Zulu properly, does that mean learners are not able to rwead their home language as they indicated?
Teacher	Yes, even their home language teacher does complain some times, because these kids they mix the languages. And they end up speaking pollutaed languages.
TN	Why are these kids interacting in isiZulu most of the time instead of their home languages during the lesson? Are you influencing them because your home language is IsiZulu? Is it as a result of your home language?
Teacher	No, I don't think so because even in other learning areas like in Science, in I heard from other educators that they are using it instead of their iSepedi, instead of their Sesotho. I could not say that its because the influence is from the teacher who is teaching them because even. Sourthern teacher, teacher she is also complaining that learners are complaining their vernacular lnguages because even at home you find that they are talking Sesotho Sepedi but you arrive there they are communicating in isiZulu, I do not know may be IsiZulu is taken as one of medium of instruction. i could not say that it is influence by the teacher because even eh...Sesotho teacher they also communicate in IsiZulu
TN	Yes that was what I was going to ask you what about the teachers for example Sesotho teachers do they communicate in Isesotho
Teacher	They also communicate in IsiZulu, even the Sepedi or Sesotho teacher. They communicate in IsiZulu. It is very rare that you find them communicating in their home languages
TN	What about this one where you are insisting that the learner reads the home language version of the task. Why are you insisting on home language, instead of asking this learner to read the English version of the task
Teacher	Because eh I think to me eh if you understand something. At one stage I heard prof khambule over the television, who was thinking of a log to say our learners if they don't understand what is log in their home language wil it be easy for them to interact or to work with Logarithms if bayafeyila ukuyiunderstanda. But mangabe ngimzwakanhle u-Prof khambule long long ago even before i went ti Wits U-Prof Khambule at one stage once spoke about to say eh abantawana they need to understand their home language. Ukuthi abantwana what is log in your mother time even in the past they use to say to me uthishela ufundisa imaths ngesiZulu because I like doing that ithi in Zulu and i always try to explain to them isiZulu. And once you start doing that abantwana baya-understanda akufani noma ungakhuluma i-English waya waya they dont understand some time
TN	Because I can see here you are saying kusho ukuthi isepedi enisikhulumayo asihlangani
Teacher	exactly
TN	Why are you saying that

Teacher	It is because manguzobhekisisa kahle la-Gauteng sibapolluted isipedi sabo. Kuba YiSepedi lesi uthola ukuthi assistrong and I am the only person engiyengithi nomangikhuluma engiyengizwe bethi wena Duma usakhuluma sona IsiZulu. Kodwa uthola ukuthi nomswati uthola ukuthi la akasakhulumi isiswati proper sekuba i-mixture yesiZulu. is like isiZulu is a language of power now kanti akusisona we know its English but naso cishe ngiyo elandela i-English i would say IsiZulu because noma ungazwe uzwe nabelungu abelungu nabezokubingelela bethi Sawubona Ja its rare uzwe umlungu athi Dumelang ini ini
TN	Okay with the word at least our learners came out with these words in their home language okungenani, buncinci, bonyane but when it came to at most ididnt hear any word like okungenani, they were busy using ngaphansi, ngaphansi what does that mean, does that mean they dont have a home language version for maximum, or they were comparing it with minimum.
Teacher	No, they were not comparing it with minimum, because bona bebeyibeka kahle ukuthi bebeyibona nange-English ukuthi i-maximum can mean something that is or less than that.So ngesiZulu asisanalo igama elibeka kahle lithi ncamashi like okungenani.
TN	like okungenani
Teacher	Okungenani ikhona Ngesizulu kodwa i-maximum alikho, indlela ongayibeka ngalo ungathi kungaba inani elingaka noma ngaphansi
TN	Which might be possible even with the other languages
Teacher	yes kodwa mangibhekisisa ngithe mangenza ngikhuluma nabo teacher be-venacular like sesotho sepedi isixhosa, bona ngazuthi banawo ngoba mangkhumbula kahle ngazuthi igama esisuthwini esipedini banaso ngaze ngacomplaina ngoba elabo igam alichange iminimum nemaximum kusho ukuthi kudependa ukuthi ulisebenzise kanjani.in a context
TN	Okay okay, this one from the Sesotho group who seem not to understand English version and Sesotho version. You ended up saying if you don't understand your home language sesizakufundisa ngani manje. What was the problem with this girl even though she said it was a mistake?
Teacher	Ayi, ngingayithatha ngokuthi ke ngoba ekugcineni ubese uthi kwakuyimistake kodwa mina ngokwami ukubona nangithathukubheka, it was not a mistake ngempela waye nga understand saze sazama bonke bazama ukumchazela kodwa angazi ngibona ukuthi wayenag understandi
TN	Ja because it is important to understand
Teacher	Wayenagunderstand masethi yimistake wabona ukuthi thishela iyamkwatisa lento ngoba uyezama with our home langauges kuthi si-understande
TN	Awu-understandi Sesotho sakini, awu-understandi English sesitakufundisa ngani
Teacher	Awu-understandi Sesotho sakini, awu-understandi English sowayezama ukudoja masethi i-mistake
TN	Okay
Teacher	I am not sure noma wayefuna ukwenza a direct translation wase uba confused along the way Mhlawumbe wayefuna ukwenza a direct translation ukuthi mawufuna isuke la iye la kufuna kube nje. Yena wayengathathi the whole sentence angazi. Alifunde as a whole then alithathe ngapha nangala alifunde yena wayefuna because mangizocathanisa negroup ya-last year nathis year yigruop yesipedi yayigood kakhulu in terms of understanding. icontent and everything because i still remember..
TN	Some learners did indicate that they did not understand the problem, and you ask them to read the home language. As you have explained that you believe that when you understand a concept in home language you can interact with it. Now in this video clip, you are asking the learner that in which language did you understand the task, and he says in Sesotho. Do you think he was telling you the truth?
Teacher	At first I thought he was not telling the truth that's why I asked him to tell us what he understands and he was able to tell us. So I believed him. And Agin I think it was the meaning of the word at most which is interprted in context in Sepedi.

TN	I found this conversation very interesting, can you tell me more about it, how did you find it when Errolsaid, the language of linear programming says at most is less than or equal to, and he went further to say if bebathi at least we would say the show will not go on because it means 150 or more
Teacher	That was a very good argument by that boy, because ehe showed that he understood what the problem wanted. That group was thinking of profit which is maximising profit and minimising loss. But what was interesting when it came to the second question, they did not see that they were contradicting themselves. Thats why i say using the home language enabled them to understand and to engae with the task And again i would say well thought task
TN	What would you say about the concept, did learners understand them
Teacher	They understood the concepts very very well, and they were able to say it in their home language. That is what make me say they understood the concepts
TN	During group discussion you move from one group to the other, what do you do when you get to the other groups especially the Sepedi, Sesotho and isixhosa group because with the isiZulu group you ask them questions since I am focusing on it.
teacher	When I get to the group I listen to what they are discussing, then I ask them question like when I get to isiZulu group as you have said.i listen to find out if they are engaging with the task. If they do not understand they ask me questions. But I try and probe to see if they understand the task.
TN	Do you interact in their home language because with isiZulu it's like you speak English when you ask them questions most of the time?
Teacher	I try to imitate them, but you know I understand their home language but I am not fluent in speaking, so sometimes they laugh at me but I don't care as long as they access the amthematics. That is the important thing with me. Actually I use English in Sepedi and Sesotho group so that they concentrate instead of concentrating on my pronounciation of these words but i do understand their home languages in only that they would laugh when i pronounce some of these words. With the isiXhosa group i use IsiZulu and English because the two are very similar.
TN	The strategy you are using really shows that mathematics has its own language, it doesn't matter which language you are using, wht is important is to understand the problem and then continue solving the task. What are you views about my claim
Teacher	Well before I tried the stratgy I have always thought that English was the problem, but Pimm says that maths has its own language. Using home language helinear programmings you to access that language. Whatever language as you have seen Sepedi, Sesotho Isixhosa all understood minimum even though they were using different languages, when it cam to mathematical meaning they all came with one word minimum. So like i said the home language enables the learner to engage with the mathematics and at the end of the day you are able to respond to the task accordingly. Another thing grouping them according to their home langage increased participation as they were all actively involved. they become free to ask because they can use any language but what is common is code swicthing.
TN	Thank you very much Sir I really enjoyed working with you. I have learned a lot and I wish you all the best

APPENDIX G: LETTER TO THE PRINCIPAL
UNIVERSITY OF THE WITWATERSRAND
LINEAR PROGRAMMING RESEARCH PROJECT

Dear principal

My name is Thulisile Nkambule. At present I am doing an M.Sc degree in Mathematics Education at the University of the Witwatersrand. As part of my studies I am doing a study on teaching and learning linear programming in a multilingual classroom.

I am requesting permission to work with Mr Bheki Duma, one of your staff members and his Grade 11 learners in your school in this study. If you allow them to participate, they would be asked to allow me to observe mathematics lessons in their classroom for five days in the month of August at agreed upon times. I will also have Mr Duma to participate in a reflective interview focusing on his observed lessons. Furthermore, he will be requested to select six learners for interviews.

I am also requesting for permission to video-record the lessons and to tape record the interviews so that I can ensure that I make an accurate record of what he says and do. When the tape has been transcribed, Mr Duma will be provided with a copy of the transcript, so that he can verify that the information is correct.

I intend to protect the anonymity and the confidentiality of the teacher and learners' responses. Their names and contact details will be kept in a separate file from any data that they supply. This will only be able to be linked to their data by me. In any publication emerging from this research, they will be referred to by pseudonyms. If for any reason they would like their real names to be used in the publications, they will need to make written request to me.

A brief summary of the findings will be available to the teacher once the research has been completed. The findings might also be presented at academic conferences and published in national and international academic journals.

Please be advised that the participation of your school in this research project is voluntary. Should you wish to withdraw at any stage, or withdraw any unprocessed data you have supplied, you are free to do so. Your decision to participate or not, or to withdraw, will be completely independent of your dealings with the University of the Witwatersrand.

If you are happy for your school to participate, please indicate that you have read and understood this information letter by signing the accompanying consent form and returning it to me.

Should you require any further information do not hesitate to contact me.

Ms Thulisile Nkambule
0726639231

APPENDIX H: CONSENT FORM FOR THE PRINCIPAL

UNIVERSITY OF THE WITWATERSRAND

LINEAR PROGRAMMING RESEARCH PROJECT



Researcher: Ms Thulisile Nkambule

Supervisor: Prof. M. Setati

I ……. agree that the school can participate in the project named above. The details of lesson observations and interviews have been explained to me. An information letter has been given to me to keep.

I give consent to the following: (Tick to indicate your selection)

Video recording of the lessons:

Yes No

The possible future use of the videotext for teaching purposes:

Yes No

The participants being interviewed:

Yes No

Tape recording of the participants' interview:

Yes No

---------- ----------

Principal signature Date

---------- ----------

Witness Date

---------- ----------

Researcher Date

APPENDIX I: LETTER TO THE TEACHER

UNIVERSITY OF THE WITWATERSRAND
LINEAR PROGRAMMING RESEARCH PROJECT

Dear Teacher

My name is Thulisile Nkambule. At present I am doing an M.Sc degree in Mathematics Education. As part of my studies I am currently doing a study on teaching and learning linear programming in multilingual classrooms.

Your Principal has given me permission to send you this letter to invite you to participate in this research project. Once you have read the letter you can decide whether you want to participate or not. Should you agree to participate, I will ask you to allow me to observe your teaching in one of your Grade 11 mathematics classrooms for a week at agreed upon times during August. I will also ask you to participate in a reflective interview focusing on your observed lessons. With you permission the lessons will be video-recorded and interviews tape-recorded so that I can ensure that I make an accurate record of what you say and do. When the tape has been transcribed, you will be provided with a copy of the transcript, so that you can verify that the information is correct.

I will protect your identity and your responses will be kept confidential. Your name and contact details will be kept in a separate file from any data that you supply. In any publication emerging from this research, you will be referred to by a pseudonym. I will remove any references to personal information that might allow someone to guess your identity. Should you wish that your real name be used in the publications, you will need to make written request to me.

Once the research has been completed, a brief summary of the findings will be available to you. It is also possible that findings will be presented at academic conferences and published in national and international academic journals.

Please know that your participation in this research project is voluntary. Should you wish to withdraw at any stage, or withdraw any unprocessed data you have supplied, you are free to do so.

If you would like to participate, please indicate that you have read and understood this information by signing the accompanying consent form and returning it to me.

Should you require any further information do not hesitate to contact me.

Ms Thulisile Nkambule
0726639231

APPENDIX J: CONSENT FORM FOR TEACHER

UNIVERSITY OF THE WITWATERSRAND

LINEAR PROGRAMMING RESEARCH PROJECT

Researcher: Ms Thulisile Nkambule

Supervisor: Prof M. Setati

I---------- agree to participate in the project named above. The details of lesson observations and interviews have been explained to me. An information letter has been given to me to keep.

I give consent to the following: (Tick to indicate your selection)

Video recording of the lessons:

Yes No

The possible future use of the videotext for teaching purposes:

Yes No

……..

……..

Signature of participant Date

……..

……..

Signature of witness Date

……..

……..

Signature of researcher Date

APPENDIX K: CONSET FORM FOR TEACHER (TAPE RECORDING)

Teacher consent form for Tape recording:

I …….am aware of the data collection processes in the Linear programming Project as stated in the letter.

I give consent to the following:

Being interviewed at some point during the study (Tick to indicate your selection)

Yes or no

The tape recording of my interview with the researcher

Yes or no

…… ……

Signature of participant date

…… …….

Signature of witness date

…… ……..

Signature of researcher date

APPENDIX L: INFORMATION LETTER TO PARENT/GUARDIAN
UNIVERSITY OF THE WITWATERSRAND
LINEAR PROGRAMMING RESEARCH PROJECT

Dear Parent or guardian

My name is Thulisile Nkambule. At present I am doing my M.Sc degree in Mathematics Education. As part of my studies I am doing a study on teaching and learning linear programming in multilingual classrooms.

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

Children whose parents agree that they participate in this study will be video recorded for five days during mathematics lessons in the month of August. Children whose parents do not agree that their children be video recorded will be kept away from the focus of the video recorder. They will not be deprived from the lesson.

I intend to protect your child's anonymity and confidentiality. Their real names will not be used in the final report. I will remove any reference to personal information that might allow someone to guess their identity. The results of the research may be reported at conferences, in journals and to research funders. In case I need to use the information in the video recording for conferences or for teaching purposes, the children's faces will be hidden from public viewing.

Please not that your child is not forced to participate. Should you require any further information please contact me.

Please complete the consent form if you agree that your child be part of this research project.

Ms Thulisile Nkambule
0726639231

APPENDIX M: CONSENT FORM FOR PARENT

UNIVERSITY OF THE WITWATERSRAND

LINEAR PROGRAMMING RESEARCH PROJECT

Researcher: Ms Thulisile Nkambule

Supervisor: Prof M. Setati

I---------- agree that my child participate in the project named above. The details of lesson observations and interviews have been explained to me. An information letter has been given to me to keep.

I give consent to the following: (Tick to indicate your selection)

Video recording of the lessons:

Yes No

The possible future use of the videotext for teaching purposes:

Yes No

……..

……..

Signature of parent Date

……..

……..

Signature of witness Date

……..

……..

Signature of researcher Date

APPENDIX N: INFORMATION LETTER TO LEARNERS
UNIVERSITY OF THE WITWATERSRAND
LINEAR PROGRAMMING RESEARCH PROJECT

Dear learner

My name is Thulisile Nkambule. At present I am doing my M.Sc degree in Mathematics Education at Wits University. As part of my studies I am doing a research on teaching and learning linear programming in multilingual classrooms. Your mathematics teacher and Principal have given me permission to send you this letter to invite you to participate in this research project.

If you agree to participate in this study you will be requested to be present during the time when I will be observing lessons in your class. Only linear programming lessons will be observed.

I intend to protect your anonymity and confidentiality. Your real name will not be used in the final report. I will remove any reference to personal information that might allow someone to guess your identity and of your teacher. In case I need to use the information in the video recording for conference or for teaching purposes, your faces will be hidden from public viewing.

Remember that you are not forced to participate. Should you require any further information contact me.

If you agree to be part of this research project please complete the consent form.

Ms Thulisile Nkambule
0726639231

APPENDIX O: CONSENT FORM FOR LEARNER

UNIVERSITY OF THE WITWATERSRAND

LINEAR PROGRAMMING RESEARCH PROJECT



Researcher: Ms Thulisile Nkambule

Supervisor: Prof M. Setati

I, ……. agree to participate in the project named above. The details of lesson observations and interviews have been explained to me. An information letter has been given to me to keep.

I give consent to the following: (Tick to indicate your selection)

Video recording of the lessons:

Yes No

The possible future use of the videotext for teaching purposes:

Yes No

…….. ……

Signature of learner Date

…….. ……

Signature of witness Date

…….. …….

Signature of researcher Date

APPENDIX P: CONSENT FORM FOR LEARNER (TAPE RECORDING)

Learner consent form: Tape recording

I ……a mathematics learner at ……., am aware of all the data collection processes in the linear programming project as stated in the letter.

I give consent to the following: (Tick to indicate your selection)

Being interviewed during the study

Yes no

Being tape recorded during the interviews

Yes no

……..

……..

Signature of learner Date

……..

……..

Signature of witness Date

……..

……..

Signature of researcher Date

APPENDIX Q: ETHICS CLEARANCE

UMnyango WezeMfundo
Department of Education

Lefapha la Thuto
Departement van Onderw

Date:	21 May 2007
Name of Researcher:	Nkambule Thulisile
Address of Researcher:	Private Bag 3
	Wits
	2050
Telephone Number:	0117173414/0726639231
Fax Number:	0866937459
Research Topic:	Exploring a Strategy that Draws on the Learners' Home Languages for Teaching and Learning Linear Programming in a Multilingual Classroom of Additional Language Learners
Number and type of schools:	1 FET Institution
District/s/HO	Ekurhuleni West

Re: Approval in Respect of Request to Conduct Research

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

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

1. *The District/Head Office Senior Manager/s concerned must be presented wit copy of this letter that would indicate that the said researcher/s has/have b granted permission from the Gauteng Department of Education to conduct research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, 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 chairperson of the School Governing Body (SGB) that would indicate that researcher/s have been granted permission from the Gauteng Departmen Education to conduct the research study.*

Director: Knowledge Management and Research
Room 525, 111 Commissioner Street, Johannesburg, 2001 P.O.Box 7710, Johannesbu
Tel: (011) 355-0488 Fax: (011) 355-0286

4. *A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or 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

ACTING CHIEF DIRECTOR: OFSTED

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

APPENDIX R WITS ETHICS CLEARANCE

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3007 • Fax: +27 11 717-3009 • E-mail: enquiries@educ.wits.ac.za • Website: www.wits.ac.za

STUDENT NUMBER: 0603792
Protocol: 2007ECE65

19 September 2007

Dear Ms T Nkambule
Reith Hall
Wits
2050

Dear Ms Nkabule

Application for Ethics Clearance: Masters in Science

I have pleasure of advising you that the Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the senate has agreed to approve your application for ethics clearance submitted for your proposal entitled:

Teaching and Learning linear programming in a Grade 11 multilingual class of English language learners: Exploring the deliberate use of learner' home languages

Recommendation:

Ethics clearance is granted

Yours sincerely
MMabeta
Matsie Mabeta
Wits School of Education

Cc: Supervisor: Prof. M Setati (via eMail)