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Using multiple languages to support mathematics proficiency in a grade 11 multilingual classroom of second language learners: an action research.

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CHAPTER 1

SETTING THE SCENE

1.1. Introduction

Teaching mathematics to learners whose home language is not the language of learning and teaching (LoLT) is complex. Most mathematics teachers who teach these learners try to play a dual role, they teach English at the same time as they teach mathematics. Learners on the other hand, are faced with a challenge of understanding mathematical terminology, concepts and meanings explained in the language that they are still learning.

I teach mathematics to grades 10 and 11 learners, who are multilingual and have limited fluency in English, which is the language of learning and teaching in the school. The participation of these learners is usually very limited during classroom discussions, especially when they have to interact with me. When the discussions are between learners during group activities, they usually use their home language(s) in addition to English, and most of them do take part in such discussions. Sometimes they ask questions or make inputs in the public domain in their home language(s), and when I insist that they use English, most of them refrain from asking questions or making inputs. This makes learning and teaching difficult.

From my conversations with other teachers, I have come to realize that what my learners are doing is not unique. Most mathematics teachers experience these challenges in their multilingual classrooms. According to Pretorius (2002) in the print media, the use of more than one language has become a strategy that teachers in multilingual classrooms rely on to explain concepts. This is a view shared by some authorities in the Department of Education (DoE) in South Africa who indicate in the print media that in the Eastern Cape classrooms, you will find that teachers use learners' home languages as the medium of instruction, even though English is the LoLT (Gules, 2005).

The South African Language-in-Education Policy Act of 1996 encourages multilingualism. Schools have the right to choose their LoLT, and this right must be exercised with the aim of promoting multilingualism (ELRC., 1996). One way of promoting multilingualism in mathematics classrooms such as the one I teach in is by using multiple languages during teaching. The debates around language and learning in South Africa tend to create a dichotomy between learning in English and learning in the home language(s). These debates create an impression that the use of the learners' home languages for teaching and learning must necessarily exclude English, and the use of English must necessarily exclude the learners' home languages. The aim of the study reported here was to challenge this dichotomising between the use of home languages and the use of English for teaching and learning of mathematics.

The study explored the deliberate use of multiple languages to support the development of Grade 11 learners' mathematical proficiency in a multilingual classroom. This study was guided by the following research questions:

- How can the learners' home language(s) be used to support the development of learners' proficiency in mathematics?
- To what extent can tasks set in multiple languages support the development of learners' proficiency in mathematics?
- To what extent can learners' interactions with the tasks in multiple languages support the development of learners' proficiency in mathematics?

This was an action research in which I was transforming my teaching. I refer to this as transformation because I taught in a way that was different from my usual way of teaching.

1.2. Why Action Research?

There has been research done on mathematics teaching and learning in multilingual classrooms in South Africa and elsewhere. While this research has helped us understand

some of the complexities of teaching and learning mathematics in bilingual/multilingual classrooms, it has been done by outside researchers who are not necessarily practising school teachers (for example, Adler , 2001; Setati, 1998, 2002; Moschkovich, 1999). The researchers were not researching their own teaching. Their main aim was to gain a better understanding of the complexities of teaching and learning mathematics in bilingual or multilingual classrooms. Setati (1998) and Adler (2001) reported in their studies that when doing observations in multilingual mathematics classrooms, teachers used code switching as a resource to support learning. These teachers switched between the language of learning and teaching (LoLT) and the learners' home languages. In her study of English language learners, Moschkovich (1999) observed how a teacher supported learners in learning mathematics by using revoicing and rephrasing explanations in their home languages. Setati (1998) and Moschkovich (1999) found that the teachers they observed in their studies used learners' home languages when introducing technical terms and concepts at the beginning of the lessons.

Even though learners' home languages were used during teaching and learning in the studies mentioned above, they were not used deliberately and/or as part of transforming classroom practice. However, it is evident from the studies that learners' home language(s) play an important role in teaching and learning of mathematics. Hence their deliberate use in this action research study. Action research allows for modifications of the intended intervention after analysing, evaluating and reflecting upon the first cycle of data collected (Opie, 2004). Action research gave me, the teacher, an opportunity to research my practice as I transform it.

Since my intention was to transform my own teaching, action research was an appropriate approach, as it focused on "a specific problem in a specific setting" (Cohen and Manion, 1994). In my teaching experience, I never had an opportunity to reflect upon my teaching in a systematic and in-depth manner and think of a way of transforming it. Therefore, as a teacher-researcher, action research provided me with an opportunity to be involved through out the process (Opie, 2004). Firstly, I was in a position to translate the ideas that I came up with, of how multiple languages or tasks in multiple languages could be used

to support mathematical learning, into action in my own classrooms (Cohen and Manion, 1994). Secondly, I had an opportunity to reflect on my own practice, transform it, and come up with an intervention to support mathematical learning. This was an opportunity that other researchers in the field did not have. Since action research enabled a reflective cyclic process (Opie, 2004), if the intervention was not successful in one cycle, it could then be reflected upon, modified and implemented in the next cycle. While I could have used approaches such as Case Study or Experimental Study, they do not offer the opportunities that Action Research does.

1.3. What was Transformed?

I have been teaching mathematics at secondary school level for 15 years. While I sometimes used learners' home languages in my teaching, I used them in an unplanned manner. The tasks that I previously used in my class were set in English only. I did not use tasks that were set in multiple languages. As indicated earlier, most learners in my class have limited proficiency in English (LoLT) and thus had difficulty in understanding and interpreting mathematical tasks given to them in English. Due to learners' limited proficiency in English, the tasks I selected were comparatively easy and generally of a lower cognitive demand. The tasks were mostly from mathematics textbooks and I used them generally for assessment purposes with the aim of assessing learners' understanding of mathematical procedures, algorithms and rules. Learners did the tasks as classwork or homework exercises. While these kinds of tasks are in general worth doing with learners, in the study I also gave tasks of a higher cognitive demand.

Furthermore, multiple languages were deliberately used for teaching and learning. This implies that learners' home languages were used in a planned manner. The tasks that I used in the study were set in multiple languages and were used for learning and teaching, and not for assessment purposes. Since learners were grouped according to their home languages, each group worked on the same task set in both English and the group's home language. However, the mathematics of the task was not compromised. The cognitive-level demands of the tasks, as suggested by Stein, Smith, Henningsen and Silver (2000),

were taken into consideration. Further elaboration on the categorization of tasks is discussed in the next chapter.

1.4. Conclusion

This chapter has highlighted the challenges that teachers are faced with in teaching mathematics in multilingual classrooms to learners whose languages are not the same as the LoLT. It has also indicated the difficulty that these learners have during classroom discussions when they are supposed to communicate in English (LoLT), and how that affects their learning of mathematics. The dichotomy created by the debates in the public domain, around language and learning in South African, has been discussed. I have indicated, in this chapter, that the aim of the study was to challenge this dichotomy by exploring the deliberate use of multiple languages for teaching and learning mathematics in a multilingual classroom through an action research approach in which my teaching is transformed. Furthermore, transformations that have occurred in my teaching were briefly discussed, and the questions that have guided the study were indicated in this chapter.

The study is informed by Vygotsky's (1978) theory of socio-cultural development, which emphasizes the effect of the social on the child's cognitive development. Chapter 2 elaborates on this theoretical framework and provides a review of relevant literature. Chapter 3 describes the research design and methodology used in the study. The mathematical task used in the study and its features are presented, and the four lessons conducted during the study are described. In chapter 4 data collected is interpreted and analyzed qualitatively using categories and sub-categories that were derived from Kilpatrick, Swafford and Findell's (2001) strands of mathematical proficiency. Extracts from lessons transcripts are used to support my claims and interpretations. Furthermore, learners' views and interpretations about the strategy used in this study are presented. In chapter 5 the research findings and analysis are discussed and concluded, focusing on the use of languages, prevalence of strands of mathematical proficiency and learners' reflections about the new approach or strategy. The chapter further discusses the

challenges that one may be faced with when adopting the strategy, focusing on task translation, the manner in which learners' home language(s) may be used and the time factor. The implications of the research findings for both research and teaching are also discussed.

CHAPTER 2

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1. Introduction

This chapter presents the theoretical framework that informed the study. This study was informed by socio-cultural theories, especially Vygotsky's (1978) work, which focused on how cognitive development as mediated by the social. The chapter also discusses Vygotsky's general genetic law of cultural development (Wertsch, 1979; Vygotsky, 1978 in Tharp and Gallimore, 1991; Vygotsky, 1966, 1978) and what it means for teaching and learning in a multilingual mathematics classroom.

Furthermore, the chapter elaborates on the use of tasks in the teaching and learning of mathematics, and how well selected tasks can develop learners' proficiency in mathematics. Five interwoven and interrelated strands develop proficiency in mathematics, and the development of these strands depends on the kind of tasks used (Kilpatrick *et al*. 2001). This chapter thus highlights what Stein *et al*'s (2000) lower-level demands tasks, and higher-level demands tasks entail, and the type of strand that each type of task can develop.

2.2. Theoretical Assumptions

This study was broadly informed by Vygotsky's theory of socio-cultural development. According to this theory, the child's cognitive development depends on external factors, i.e. language, cultural and social processes. This development, from the Vygotskian perspective, occurs in and through socially mediated activity, and language plays a key role in mediation (Vygotsky, 1978).

This theory is helpful because it provides a framework within which one can describe the role that the learners' home languages as used by the teacher, the learners and in the tasks

can play in a multilingual classroom. Central to Vygotsky's theory is the fact that higher mental functions are formed through social interaction (Vygotsky, 1978). This resonates with Hatano's work, which argues that humans construct their own knowledge, and that the process of knowledge reconstruction "is not a purely individual enterprise but is constrained socioculturally" (Hatano, 1996:199). In other words, learners do not just construct mathematical knowledge on their own but they do so in interaction with resources around them, both human and non-human. Hence, this study highlights the importance of well thought-out tasks and an environment where learners can interact with each other and with the teacher in languages they are comfortable with. According to Vygotsky's general genetic law of cultural development,

> *Any function in the child's cultural development appears twice, or on two planes. First it appears on the social plane and then on the psychological plane. First it appears between people as an interpsychological category, and then within the child as an intrapsychological category (Vygotsky, 1978).*

This law suggests that in order to explain the psychological, we must look at the external world or the social plane in which the child's life develops and not only at the child (Tharp and Gallimore, 1991). This external world includes people who transmit structures and the environment in which the individual's higher cognitive processes are formed through speech, social interaction and the process of co-operative activity. The interpsychological or the social plane is the classroom in which learning and teaching occurs. On the interpsychological plane, there are learner-learner and teacher-learner interactions whereby the learners and the teacher communicate mathematical ideas and concepts through language. In Vygotsky's (1978) terms, language is basically used as a mode of communication between the child and the people in his/her environment. The mathematics classroom in which the study was done was therefore viewed as a social context in which the teacher, using English and the learners' home language(s), and through tasks set in multiple languages, supported the learners' mathematics learning. The classroom organisation and implementation of the tasks was guided by Vygotsky's theory.

Vygotsky's general genetic law stated above highlights the connection between the interpsychological and the intrapsychological functioning, as Wertsch (1985:61) argues, **"**the form of interpsychological functioning has a powerful impact on the resulting form of intrapsychological functioning". This suggests that, from Vygotskian perspective, the social play a significant role in determining the type and nature of intrapsychological functioning.

The process by which the interpsychological becomes the intrapsychological is referred to as 'internalization' (Wertsch, 1985; Tharp and Gallimore, 1991). This is a process whereby the individual accomplishes activities performed on the external plane on the internal plane. This, in Vygotskian terms is not merely a transferral of external activities to the internal plane or a copying of external reality on a pre-existing internal plane, but a process of formation of the individual's higher cognitive function in structures transmitted to that individual by others through social interaction, cooperative activity and language or speech. As Leont'ev (1981: 57) in Tharp and Gallimore (1991) explains, internalization is a process in which the internal plane of higher mental processes is formed. In my view, one of the ways, among others, in which this process of internalization can take place in a classroom situation, is during learning and teaching.

According to Vygotsky (1978), there is interrelation between learning and cognitive development. The useful construct in understanding social relations in learning and development is his concept of 'the zone of proximal development' (ZPD), which is discussed in the next section.

2.3. The Zone of Proximal Development (ZPD)

Vygotsky (1978) argues that in order to discover the actual communion of the developmental process to learning capabilities, at least two developmental levels should be resolved. The first level is referred to as 'the actual developmental level', which is "the level of development of a child's mental functions that has been established as a result of certain already completed developmental cycles" (Vygotsky, 1978:85). This

implies that this first level defines the learners' already matured mental functions. Suppose a learner works on a task independently and succeeds, that would suggest that his/her cognitive functions for the particular task have matured.

The second level is referred to as 'the potential developmental level', which is the level of the child's mental functions that has been established as a result of solving problems through social assistance (Tharp and Gallimore, 1991). This is a level of cognitive development where learners work on a task successfully under teacher's guidance or with some assistance from the more knowledgeable peer. The gap, the distance, the region or the difference between the child's independent or individual capacity and the capacity to perform through social assistance is the ZPD.

Wertsch (1985) highlighted that Vygotsky suggested the notion of ZPD in order to solve two practical problems in educational psychology, which are "the assessment of children's intellectual abilities and the evaluation of instructional practices" (p.67). He further argues that the process of moving from the interpsychological functioning to the intrapsychological functioning is possible through the child's ZPD. The zone of proximal development (ZPD) is therefore defined as "the distance between a child's actual development as determined independent problem solving and the higher level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978:86). This is the gap between the child's actual level of development and his/her potential level of development. In Jaworski's (1994) view, Vygotsky has introduced the concept of ZPD to provide some measure of a learner's development related to instruction offered. In a classroom environment, if the focus is on individual learners and each learner is working on tasks, the difference between each learner's level of performance on tasks without teacher guidance or help, and his/her level of performance in solving the tasks under teacher guidance and help, is that learner's ZPD for the particular tasks. If a group of learners are working on tasks, the difference between the level of the group's performance in solving the tasks without teacher guidance and their level of performance under teacher guidance and assistance is the group's ZPD. Depending on the number and kinds of skills or

competencies which tasks develop, each learner or group can have a number of ZPDs, as the following quotation suggests,

> *There is no single zone for each individual. For any domain of skill, a ZPD can be created. There are cultural zones as well as individual zones, because there are cultural variations in the competencies that a child must acquire through social interaction in a particular society (Rogoff, 1982 in Tharp and Gallimore, 1991).*

The quotation suggests that during the teaching and learning of mathematics, the development of several mathematical skills or competencies can take place when learners interact with each other or with the teacher, and depending on the nature of tasks, different tasks can develop different skills or competencies. This is discussed later in the chapter.

As highlighted before, the transition from assisted performance (interpsychological category) to individual performance (intrapsychological category) takes place in the ZPD. Tharp and Gallimore (1991) argue that this transition is not abrupt. They suggest a four-stage model, which focuses on the relationship between individual control or performance and social control or assisted performance. The model influenced the way I planned the implementation stage of this action research. This model is discussed in the next section.

2.4. The Four Stages of the ZPD

Stage 1: Performance assisted by more capable others

In Vygotskian terms, certain circumstances in which the child's learning takes place and contributions of other people involved in his/her learning, determine his/her achievements and cognitive development. According to Tharp and Gallimore (1991), children's independent task performance in the intrapsychological plane, relies first on

the external assistance by adults or the more capable peers, and the nature of the task and the child's age will determine the type and magnitude of the external assistance required. It is therefore significant for learners of mathematics to actively participate in class, teachers should determine the actual task performance level of learners in order to organize and direct the process of learning. As highlighted by Scott (1998), the teacher or the knowledgeable other has a significant role to play "in mediating and 'passing on' existing public knowledge to students" (p.47). The teacher can help learners to move to the higher level of potential development by using Vygotsky's concept of 'scaffolding'. 'Scaffolding' has metaphorically been used to mean temporary support given to learners to simplify their role in performing the task (Tharp and Gallimore, 1991). During the process of scaffolding, which occurs in the interpsychological plane, the task is not being simplified, but it is being broken down in a sequence of steps while its difficulty is being held constant throughout. Jarwoski (1994) suggests that 'scaffolding' "promotes movement across the ZPD" (p.109). Teachers do scaffolding through mediation during teaching and learning, where mediation is defined as "closer teacher direction and guidance" (Brodie, 1996:12). Scaffolding is a process whereby a teacher or a more capable other assist learners' performance of the task, and as Vygotsky (1979) suggests, there should be systematic cooperative conditions among learners and between learners and the teacher during this process. The semiotic tool that can be used as a mediating agent (Berger, 1998; Vygotsky, 1979) is language. The role of language is discussed later in this chapter.

Since scaffolding is a temporary support given to learners by a teacher as they work on a task, during this stage, there may be a steady decline in assistance in the interpsychological plane and a steady increase in individual performance by learners but still in the interpsychological plane, where learners begin to use language to ask the teacher questions thereby influencing the kind and level of assistance. According to Tharp and Gallimore (1991:141), this is a transition "from other-regulation to self-regulation". Citing Rogoff (1986), they also highlight that this is a point when learners are not only acquiring the performance "but also the process of transfer of the performance". The mission shall have been accomplished when learners have completely

taken over the task performance, which is, working on the task in the intrapsychological category.

Stage II: Individual performance

During this stage, the learner works on the task without assistance from more capable others. The performance is now in the intrapsychological plane where the learner uses language to communicate to self to assist performance, especially during task difficulty. Children use self-directed speech, according to Tharp and Gallimore (1991), as a tool for self-guidance. In Vygotskian terms, "once children begin to direct or guide behaviour with their own speech, an important stage has been reached in the transition of a skill through the ZPD" (Tharp and Gallimore, 1991). However, at this stage performance is not yet fully matured or automatized, but still in the process of developing.

Stage III: Developed, automatized and 'fossilized performance

At this stage, the learner does not need any assistance as internalization and 'automatization' of the task execution has taken place. According to Tharp and Gallimore, the learner's performance is already developed since he/she has "emerged from the ZPD into the developmental stage for the task" (p.144). Since individual performance is now matured, any assistance may be detrimental, as it would be disruptive and irritating. In Vygotsky's view, performance is now 'fossilized'. This implies that the learner has reached the stage where he/she does not want to be interrupted by the social when working on a task.

Stage IV: De-automatization of performance leading to recursion back through the ZPD

Tharp and Gallimore (1991) argue that it does not mean that when individual performance has matured for a particular task or when cognitive strategies are mastered, children cannot ask for assistance when they find it difficult to continue with the task. A learner can therefore ask for external mediation from capable others, either from the

teacher or from other members of the group or class. During this stage, there is a backward shift from self-regulation to other-regulation, where self-speech is made external. A learner who has mastered a certain mathematical skill may be in the ZPD of the other skill that needs to be developed, and as a result, assistance from others would again be needed, and the whole cycle starts again. As it is suggested,

> *Indeed, enhancement, improvement, and maintenance of performance provide a recurrent cycle of self-assistance to other-assistance. A most important consideration is that de-automatization and recursion occur so regularly that they constitute a Stage IV of the normal developmental process (Tharp and Gallimore, 1991:145).*

The above quotation suggests that movement through the ZPD is cyclic and repetitive, and therefore recursion is required from time to time. In a classroom, this movement is from the interpsychological plane between the learner and the teacher, or more capable peers, and to the intrapsychological plane, within the learner, and then backwards from within the learner to the teacher, or more capable peers, in the interpsychological plane. In the whole process, language plays a significant role.

2.5. The Role of Language

Teachers, to lead the discussions, give direction and guide learners' constructions use language (Jaworski, 1997; Wertsch, 1984). Berger (1998) indicates that language serves as a cognitive re-organiser that aims at changing the quality of teaching and therefore helps in developing thinking. When learners interact with each other in class through language (speech), they add some value to their cognitive development. This suggests that when a learner exchanges mathematical ideas with his/her peers, he/she moves from one state of knowing to another state of knowing, since learning is an additive process (adding to what is already there). Hatano (1996: 212) suggests that the teacher can mediate learning by, "(a) presenting various models to enhance students' understanding, (b) using tools for inducing initial success, (c) amplifying conceptions generated by

students, and (d) asking students to reflect on what they actually do". Other resources such as leading questions, prompts, elicitation, confirmations, revoicing and rephrasing may also be used as a 'scaffold'.

Through language, the teacher's assistance and effects of peers (Ginsberg, 1985: 9), and the use of mathematical tasks, learners become active participants in the process of knowledge construction. Language is a communication tool that is more than a mere translation of words. Language is an important tool for thinking and learning and is the "major tool for mediating the interaction between learners and between the teacher and learners" (Setati, 2005). From the social constructivists' view, as indicated earlier on, as learners work through the instructional tasks, the teacher or the more knowledgeable peer does mediation. Mediation is done through language. This suggests that when learners are communicating mathematical ideas and concepts with one another or with the teacher, language becomes a medium through which such ideas and concepts are negotiated. It is therefore a tool to share ideas and a "vehicle in the construction of mathematical knowledge" (Gorgorio and Planas, 2001:7). As I have indicated earlier on, my learners' had limited proficiency in English, which is the LoLT, in my view, if mathematical ideas are communicated only in the LoLT, a breakdown in communication may occur and learning and teaching may be limited. Drawing from the constructivists' perspective, Carraher (1996) suggests that through instruction, students must be provided with opportunities "to reorganize and advance their knowledge, where necessary" (p.243). Therefore, to provide learners with an opportunity to develop their mathematical proficiency, multiple languages were used during scaffolding to support learning. This suggests that the use of multiple languages played a vital role in assisting learners to develop proficiency in mathematics, since they would not do that on their own.

Stein *et al.* (2000), highlights learners' age, grade-level, prior knowledge and experience as factors that need to be considered when selecting or creating instructional tasks. In my view, the learners' language background should be considered because if the tasks selected or created are in the language which learners have limited fluency in, learners

may have difficulty in understanding and interpreting the task, even if the task matches learning goals, such goals may not be realised.

When I talk about language here, I am referring to the language of mathematics, the LoLT and the language or discourse of schooling. Since mathematics is increasingly regarded as a language (Pimm, 1981, 1987, 1991; Pirie, 1998; Herbel-Eisenmann, 2002) with specialised vocabulary and syntax and lexical density, its significance cannot be ignored. Current views on mathematics learning (Moschkovich, 1999, 2002; Setati, 2005; DoE, 1997, 2001) do not regard mathematical learning as only following procedures or solving different types of equations, but also as participating in discussions about mathematical ideas, explaining solution processes, and presenting arguments, either verbally or in written form. Ball and Bass (2003), argue that mathematical language is therefore fundamental to mathematical reasoning and communication about mathematical ideas, claims, explanations, and proofs since it is used as a vehicle for the enactment, formation and usage of mathematics. They further point to the importance of mathematical language by indicating that resources that are used to develop, make and justify claims are provided by mathematical language. This indicates that mathematical language is fundamental to learning and teaching mathematics, and teachers should create an environment that will develop learners' mathematical communicative competence. The question here is which language(s) is the teacher using to develop the learners' communicative fluency in mathematics? Herein rests the importance of the LoLT. Besides the LoLT, there is a specific way in which language is used in schools and mathematics classrooms. Zevenbergen (2000) argues that the learner's home language and the way in which it is used can be a form of capital. In her study, she found that learners from working class families struggled to understand and engage with the discourse of mathematics classrooms. In this action research, the learners' home languages were used as a resource in facilitating their mathematical proficiency.

I used multiple languages to set tasks that were given to learners to develop their proficiency in mathematics. In the section that follows, I elaborate more on the

importance of using instructional tasks in developing mathematical proficiency in the study.

2.6. Mathematical Tasks

Tasks are critical in the learning and teaching of mathematics. One of the important aspects of learning mathematics is developing mathematical understanding and the learners' ability to think mathematically. However, developing mathematical thinking is not easy. As Ball and Bass (2003) argue, there can be no mathematical understanding without mathematical reasoning. Learning mathematics is not only about application of rules and procedures. According to Ball and Bass (2003), knowing procedures and mathematical ideas as just routine or mere fact without mathematical reasoning is not enough. Through tasks, learners can learn how to reason mathematically. Well-selected tasks can provide learners with an opportunity to gain mathematical power, that is, to be mathematically competent, which Kilpatrick *et al.* (2001) refer to as mathematical proficiency. Kilpatrick *et al.* (2001) suggest five interwoven and interdependent components/strands that are significant in developing learners' proficiency in mathematics. These strands are conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. The use of tasks during the learning and teaching of mathematics is important in developing learners' abilities in the five strands of mathematical proficiency because they (tasks) form the basis of learners' opportunities to learn mathematics (Stein *et al*., 2000).

As a teacher, one needs to be clear about the learning goals before selecting or creating tasks, so that the selected or created tasks can match the desired goals. This implies that the cognitive demands of the tasks must be taken into consideration because "it is the level and kind of thinking in which students engage that determines what they will learn" (Stein, *et al.*, 2000:11). In other words, what the learners will learn is dependent on the opportunities that the tasks they are working on provide.

Lower-level demand tasks are classified into 'memorization' tasks and 'procedures without connections' tasks. According to Stein *et al*. (2000:16) memorization tasks "involve either reproducing previously learned facts, rules, formulae, or definitions or committing facts, rules, formulae, or definitions to memory". These types of tasks may not require the use of procedures due to the unavailability of procedures or due to the short time limit required to complete them using procedures. There is no ambiguity in these tasks as what should be done is clearly articulated.

Procedures without connection tasks, on the other hand, require the use of procedures or algorithms and they are less ambiguous on which procedures are to be used. They lack connection to the mathematical concepts or meaning that underlie the procedure to be followed, and instead of developing mathematical understanding, their focus is on producing correct answers (Stein *et al.*, 2000). These types of tasks consist mostly of routine problems, which are mathematical problems that learners are able to solve using reproductive thinking by reproducing and applying a solution procedure or method learned or taught before (Kilpatrick *et al.*, 2001). Since memorization tasks and procedures without connection tasks do not have the capability to engage learners in complex forms of thinking, they can be used to develop learners' **procedural fluency**, which "refers to knowledge of procedures, knowledge of when and how to use them appropriately, and skill in performing them flexibly, accurately, and efficiently" (Stein *et al.*, 2000:121). Using procedures appropriately and accurately in mathematics requires learners' understanding of mathematical concepts. It is through understanding that learners remember the correct procedures when solving mathematical problems, and therefore able to reconstruct them if the need arises.

Kilpatrick et al. (2001) argue that, when solving mathematical problems, it is important that learners know not only one strategy, but also a number of strategies and know which strategies might be of use to a specific problem. They refer to this as **strategic competence**, which is "the ability to formulate mathematical problems, represent them, and solve them" (p.124). This implies that the skill of problem formulation, representation and solving must be developed in learners during teaching and learning.

For learners to be developed in strategic competence, teachers must use high cognitive demands tasks that generally have a potential to engage learners in complex forms of thinking and reasoning (Stein *et al.*, 2000). High cognitive demand tasks are classified into 'procedures with connections' tasks and 'doing mathematics' tasks. Procedures with connections tasks emphasize the use of procedures in order to develop "deeper levels of understanding of mathematical concepts and ideas" (Stein *et al.*, 2000:16). Such tasks assist in the development of meaning as they can be represented in various ways, and a certain amount of cognitive effort is needed when working on them. Therefore, the procedures used cannot be followed without understanding.

'Doing mathematics' tasks on the other hand do not specify a procedure or approach to be used or followed, but require thinking that is non-algorithmic and complex. Considerable cognitive effort is needed when working through these tasks as the solution process required is unpredictable (Stein *et al.*, 2000). Learners who are strategically competent are able to form mental representations of problem situations (to build mental images), identify mathematical relationships, and come up with appropriate strategies when the need arises. According to Kilpatrick et al. (2001), flexibility is a basic characteristic that should be developed in learners of mathematics, since it is a basic characteristic required for solving mathematical problems, especially non-routine problems. Unlike routine problems, non-routine problems need productive thinking, as the learner has to come up with "a way to understand and solve the problem" (Kilpatrick *et al*., 2001:126). Embedded in 'doing mathematics' tasks are opportunities to develop strategic competence abilities in learners.

Learners' abilities to solve non-routine problems depend on their abilities to solve routine problems. On the other hand, when competence in solving non-routine problems is developed, "a context and motivation for learning to solve routine problems and for understanding mathematical concepts such as *given*, *unknown*, *condition*, and *solution*, is provided" (Kilpatrick et *al.*, 2001:127). This suggests that there is interdependency between competence in solving routine problems and competence in solving non-routine problems, and therefore interdependency between lower and higher level tasks. As

Kilpatrick *et al.* (2001) argue, when learners use their strategic competence to identify and choose the appropriate procedures to solve mathematics problems, their procedural fluency is developed. However, the ability to choose strategies that are effective for particular problems requires learners' mathematical understanding and thinking to be developed, as they should have the capacity to explain, justify, think logically about and reflect upon the relationships among concepts and situations, which is a component referred to as **adaptive reasoning** (Kilpatrick *et al.*, 2001). To develop learners' abilities in adaptive reasoning, high cognitive demands tasks like 'procedures with connections' tasks and 'doing mathematics' tasks can be used. These tasks may require learners to explain and justify how the solution can be obtained, since 'doing mathematics' tasks "demand self-monitoring or self-regulation of one's own cognitive processes" (*Stein et al.*, 2000:16). When working with these tasks, learners should examine constraints that may limit possible solution strategies and solutions. Learners' reasoning skills may improve and therefore improving their **conceptual understanding**, if they are able to justify and explain mathematical ideas. Conceptual understanding, which refers to "comprehension of mathematical concepts, operations, and relations" (p.116), enables learners to know the importance of certain mathematical ideas and the contexts in which they are relevant.

However, the way learners view mathematics is also important in developing their mathematical proficiency. As Kilpatrick *et al.* (2001) suggests, for learners' conceptual understanding, procedural fluency, strategic competence, and adaptive reasoning abilities to develop, they must "see sense in mathematics, perceive it as both useful and worthwhile, believe that steady effort in learning mathematics pays off, and see oneself as an effective learner and doer of mathematics" (p.131), which is a competence referred to as **productive disposition.** The development of this strand depends on the development of the other strands and helps the other strands to develop. When learners are able to know and understand mathematical concepts, select an appropriate procedure, solve problems using flexible approaches, and justify and explain solutions, they become confident in their mathematical knowledge and ability, and their attitude towards mathematics becomes positive.

2.7. Conclusion

In this chapter, I have drawn on the theory of social constructivism, especially on Vygotsky's general genetic law of cultural development, highlighting how this influences the process of learning and teaching in a mathematics classroom. The chapter elaborated on Vygotsky's concept of ZPD and the four-stage model of transition that occurs in the ZPD as suggested by Tharp and Gallimore (1991). The roles played by the teacher or the more capable other and the learners through language during the four stages were highlighted. The chapter further elaborated on Kilpatrick et al's (2001) five intertwined strands that are important in developing learners' proficiency in mathematics and the type of tasks that can be used for such development. Stein et al's (2000) lower-level and higher–level demands tasks were discussed.

In the chapter that follows, the research design and methodology are discussed. The context in which the study was undertaken is described. The methodological approach used is explained and the rationale for using an action research approach is provided. Data collection methods are mentioned and explained.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1. Introduction

The purpose of this chapter is to present a context in which the research was done, the methodological approach chosen for this research and specific research techniques or procedures used in collecting and analysing data. The reasons for choosing an action research approach and the procedures used are being justified in this chapter. The chapter further presents the action research cycle and how each stage of the cycle unfolded during the four lessons presented. Since the mathematical task was crucial to the study, the task sheet used in the study is presented. Each question in the task sheet is analysed and discussed in order to determine, as suggested by Stein *et al*. (2000), the task features and therefore its level of cognitive demand. Issues of validity, reliability and ethics are elaborated in the chapter.

3.2. The Research Context

The study was undertaken at a school where I teach. It is a multilingual high school located in Soweto, a township southwest of Johannesburg. It caters for learners from Grade 8 to Grade 12. I chose to do the study in a Grade 11 class that I teach because it was the only Grade 11 class I was teaching at the time and I taught the same group of learners in 2004 while they were in grade 10. It was convenient for me to do the study in that class, as I did not have to interfere with the daily school timetable or arrange visits to another school.

There were 36 learners in the class. Learners in the class were of varying abilities, ethnic groups and gender. The class was multilingual, and the home languages of learners were Setswana, Xitsonga, IsiZulu and Tshivenda. All the learners learnt English second language as a subject as well as their respective home language(s) as a subject at first

language level. As indicated earlier, generally learners' fluency in English was limited. As the teacher who was teaching the class, I was a critical participant in the study. I am multilingual and able to communicate in the following languages, Setswana, Sesotho, Sepedi, Xitsonga, IsiZulu, Tshivenda, English and Afrikaans. My home language is Setswana. I have been teaching mathematics at secondary school level for 15 years.

3.3. Methodological Approach

I have chosen an action research approach because I was researching my own practice to transform and improve it. I referred to this as transformation because as explained in chapter 1, I did things differently from how I used to do them. Unlike other research approaches like case study, survey, experiments and many others, action research was an approach that gave me an opportunity to research my own teaching as I change or transform it. As Davidoff and van den Berg (1990) argue,

> *Action Research is a way of taking a systematic, close, critical look at the way in which we teach, with a view to changing it so that the classroom experience becomes a more meaningful one for all those involved in it (p.28).*

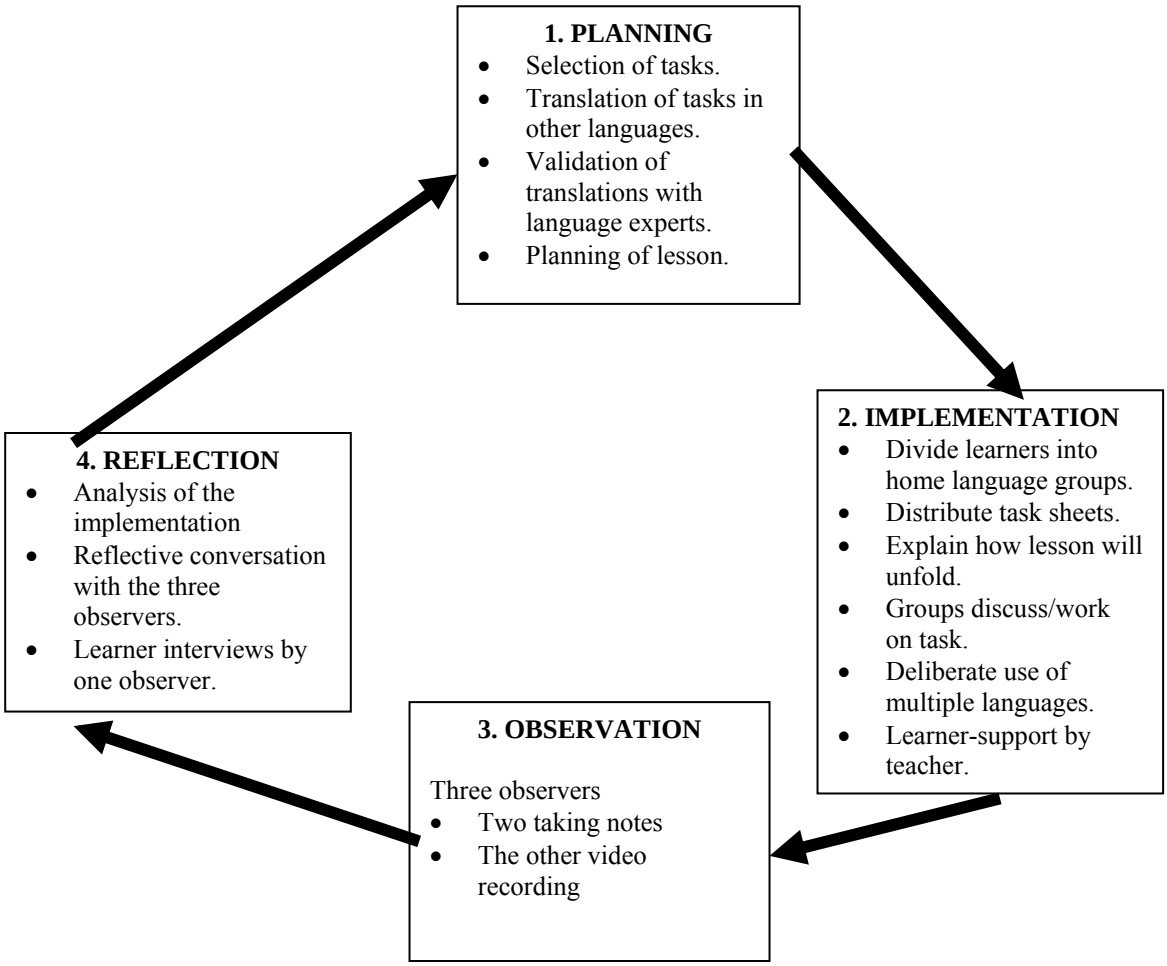
The quotation suggests that through action research, an opportunity is created where a teacher can systematically reflect on his or her classroom activities so that effective and efficient changes that will be beneficial to all during learning and teaching can be made. Reflecting critically on what takes place in ones classroom is key to the beginning of a process of classroom transformation.

3.4. The Action Research Cycle

The action research process is cyclic and thus each lesson that I taught was taken as a cycle. In total, there were four lessons in this study. Each cycle included planning, implementation, observation, reflection, and planning a revised action (Davidoff and van

den Berg, 1990). Each lesson was 80 minutes long. In all lessons, a mathematics task set in multiple languages was used for teaching and learning. Figure 1 below shows the cyclic nature of this action research project:

***FIGURE 1**: Action research cycle.*



Below is a description of what occurred in each stage of the action research cycle.

3.4.1. Planning Stage

For a teacher to decide to do an action research, as argued by Davidoff and van den Berg (1990), he/she may have identified a problem in his/her classroom that impacts negatively in his/her teaching, or he/she may wish to do things differently in his/her classroom. It is during this stage that what is viewed as a problem or what one wishes to

transform is formulated. The problem I identified in my class and the changes made in my teaching during this study, were discussed in chapter 1 and were part of the formulation of the planning stage.

It was during this stage that the instructional task used in the study was selected and translated. The task selected was in English (LoLT) and was translated into the learners' home languages (IsiZulu, Xitsonga, Tshivenda and Setswana) found in my classroom. For purposes of accuracy, I did the Setswana translation, since my first language is Setswana, and then I requested my colleagues who teach mathematics and are first language speakers of the three remaining languages to do the translations in those languages. In my view it was important for the first level of translation to be done by mathematics teachers who are also first language speakers of the languages because that would ensure that the mathematics in the task remains unaltered. In the second level of translation, the translated tasks were given to language teachers who are experts in the respective languages and who teach those languages at first language level to check the translations and make language corrections where necessary. For validation of the translations, in the third level of translation, the translated tasks were then given back to mathematics teachers to check whether the mathematics was not 'lost' during language corrections. The task is presented and discussed later in this chapter.

According to Davidoff and van den Berg (1990) negotiation is a very significant component of the planning stage of action research, particularly when researching with people. I therefore requested the assistance of my supervisor and two other research colleagues to observe and take notes as I teach, to video-record the lessons, reflect with me after each lesson and suggest changes to be made, to interview learners and video and tape-record the interviews.

An important aspect of the planning stage was lesson preparation and more specifically the mathematical tasks used, which was my main instrument. The task in this study was used as an instructional tool and not as an assessment tool. I chose to use it because it enabled me to set up a classroom environment that is both mathematically and

cognitively challenging. As discussed in chapter 2, tasks play an important role in teaching and learning, as they provide learners with an opportunity to gain mathematical power, that is, to be mathematically competent, which Kilpatrick *et al.* (2001) refer to as mathematical proficiency.

The task used in the lessons that are a focus in this study was selected from the Malati Draft Materials (30-04-2005). It consisted of 10 questions. It was used as an instructional task to teach Linear Functions because Functions is one of the topics included in the Grade 11 syllabus. It was important that the type of task selected provide learners with opportunities to develop mathematical proficiency. Stein *et al.* (2000) suggest that before tasks can be selected or created, learning goals should be clearly articulated so that tasks selected or created match the desired learning goals. They further argue, "Being aware of the cognitive demands of tasks is a central consideration in this matching" (Stein *et al*., 2000:11). It was therefore critical for me to select a task that has features of tasks that can be used to support the development of learners' proficiency in mathematics. Below is the English version of the task used in the study (the versions in other languages are included in **appendix A**).

MATHEMATICS TASK

COST OF ELECTRICITY:

The Brahm Park electricity department charges R40 – 00 monthly service fee then an additional 20c per kilowatt-hour (kwh). A kilowatt-hour is the amount of electricity used in one hour at a constant power of one kilowatt.

1. *The estimated monthly electricity consumption of a family home is 560 kwh. Predict what the monthly account would be for electricity.*
2. *Three people live in a townhouse. Their monthly electricity account is approximately R180 – 00. How many kilowatt-hours per month do they usually use?*

3. *In winter the average electricity consumption increases by 20%, what would the monthly bills be for the family home in (1) above and for the townhouse?*

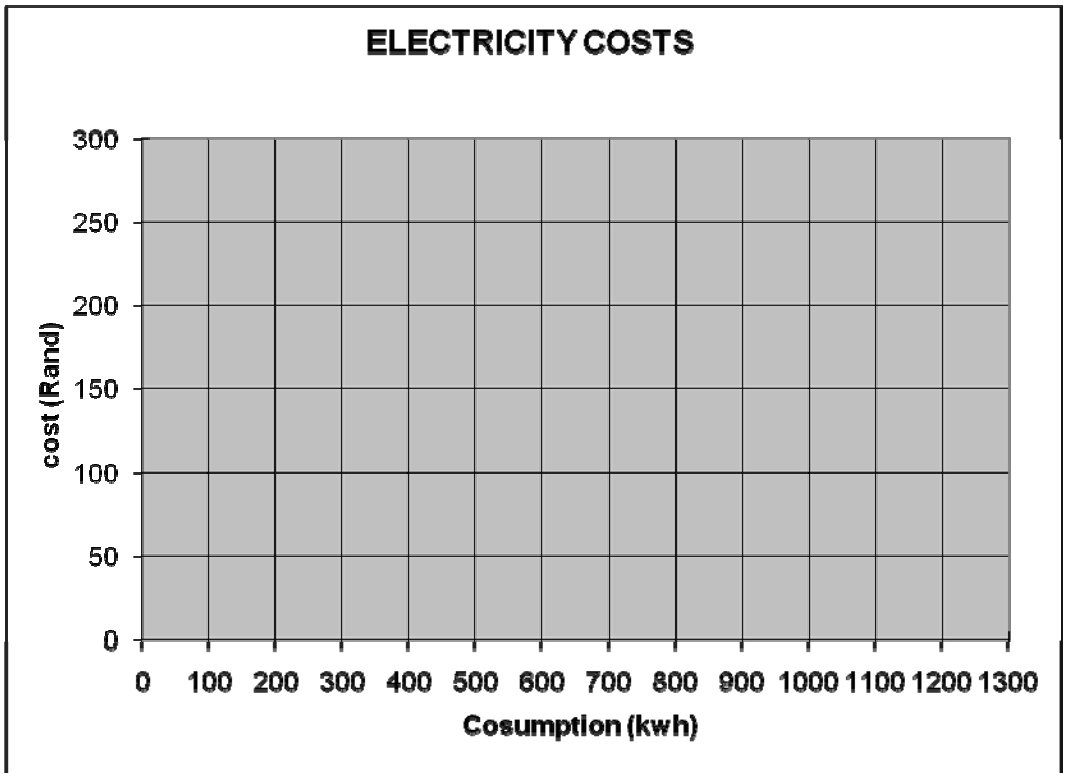
4. *In your opinion, what may be the reason for the increase in the average electricity consumption in (3) above?*

5. *Determine a formula to assist the electricity department to calculate the monthly electricity bill for any household. State clearly what your variables represent and the units used.*

6. *a). Complete the following table showing the cost of electricity in Rand for differing amounts of electricity used:*

Consumption (kwh)	*0*	*100*	*200*	*300*	*400*	*500*	*600*	*700*	*800*	*900*
Cost (in Rand)										

b). Draw a graph on the set of axes below to illustrate the cost of different units of electricity at the rate charged by the Brahm Park electricity department.



After careful consideration, the electricity department decide to alter their costing structure. They decide that there will no longer be a monthly service fee of R40 – 00 but now each kilowatt-hour will cost 25c.

7. *What would be the new monthly electricity accounts for the family home and the townhouse?*

8. *a). Complete the following table showing the cost of electricity in Rand for differing amounts of electricity used using the new costing structure:*

Consumption (kwh)	*0*	*100*	*200*	*300*	*400*	*500*	*600*	*700*	*800*	*900*
Cost (in Rand)										

b). Draw a graph on the same set of axes in question 6.b. to illustrate the cost of electricity for different units of electricity using the new costing structure.

9. *Do both the family home and the townhouse benefit from this new costing structure? Explain.*

10. *If people using the electricity had the option of choosing either of the two costing structures, which would you recommend? Clearly explain your answer using tables you have completed and graphs drawn in questions (6a), (6b), (8a), and (8b) above.*

As highlighted in chapter 2 features of the task determine its level of cognitive demand (Stein *et al*., 2000). The task I selected has the following features:

- *A 'real world' context is used.*

  The context used in the task is that of calculations of monthly costs of electricity consumption of household. This is a 'real world' context since electricity is used in our every day lives. My assumption was that learners in my class are familiar with the payment of the consumption of electricity in their homes, either in a form of pre-paid cards or monthly payments, even though they might not be familiar with how costs are calculated.

- *It is a problem situation*.

  The task poses a formulated problem situation that learners have to identify, interpret and solve. For learners to solve the problem successfully, they should first understand the situation and the key features of the problem in order to formulate it mathematically. As Kilpatrick *et al* (2001) argues learners could find it difficult to represent a problem accurately if they do not understand the situation and its key features, and may have difficulty in solving it. The key features of the problem are the number of kilowatt-hours use, the additional twenty cents (20c), which is the amount paid per kilowatt-hour, and the forty Rand (R40-00) monthly service fee.

The problem situation, which learners had to understand, is the context used, the relationship between concepts, for example how 20 cents relate to the number of kilowatt-hours, what is given and what needs to be calculated. The problem consists of key words like 'additional', which suggest that an arithmetic operation 'addition' should be used, and '20c per kilowatt-hour', which suggest that every consumption of one kilowatt-hour must be multiplied by twenty cents. The numbers 20c, R40-00 and 560 kwh and the key words "cue appropriate arithmetic operations" when learners use a "common superficial method" for representing problem such as this (Kilpatrick *et al*, 2001:125). This kind of problem situation may have an ability to can support the development of learners' **proficiency in conceptual understanding and strategic competence**. When learners can identify essential components of the problem situation, build a mental image of such components and represent it mathematically, they may come up with some solution strategies and choose the one that is appropriate for solving the problem (Kilpatrick *et al*, 2001).

- *Some questions require an explanation.*

  In the task, questions 4, 9 and 10 require learners to explain their answers. Question 4 requires learners to give a personal opinion of what they think might be the cause for the increase in electricity consumption in winter. In answering the question, learners' general knowledge and daily experiences are required in this regard. In their explanation, learners are required to give reasons for the increase in consumption. Question 4 has an ability to improve learners reasoning skills and therefore develop their **proficiency in adaptive reasoning**. Question 9 is not a one-answer question or 'yes or no' answer question as it asks for an explanation. The explanation needs a comparison of the two different costing structures for both the household and the townhouse and an analysis of whether the family home and the townhouse benefit from the new one. Even though it is not explicit in the question 9, there is a need to calculate cost of consumption in winter and compare it with the cost when using the old costing structure when explaining. This is a challenging question and it supports the development of learners' **proficiency in strategic competence, procedural fluency and adaptive reasoning**. Question 10 requires a

comparison of tables completed and graphs drawn in previous questions. The identification and understanding of concepts or variables that are involved is required when comparing tables and graphs. Comparison between concepts may include similarities and differences between them. In this regard, learners' **proficiency in conceptual understanding** may be developed. This question develops learners' proficiency in analysing data from the tables and interpreting graphs and to use their findings to recommend a better costing structure and to give reasons for their choices. It engages learners in complex forms of thinking and reasoning, as it requires learners to justify and explain their recommendations, and therefore developing their **proficiency in adaptive reasoning**. Question 10 has an ability to develop learners' **proficiency in productive disposition** as they may realise the importance of mathematics in solving real-world problems and view it as useful and worthwhile.

- *It may require the use of a calculator.*

  The use of calculator is required when calculating costs of electricity consumption and when calculating percentages. For example, for calculating monthly cost in question 1, 560 must be multiply by 0,20 and such a procedure may need the use of a calculator, especially for novice problem solvers. Calculations of percentage in question 3 may be done using a calculator.

- *Learners must use prior knowledge and experiences when working on the task.*

  Working on the task requires some prior knowledge and experiences. For example, to understand the problem situation learners must first be familiar with the context used, that is, it must be a context that they may have experienced in their daily lives. Learners' prior knowledge of conversions to decimal fractions and working with decimals is required as the 20 cent and 25 cent must be converted to rands. The knowledge of working with percentages is needed for question 3. For question 5, learners' prior knowledge of linear equations is needed to come up with a formula. For questions 6 and 8, learners' experiences and knowledge of linear functions and linear graphs is crucial in successfully complete tables and to draw graphs.

- *Approach to follow is not suggested.*

  In the first nine questions in the task, there is no suggested approach that should be followed, except in question 10 where it is indicated that tables completed and graphs drawn in previous questions should be used when explaining the answer. However, in question 10, how tables and graphs should be used is not suggested.

These features discussed above suggest that the selected task was a higher-level demands task, and therefore suitable to be used to support the development of learners' proficiency in mathematics.

3.4.2. Implementation Stage

This is a stage in each lesson where changes that were initially planned for each lesson were implemented during teaching and learning. As indicated in chapter 1, I planned to use multiple languages 'deliberately' during teaching and learning, and teach using a mathematics task written in both English and learners' home languages. The word 'deliberate' is emphasised because learners' home language(s) were used in addition to English in a deliberate, strategic and planned manner. The same mathematics task was used in all four lessons, doing a certain number of questions in each implementation stage. Below is the description of the lessons taught during each implementation stage of this action research.

Description of lessons

Lesson 1

This lesson was the first implementation stage of the action research. The main focus in the lesson was to ensure that learners understood the statement *'The Brahm Park electricity department charges R40 – 00 monthly service fees then an additional 20c per kilowatt-hour (kwh). A kilowatt-hour is the amount of electricity used in one hour at a constant power of one kilowatt'* and to work on questions 1 and 2. I first instructed learners to form groups according to their home language(s). Gorgorio and Planas (2001)

suggest that when learners are grouped in such a way that they share a common language and work on problem-solving tasks, their learning processes may be improved. Hence the manner in which groups was formed. In total seven groups were formed. There were two Setswana groups, two Tshivenda groups, two IsiZulu groups and one Xitsonga group. There were five learners in each of the six groups and in the seventh group only five learners. Since the construction of knowledge in the classroom, from the social constructivists perspective, does not only entail interaction between the teacher and learners, but also includes interaction through language between learners themselves in the social and cultural environment (Jaworski, 1994), groups were formed to encourage learners to interact with one another and to work on tasks as a group and not individually. I hoped that when learners are grouped in their home languages, they would be encouraged to participate actively in class discussions. Group discussions have a tendency to "support the shift away from the teacher as a sole arbiter of mathematical truth and toward the class as a mathematical community" (Schoenfeld, 1992:123).

Since the plan was to use multiple languages deliberately during lessons, I distributed the task sheets and each learner in the group was given a task sheet set in both English and their home language. I indicated to learners that multiple languages were going to be used and that the mathematics task would be used as a teaching tool, as the extract below shows.

[T- Teacher; Ls – Learners]

T: Our lesson is going to be in all languages. So, re tlo bua Setswana, rhiambe Tshivenda, ri valavhule Xitsonga, sikhulume IsiZulu, and … and … this lesson is going to …, by eleven o' clock we must have finished, and the lesson will still continue tomorrow and the other day. Er … what I am going to give you, I am going to give you tasks that are going to be based on the lesson, and I will explain after giving tasks. *(Distributes task sheets to learners who have divided into different language groups)*. Tswana, Motswana ha o emisi letsogo monna *(Refers to one learner in the Setswana group)*. Vha hina vhakweru *(Refers to the Xitsonga group). [Our lesson is going to be in all languages. So, we are going to speak in Setswana, Tshivenda, Xitsonga and IsiZulu, and … and … this lesson is going to …, by eleven o' clock we must have finished, and the lesson will still continue tomorrow and the other day. Er … what I am going to give you, I am going to give you tasks that are going to be based on the lesson, and I will explain after giving tasks (Distributes task sheets to learners who have divided into different language groups). Tswana,*

Motswana don't you raise your hand young man (Refers to one learner in the Setswana group). Vha hina vhakweru *(Refers to the Xitsonga group).]*

Informing learners that we were going to use multiple languages was to make them aware that using their home languages during lessons in addition to the official LoLT of the school (English) was not only allowed but also encouraged. I further informed learners how the task sheets would be used and how the lesson would unfold. Even though I had planned that the statement from the task sheet would be read in learners' home languages in addition to English, two learners were asked to read to the whole class the statement of the problem in the task sheet in English, as the extract below shows:

T: … Now I want that all of us turn to the English version, so that we can get the feel of the whole thing. Can one of us read the first statement there? Who volunteers to read? Sipho can you read?
Sipho: *(Reads the statement)* "The Brahm Park electricity department charges R40 – 00 monthly service fees then an additional 20c per kilowatt-hour (kwh). A kilowatt-hour is the amount of electricity used in one hour at a constant power of one kilowatt".
T: Thank you. Nkateko, can you read?
Nkateko: *(Reads the statement in English).*

The above extract indicates that even though the task sheet was written in both English and the learners' home languages, in the public domain I asked them to read the English version only. When reflecting on the lesson with the observers, it was suggested that I also ask learners to read in their home languages and not in English only since my plan was to deliberately use multiple languages during lessons. Thus, this was done in the subsequent lessons.

After the statement, *'The Brahm Park electricity department charges R40 – 00 monthly service fees then an additional 20c per kilowatt-hour (kwh). A kilowatt-hour is the amount of electricity used in one hour at a constant power of one kilowatt',* was read to the whole class, rather than explaining it to learners as I usually do in my mathematics lessons, learners were asked to study the statement in their groups and talk about what it means. They were reminded that the task sheet was written in both English and their home languages.

T: Right, manje ke, for two minutes, just two minutes, ngifuna ukuthi in your groups, read the statement, the statement only, in your groups, and discuss what the statement means, what you understand. If there is something ongaizwisisi kahle, ubuze. I'll be moving in your groups listening to your discussions. Remember, ngapha kune ilanguage yakho, ngapha kune English *(Shows learners the two versions of the task)*. Motswana, ke tla be ke le botsa gore ke eng se le se tlhaloganyang ka polelo eo. *[Right, now for two minutes, just two minutes, I want that in your groups, read the statement, the statement only, in your groups, and discuss what the statement means, what you understand. If there is something that you don't clearly understand, ask. I'll be moving in your groups listening to your discussions. Remember, this side is in your language, and this side is in English (Shows learners the two versions of the task). Motswana, I will be asking you what is that that you don't understand about the statement of the problem.]*
(Groups read the statement and discuss. One observer and I, move around groups listening to their discussions).

By reminding them that the task was given to them in two versions (English and their home language), I was emphasising to them that they are allowed to use both languages. Learners were to discuss how they understand the statement before they could attempt to work on the questions that followed. As highlighted earlier on, since the mathematics task was a real-world problem situation, learners had to understand the context used, the relationship between concepts and the key features of the problem so that they could successfully solve the task.

Since this was the beginning of the implementation stage, the lesson was slower as compared to the other three lessons. I allowed groups more time to discuss the statement highlighted earlier on. However, one IsiZulu group worked faster than others, because when I indicated to learners to continue working on question 1, that group had already completed their answer to question 1 and were busy with question 2. Even though my plan was to do questions 1 and 2 in this lesson, only two groups (Xitsonga and IsiZulu) completed both questions. I also noticed that some learners in the other IsiZulu group had limited participation during discussions and some learners in all the groups were not writing anything in their task sheets.

Lesson 2

In this lesson, I requested the more capable learner from the more participative IsiZulu group to exchange groups with one learner from another IsiZulu group that had limited participation in the first lesson. My plan was that the more capable learner would assist and encourage others in the group to participate in group discussions and in working on questions in the task. At the beginning of the lesson, we looked back on the solution obtained for question 1.

T: Sisi *[Lady]*, please join that group *(points at the first IsiZulu group)*. Why are you five here *(Referring to the first Tshivenda group)*? Right, now class we are going to continue from where we ended yesterday. But before we continue, let us look at what we found yesterday. We have found that karabo ya ntlha *was* er… re ne re khalkhuleita the estimated monthly consumption, and the answer was …, what was the answer? *[We found that the first answer was er ...we were calculating the estimated monthly consumption, and the answer was ..., what was the answer?]*
Ls: One fifty two.
T: *(Writes 'R152-00/month' on the board)* One fifty two rand per month.
Ls: Yes

In this lesson, we worked faster than in lesson 1 since the learners were already familiar with the context of the questions. We did questions 2, 3, 4 and 5. Unlike in lesson 1 where we read the first statement in English only, questions were read in multiple languages. For example, I instructed one learner to read to the entire class question 2 in Setswana and the other learner to read in Tshivenda.

T: Right, can we quickly do number two. But let us … let us remind ourselves on the question before we do number two, okay. Let me ask …, can you read number two in your language, the statement just once, the statement once in your language, ka Setswana *[In Setswana]*. E bale ka Setswana *[Read it in Setswana]*, the statement itself, the statement.
Gabriel: *[Reads the statement in SeTswana]*.
T: Right, then ke kopa *[Right, then please]*… can you read the question itself for number two *(Points at the learner in the second Tshivenda group)*.
Carol: *(Reads the question in Tshivenda)*.
T: So that is question number two. I've, I've seen ukuthi bakhona abanye abase bayiyenzile, but very few, about two … one group ise iyiyenzile. So in … we are going to do that one, sizoyiyenza nge-two minutes in our groups, question number two. *(Goes to the second Setswana group)* Re dira number two ne. Ke le fa metsotso e mebedi fela. Le e entse? *[So that is question number two. I've, I've seen that some have already done it, but very few, about two ... one group has already done it. So in ... we are going to do that one, we will do it in two minutes in our groups, question number two. (Goes to the*

second Setswana group.) We do number two ne. I give you only two minutes. (Goes to the Xitsonga group) Have you done it?]

Ls: Yes.

T: Who wants to explain?

Nkateko: *(Inaudible)*.

Groups that did not either do or complete question 2 the previous day were given an opportunity to do so, and I moved around the groups that had already completed the question so that they can explain how the solution was obtained. As in lesson 1, when groups worked on the question, I listened to their discussions and assisted where necessary. When a particular group has successfully found a solution for a particular question, they were instructed to do the next question.

Lesson 3

In this lesson, which was the implementation stage for the third cycle, we continued with question 5, as some groups did not manage to complete it the previous day. As in lesson two, I requested one learner to read question 5 in his home language.

T: Are we all looking at question number five? Siphiwe, can you read question number five in Zulu. *(Noise in class, pulling of chairs and tables as learners settle down)* Can we all listen please *(A sound of a knock at the door)*. Before you read, just a second *(Goes to the door, talks to someone at the door and returns)*. Right, Siphiwe can you read in Zulu, question number five?

Siphiwe: *(Reads question five in Zulu)*.

The difference between this lesson and the previous lessons is that when working on question 5, I did not give learners an opportunity to discuss in their groups, but I interacted with the entire class, asking them questions to evaluate their understanding of the question.

T: Right, angithi sizwile ukuthi utheni? What does the question want? Ifunani i-question *[Right, have we heard what he said? What does the question want?]*

L1: Formula.

T: *(Writes on chalkboard)* Formula, okay. Kule formula, what … what should appear in that formula? Kufunekani futhi *[Formula, okay. In this formula, what ... what should appear in that formula? What else is required?]*

L2: *(Inaudible)*.

T: Yini *[What]*?

L2: Ama *[The]… (Inaudible)*.

T: Ama *[The]*…?

Ls: Ama-units *[Units]*.

T: Ama-units *[Units]*, okay *(Writes on chalkboard, 'units')*. What else?
Ls: Variables.
T: Variables *(Writes on chalkboard: 'formula → units → formula')*. Okay, so when you think of a formula, these are what you need to use or think about. Ke dilo tse o naganang ka tsone o di dirise Right, how …, formula e re buang ka yone, what is it for? Ke ya gore e etse eng go ya ka khwetšene *[They are things that you think about and use. Right, how …, the formula that we are talking about, what is it for? According to the question, what is it for?]*

During this lesson, I encouraged learners to interpret and explain question 5 in their home languages, as this extract shows:

Ronald: To calculate the monthly electricity bill.
T: For what, for eng? *[for what?]*
Ronald: For, for any household.
T: E raya goreng? O e tlhaloganya yang wena ka Setswana? *[What does it mean? How do you understand it in Setswana?]*
Ronald: Er … e raya gore er … [Er … e raya gore er …] *(Looking at the Setswana version of the task sheet)*.
T: E raya goreng ka Setswana? *[What does in mean in Setswana?]*
Ronald: E raya gore *[It means]* er … *(Reads the Setswana version)*. Er …, e thusa go … "go balela dituelo tsa motlakase tsa ntlo enngwe le enngwe ka kgwedi" *[It helps to … "to calculate the costs for monthly electricity consumption for any household"]*.

We also worked on questions 6 to 8 where we completed tables and drew graphs representing the cost of electricity for the old costing structure (Questions 6a and 6b) and for the new costing structure (Questions 8a and 8b). Question 7 required the calculation of the cost for both the household and the townhouse using the new costing structure where the R40-00 monthly service fee was not charged but the cost per kilowatt-hour was increased from 20c to 25c.

Learners worked on these questions on their own in their groups and I moved around the groups to probe and/or assist where necessary, and further interacted with the whole class, as the extracts below show.

Interaction with groups:

T: *(To the Tshivenda group 1)* Where is the table? This is the consumption (points at *table on worksheet)*. Use the formula *(points at the chalkboard)*. There is the formula. The formula is given. *(To the IsiZulu group 1)* Finished here?
Ls: Yes.
T: Let's check. Consumption is zero… *(inaudible)*.

T: (To Tshivenda group 1) Akere formula le na le yone? Kiye formula. 'b' e e representang? *[You do have the formula. Here is the formula. What does 'b' represent?]*
Ls: Consumption.
T: Consumption. Zero comma two multiply by consumption plus forty, kiye formula e le e berekisang. Use the formula. If it's zero, then you say zero comma two multiply by zero, o bo eda forty rand. Then you fill in this *(points at the table in the worksheet)*. *[Consumption. Zero comma two multiply by consumption plus forty, here is the formula that you use. Use the formula. If it's zero, then you say zero comma two multiply by zero, then you add forty rand.* Then you fill in this *(points at the table in the worksheet).]*
(Noise in class due to group discussions as learners work on question 6. Learners inaudible).

Interaction with whole class:

T: Right, I think we have all finished. We need to plot the graph after that. Let's plot the graph.
Ls: *(Inaudible. Making noise)*.
T: Did you plot the points? Plot the points, plot the points. Now, when you look at this equation, you can look at this equation… *(Learners making noise)* Excuse me, sorry, when you look at this equation, okay. Steve… Steve… Thamsanqa, when you look at the equation, what graph is this? What kind of graph do you expect from this equation, similar to this one?
L: Parabola.
T: Parabola?
Sipho: No, straight line.
T: Why straight line? What's the formula for straight line?
Sipho: Y is equal to … *(inaudible)*.
T: Y is equal to…?
Sipho: mx plus c.
T: y is equal to mx plus c. So, if you look at the graph you need to expect…
Ls: Straight line.
T: You see.
Sipho: Hoo *[Okay]*.
(Teacher goes to groups. He moves around groups).

As I interacted with learners, I wrote their answers on the chalkboard so that we can refer to them later in the lesson.

Lesson 4

This was the implementation stage for the fourth and the last cycle of this action research. In this lesson, I interacted with the whole class, where we first looked at the graphs drawn in the previous lesson. Unlike in lesson 3, I drew the graphs on a chart before the lesson

started in order to save time. Even though questions 6b and 8b required the graphs to be drawn on the same system of axes, I drew them on separate charts and then drew them on the same system of axes on the third chart, so that learners could see the graphical comparison of the two payment structures, as this extract shows.

T: Right, is there any group that has not yet drawn graphs?
Ls: No.
T: Right, now let's look at graph ya…, for the new…, for the old structure first. The graph ya old structure yethu was like…, is like this *(sticks on a graph drawn on a chart against the chalkboard)*. I hope you all see, okay, and we … sisesathi i-equation yethu ya le graph le, when you came up with the equation, before you drew the graph, we came up with the equation similar to that *(points at the equation 'y=0.2x + 40' written on the chart)*. Even though our… ama-variables wethu ayadifara, the equation is similar to that ye graph yethu ye old-structure. E simolla mo forty, … mo forty ha the cost e le er… the consumption e le zero *(points at graph drawn on chart)*, because ne tshwentse re patale… re patale service fee ya forty ranta even re sa berekisa motlakase. So, that's our graph e leng straight line, yanong e be re tla ka the new-structure. Mo new-structure, go ile ga ntshiwa forty ranta ya service fee then ra tla ra drowa graph ya teng. Now o… ha o, before ke baya grafo ya teng, ke… re e beya mo. Mo new-structure ya… ya… ya go khalkhuleita dicost tse di pataloang, what do you think is the equation ya the new-structure? Equation ya new-structure?
[Right, let's look at the graph for …, for the new …, for the old structure first. the graph for the old structure was like …, is like this (sticks on a graph drawn on a chart against the chalkboard). I hope you all see, okay, and we …we said the equation for this graph, when you came up with the equation, before you drew the graph, we came up with the equation similar to that (points at the equation 'y=0.2x + 40' written on the chart). Even though our… our variables differ, the equation is similar to that of our graph of the old structure. It starts at forty … at forty when the cost is er… the consumption is zero (points at graph drawn on chart), because we were supposed to pay… to pay forty rand service fee even though we did not use electricity. So, that's our graph which is a straight line, and now coming to the new structure. With the new structure, the forty rand service fee was excluded and we drew the graph for the new structure. Now you…if you, before I paste the graph, I… we paste it here. In the new structure, for… for… for calculating the costs that are paid, what do you think is the equation for the new-structure? Equation for new-structure?]

In all lessons, as learners read, discussed and worked on questions in their respective groups, I circulated among the groups, checking how they were doing and listening to their discussions. In particular, I paid attention to which language version of the task they were using, the language(s) they used to interact with one another and the depth of their mathematical discussion. To maintain the cognitive demand of the tasks during the lesson, I used classroom support factors suggested by Stein *et al.* (2000), such as, 'scaffold' learners by asking probing questions to provoke their thought, sustained

pressure for explanation and meaning, and also model high-level thinking and reasoning. I also encouraged learners who are more capable to model high-level thinking and reasoning. I used and encouraged the use of multiple languages.

3.4.3. Observation Stage

In all four lessons, I chose to have three outside observers who are also experienced researchers and teachers in my class because action research is collaborative and participatory (Cohen and Manion, 1994; Davidoff and van den Berg, 1990). These observers gathered data by video recording and taking notes as I was teaching because as a teacher-researcher, it was difficult, if not impossible, to be an observer and teacher at the same time. One of the observers was my research supervisor and the other two were my research colleagues in mathematics education, one studying towards a PhD and the other an M.Sc degree. To enhance data collection, lessons were video-recorded so that I could refer to them during reflection and analysis stage. The advantage of a video-recorder is that it captures both action and talk during lessons.

3.4.4. Reflection Stage

As Davidoff and van den Berg (1990) argue, this is a stage that involves a critical retrospection of what was taking place in ones classroom activity "to see what it can teach you about your future actions" (p.4). It was during this stage that after each lesson I had a discussion with the observers where I expressed my own impressions of what took place in the classroom. The observers' role was to interact with me on the critical incidents in the lessons they observed, critically evaluate the outcomes of what took place in the classroom and to together negotiate further changes (if any) that were to be made for the next lesson. After every lesson I also recorded my impressions of each lesson in my diary – how the lesson unfolded, the kind of changes I made in my teaching, the level of learners' participation and how they reacted to the changes made, and the unexpected consequences. During the discussions with observers, I took notes, which also served as data for the study.

Since the changes I made were implemented in a classroom of learners who I had been teaching for more than a year, I needed to know their views and interpretations of the changes I have made in their classroom (Davidoff and van den Berg, 1990; Opie, 2004). Such information was therefore, gathered through individual learner interviews that were done only after the last lesson. According to Tuckman (1972, cited in Cohen and Manion, 1994), an interview provides a researcher access to what is "inside a person's head" and avails an opportunity to determine the knowledge or information that a person has, his/her likes or dislikes, and attitudes and beliefs. As indicated earlier on, learners were divided into home language groups during lessons. There were two Setswana groups, two Tshivenda groups, two IsiZulu groups and one Xitsonga group. Each group consisted of not less than four learners. Four learners, one from each home language group, were selected for interviewing to hear their reflections on the lessons. The interviews were semi-structured. Semi-structured interviews allow some flexibility and freedom (Cohen and Manion, 1994), and enable further probing. A fellow researcher, who was once a senior teacher of mathematics in the same school, conducted the interviews. I requested this teacher to do the learner interviews because she was not one of the observers and I also assumed that if learners are interviewed by someone who they are familiar with and at the same time is not teaching them anymore, they will not feel intimidated but will be free to talk frankly about their experiences of the lessons and the changes made. The interviews were video and tape-recorded and then transcribed. The interview transcript is included in **appendix B**.

Gathering data "from as many sources and perspectives" (Davidoff and van den Berg, 1990: 42) enabled me to make meaning of my observations in my reflection. Davidoff and van den Berg (1990) further suggest that reflection can assist teachers to have some sense of the external constraints that act on a situation. For example, at some stage during data collection, the noise level outside the classroom in which I was conducting the study was so high that we had to close all the windows.

3.5. How Data was Analysed

Since this was an action research study in which I planned to transform my teaching, the purpose of analysing data was to explore whether and how the new ideas and the changes implemented in my Grade 11 multilingual mathematics classroom supported or constrained the development of learners' proficiency in mathematics. Drawing attention to the problem of interpreting data in action research, Winter (1982) cited in Cohen and Manion (1994) argue that though action research tradition has a methodology for data collection, it does not as yet have a methodology for the interpretation of data. What this means is that there is no suggested methodology of carrying out an interpretive analysis of data in action research. In fact, this is not surprising because when doing action research, one is doing an analysis of the self. And when doing self analysis, one need not only focus at what worked, but also at what did not work, i.e. one has to guard against bias and rigorously analyse and interpret one's actions, which in my view is self-exposure - an exercise not easy do to. However, in this study, guided by the research questions, I tried to be rigorous and systematic by using Kilpatrick *et al*'s (2001) five strands of mathematical proficiency as a framework to analyse and interpret data. In guiding my exploration of how learners' home language(s) could be used, the extent at which tasks set in multiple languages, and the interaction with such tasks could support the development of learners' proficiency in mathematics, I focused on the following:

- When were the home language(s) mostly used (e.g. during learner-learner interactions or teacher-learner interactions)?
- Where were they used (groups or whole class) and what were they used for (e.g. giving instructions, questioning, explaining, guiding, probing, etc)?
- How often were they used?
- Which strand(s) were developed when interacting with tasks? How often did the development of such strand(s) occur?
- What 'action' (displaying, reinforcing, challenging and evaluating) was displayed and how often did either the teacher or learners when interacting with tasks display it?

- Which language (English or home language) was mostly used by both the teacher and learners when interacting with tasks?

Video recordings of data collected during the four lessons in this study were transcribed. In the transcript, utterances, which were in learners' home languages, were translated to LoLT (English) and square-bracketed next to the original utterance. For each lesson, both learners' home language and English utterances were counted. If home language(s) and English were used within one statement or paragraph, such a statement or paragraph was counted as an English and a home language utterance. An utterance was regarded as a statement said by a learner or me, the teacher, either as a one word or one-line statement or paragraph.

Using Kilpratrick's *et al*'s (2001) strands of mathematical proficiency, the transcripts were then categorised. (See **appendix C** for the transcript of the lessons). The purpose of categorising was to try to understand how the deliberate use of the multiple languages and the use of and interaction with tasks set in multiple languages facilitated learners' development of mathematical proficiency. The main categories, which were the five strands of mathematical proficiency as defined by Kilpatrick *et al.* (2001), were then categorised further into sub-categories, by adding what Langa (2006) refers to as an 'action' that either a learner or the teacher did or displayed to each strand of mathematical proficiency. The five strands used for the categorisation of the transcript were:

- Procedural fluency (PF)
- Strategic competence (SC)
- Adaptive reasoning (AR)
- Conceptual understanding (CU)
- Productive disposition (PD)

The sub-categories and the codes thereof, for the above categories, were developed in order to establish how interactions between learners and me and among learners

themselves occurred as we interacted with the mathematics task set in multiple languages. Since it was not possible for the video camera and I to focus on all groups during lessons, I selected the Tshivenda group, which I focused on for purposes of data analysis. Furthermore, the development of sub-categories was to establish whether the language used was critical in supporting the development of learners' proficiency in mathematics when using and interacting with a task set in multiple languages and the extent at which these tasks could support the development of their mathematical proficiency. Below is the description of sub-categories as given in Langa (2006: 27-29):

- **Procedural fluency**
  - ***Displaying procedural fluency (DPF):***
    Evidence of knowledge of procedures to be used, when and how to use them suitably, and evidence of skills to perform them flexibly, accurately an efficiently.
  - ***Reinforcing procedural fluency (RPF):***
    Temporary assistance or support by teacher or more capable learner, to enable learners to perform procedures flexibly, accurately and efficiently, by motivating and encouraging them.
  - ***Challenging procedural fluency (CPF):***
    Challenging learners to perform procedures flexibly, accurately and efficiently by either a teacher to a learner or a learner to another learner through questioning and/or probing.
  - ***Evaluating procedural fluency (EPF):***
    Evaluating and assessing learners' knowledge of procedures to be used and their capacity to perform them flexibly, accurately and efficiently.

- **Strategic competence**
  - ***Displaying strategic competence (DSC):***
    Learners indicating the knowledge of number of strategies and know which strategy might be useful to find a solution for a particular mathematical problem. This simply means evidence of mathematical problem formulation, representation and solving skills by learners.

- ***Reinforcing strategic competence (RSC):***

  Teacher encouraging and motivating learners, or learners encouraging and motivating each other, to use various strategies in order to formulate, represent and solve mathematical problems and to identify a more suitable strategy for a given mathematical problem.

- ***Challenging strategic competence (CSC):***

  Stimulating or provoking learners through questioning and/or probing by the teacher or another learner on how they have formulated, represented and solved mathematical problems, i.e. questioning the strategies used.

- ***Evaluating strategic competence (ESC):***

  Evaluating and assessing learners' knowledge of strategies to be used to a specific mathematical problem and their capacity to formulate, represent and solve mathematical problems.

- **Adaptive reasoning**

  - ***Displaying adaptive reasoning (DAR):***

    Learners showing the ability to explain and justify mathematical ideas and how the solution to a specific mathematical problem was obtained. This is displaying a skill of explaining, justifying, and thinking logically about and reflecting upon the relationships among concepts and situations.

  - ***Reinforcing adaptive reasoning (RAR):***

    Teacher encouraging and motivating learners or learners encouraging and motivating each other, to explain and justify mathematical ideas and how the solution to a specific mathematical problem was obtained.

  - ***Challenging adaptive reasoning (CAR):***

    Stimulating or provoking learners through questioning and/or probing by a teacher or another learner on their explanation, justification, logical thinking about and reflection upon relationships among mathematical ideas.

- ***Evaluating adaptive reasoning (EAR):***

  The teacher evaluating and assessing learners' ability to explain, justify, think logically about and reflect upon relationships among mathematical ideas, and to explain and justify the solution to a given mathematical problem.

- **Conceptual understanding**
  - ***Displaying conceptual understanding (DCU):***

    Learners showing the ability to comprehend mathematical concepts, ideas, operations and relations, and knowing the importance of certain mathematical ideas and the contexts in which they are relevant.
  - ***Reinforcing conceptual understanding (RCU):***

    Teacher encouraging and motivating learners, or learners encouraging and motivating each other, to utilise their understanding of mathematical concepts, ideas, operations and relations, and to apply their knowledge of the importance of certain mathematical ideas and identify contexts relevant to such ideas.
  - ***Challenging conceptual understanding (CCU):***

    Stimulating or provoking learners through questioning and/or probing by a teacher or another learner on their capacity to understand mathematical concepts, ideas, operations and relations.
  - ***Evaluating conceptual understanding (ECU):***

    The teacher evaluating and assessing learners' ability to understand mathematical concepts, ideas, operations and relations, and their capacity to use them in relevant contexts.

- **Productive disposition**
  - ***Displaying productive disposition (DPD):***

    Evidence of some indication by learner(s) of seeing sense in mathematics, regarding it as both useful and practicable, believing that constant effort in learning mathematics pays off, and seeing oneself as a capable learner and doer of mathematics.

- ***Reinforcing productive disposition (RPD):***

  Teacher encouraging and motivating learners, or learners encouraging and motivating each other, to see sense in mathematics, to regard it as both useful and practicable, and to view themselves as capable learners and doers of mathematics.
- ***Challenging productive disposition (CPD):***

  Stimulating or provoking learners through questioning and/or probing by a teacher or another learner on the way they view mathematics and themselves as learners and doers of mathematics.
- ***Evaluating productive disposition (EPD):***

  Evaluation and assessment of learners' view of mathematics and of themselves by the teacher, i.e. whether they regard mathematics as useful and practicable, and whether they view themselves as capable learners and doers of mathematics.

Other categories

As indicated earlier on, from the Vygotskian perspective, a learner does not construct knowledge on his/her own, but needs to interact with others. During each cycle, the resources which learners interacted with were the teacher, the mathematics tasks and with one another. It was therefore necessary for me to develop extra categories that would assist me in identifying and analysing such interaction in the transcript. The categories are:

- **Learner-learner interactions (LLI):** Learners interacting with each other during group discussions as they interacted with the mathematical task.
- **Teacher-learner interactions (TLI):** Teacher interacting with learners in their groups or as a class, and includes among others, giving instructions, questioning and responding.

The above categories and sub-categories were used to categorise transcripts of the four lessons, particularly learner-learner interactions, i.e. when learners were discussing as they worked on the mathematical task in their groups, and teacher-learner interactions, i.e. when the teacher communicated with learners in their home language groups or as a

class. The language in which I (the teacher) used or learners used, and the number of times it was used was identified. This was done to identify the frequency of each strand of mathematical proficiency and of the related language used.

Since strands of mathematical proficiency are not autonomous but interwoven and interdependent (Kilpatrick *et al.*, 2001), some of the learners' or my utterances in the lesson transcripts were categorised more than once. For example, the teacher's utterance below was categorised three times.

[T – Teacher]

T: Where does this come from *(Referring to 0,20 on the group's answer sheet)*? Zero point two, what is that? **EAR/CSC/CCU/E/TLI**

Given: *(Inaudible)*.

T: How many rands are there?

The teacher asked learners how 0,20 was obtained and what it represented. In answering the question, learners would be required to:

1. explain the strategy used (strategic competence) as the teacher was **challenging strategic competence**,
2. explain and justify the answer, 0.20 obtained (adaptive reasoning) since **adaptive reasoning** was **evaluated**, and
3. to explain what 0.20 represented (conceptual understanding) because **conceptual understanding** was **challenged**.

The categories and subcategories were used to analyse whether and how the deliberate use of multiple languages and of tasks set in multiple languages supported learners' mathematical proficiency.

3.6. Validity and Reliability

Even though one is not expected to use data in action research to make a claim that is generally representative, the issues of validity and reliability cannot be ignored (Winter, 1982 in Manion and Cohen, 1994). According to Maxwell (1992), validity pertains to the

data or accounts, or conclusions researched by using a particular method in a particular context for a particular purpose, but in itself do not belong to that particular method. Reliability on the other hand indicates whether there is or no quality in research (Opie, 2004). These two concepts in qualitative research pertain to usefulness or quality, legitimacy, credibility or trustworthiness, and rigor. In the section that follows, I discuss the issue of validity and reliability in this study, in relation to the data collection, data analysis, the research findings and research instrument.

3.6.1. Validity

The issue of validity in this study was attended to by using Maxwell's (1992) realist typology of validity categories that he views as relevant to qualitative research. Maxwell describes five categories of validity for qualitative research. Of relevance to this study are: descriptive validity, interpretive validity and theoretical validity, which Maxwell argues are "the ones most directly involved in assessing a qualitative account as it pertains to the actual situation on which the account is based" (1992: 292). The other two categories, generalizability and evaluative validity, in Maxwell's (1992) terms, are additional and thus I do not attend to them in this discussion.

Descriptive Validity

Descriptive validity, according to Maxwell (1992), is the validity of the accurate description of what the researcher saw or heard, without making up or distorting anything, or a valid description of the physical objects, events, and behaviours in the setting he/she studies. This includes, among others, informants' statements during interviews and utterances and actions in the classroom. In my study, video recording all lessons and transcribing learners and my actions and utterances verbatim addressed this category. When transcribing video-recordings of lessons, learners' and the teacher's actions were indicated as accurately as possible in italics inside the brackets. For example, when learners were discussing in their groups, when learners were not responding to my questions, when a learner or I was writing on the chalkboard, when learners were reading or working on the task, etc. As Wolcott (1990b: 27) in Maxwell

(1992: 286) argues, "description is the foundation upon which qualitative research is built". However it should be noted that it is possible that some features of what was observed or heard might have been omitted when describing what occurred in the classroom and during learner interviews, i.e. what learners were doing and saying, my action and utterances, learners' responses during interviews, etc, because "… no account can include everything" (Maxwell, 1992: 287) and "accuracy is a criterion relative to the purposes for which it is sought" (Runciman, 1983: 97 in Maxwell, 1992).

Interpretive Validity

Qualitative researchers, in Maxwell's (1992) view, are concerned with what the physical objects, events, and behaviours mean to people engaged in and with them, and that includes anything that could be encompassed by the participants' perspective. Interpretive validity is therefore inherently a matter of deduction from the participants' words and accounts in the situation studied, and the researcher is the one who constructs their meanings based on participants' accounts and other evidence that might be viewed as relevant. In this study, I had an opportunity to use a variety of methods to collect data (Cohen and Manion, 1994), and collecting it from different sources (triangulation). Collecting data from multiple sources assisted in achieving interpretive validity since during data analysis, interpretations were evidenced from different data sources. Every claim and interpretation made during analysis was substantiated by extract(s) from lesson transcripts, as Maxwell (1992) suggests, "Interpretive accounts are grounded in the language of the people studied and rely as much as possible on their own words and concepts" (p.289). Data that was used in this study were notes provided by the three observers, notes from my diary, transcripts of video-recorded lessons and of tape-recorded learner interviews. Data from various sources also assisted in minimizing bias during interpretation.

Theoretical Validity

This category refers to the validity of an account as a theory of some phenomenon and actually addresses the theoretical constructions that are being brought by the researcher to, or being developed through the study (Maxwell, 1992). Maxwell (1992) further

suggests that there are two aspects of theoretical validity that correspond to the two components of any theory, the validity of the concepts or categories as they are applied to the setting being studied, and the validity of the postulated relationship among the concepts or categories.

In this study I used Kilpatrick *et al*'s (2001) interrelated and intertwined strands of mathematical proficiency as main categories. Furthermore, sub-categories were developed by adding what Langa (2006) refer to as an 'action' that either a learner or the teacher did or displayed in each of the strands of mathematical proficiency. These constructs assisted me to analyse and interpret the lesson transcripts and were used exactly as defined by Kilpatrick *et al* (2001).

The theory of social constructivism, particularly from Vygotsky's perspective as discussed in the previous chapter, further guided my interpretation during analysis of how and why learners interacted with each other in their groups, with the task and with myself in supporting their development of proficiency in mathematics. Data that was used in this regard were lesson transcripts, observers' notes and my own views about the lessons.

3.6.3. Reliability

Wellington (2000), cited in Opie (2004), refers to reliability as the magnitude of consistent results provided by a test, a method or a tool used in different settings or situations by different researchers. In case of this study if a different researcher tries to construct categories out of data used in this study, it is highly possible that he or she will come up with categories that are different from the ones generated in this study. However, if categories have already been constructed and described, as Setati (1996) asserts, it is likely that other researchers may recognise them and the result may be replicated.

In this study, the issue of reliability was attended to by giving the categories and sample data to another researcher who used same categories in her study, to check if their use in my data can be valuable and effective.

3.7. Ethical Considerations

Ethical issues are very important in educational research and need to be considered in every stage of the research process. According to Cohen and Manion (1994) ethical issues may surface from, among others, the research context, research procedures, data collection methods, type of data collected, what will happen to the data collected, and the nature of the participants. It is equally important to also consider power differential between the adult researcher and learners who are minors when conducting educational research. In this study, I did consider ethical issues and issues of power during the research sequence as discussed below.

3.7.1. Access and Acceptance

According to Bell (1987), cited in Cohen and Manion (1994), one has to seek out permission from relevant authorities and individuals as early as possible before carrying out an investigation. To attend to this, as I could not take for granted that access to the school is an obvious case or could not pose a problem, ethical clearance was sought from the Gauteng Department of Education (GDE), to allow me to do the study in the school, since public schools in Gauteng Province fall under the GDE. Ethical clearance was again sought from the human research ethics committee of the University of the Witwatersrand, to seek clearance for involving humans (learners) in the study. It was therefore important for me to formally approach the University's research ethics committee because, being ethical, as Cavan (1977) in Cohen and Manion (1994) suggests, means being sensitive to the human rights of the participants and respecting their human dignity. The ethics committee ensured that the research that I proposed to do was ethical so that the University's name and the research participants (learners and I) are protected.

While I had already had a conversation with the principal about the study, I decided to formalise our agreement by writing a letter to request permission to undertake the study in the school in my class. After obtaining permission from the principal, I then negotiated with learners in my class, explaining in detail about the envisaged study, the reasons for doing it, and requesting them to participate in the study. Formal consent letters and forms informing learners' parents and/or guardians about the study were sent to parents/guardians for them to sign granting or not granting permission for their children to participate in the study. Learners were also given assent forms to sign.

See appendix D for copies of information letters sent to parents/guardians and learners, parents'/guardians' consent forms, learners' assent forms, the principal's letter of consent and the GDE's ethical clearance certificate and a copy of the University of the Witwatersrand's clearance certificate.

3.7.2. Informed Consent

Diener and Crandall (1978) cited in Cohen and Manion (1994: 350) define 'informed consent' as "the procedures in which individuals choose whether to participate in an investigation after being informed of facts that would be likely to influence their decisions". It was therefore necessary for me to inform and thoroughly explain to participants the risks, dangers and/or benefits involved as a result of taking part in the study. Cohen and Manion (1994) add that 'informed consent' consists of four governing factors:

Competence

Competence means that when relevant information is given, responsible and mature individuals will make correct decisions (Cohen and Manion, 1994). I addressed this by giving the principal, learners and parents/guardians information letters that explain the study in detail. As indicated earlier on, parents/guardians were given consent forms and learners were given accent forms to sign. When giving consent, according to Cohen and Manion (1994), the right of self-determination is protected and respected, and at the same

time ensures that if anything goes wrong in the study, some of the responsibility is placed on the participant.

Voluntarism

Frankfort-Nachmias and Nachmias (1992) cited in Cohen and Manion (1994) argue that it is important that participants are aware that taking part in the study is voluntary at all times. Participants in my study were therefore not forced to participate, they were informed in writing that they can freely choose to participate or not to participate in the study and have the right to withdraw at any stage during the study, if they so wished.

Full Information

Researchers are ethically obliged to inform participants fully about the study and its direct or indirect effects on them. I disclosed to the principal, parents/guardians and learners that the research was for my masters degree programme. Since participants were learners that I taught, I assured them that their participation or non-participation would not affect their mathematics marks or term results in any way as participation was for research purposes only.

Comprehension

Cohen and Manion (1994:351) refer to 'comprehension' as "the fact that participants fully understand the nature of the research project, even when procedures are complicated and entail risk". This factor was addressed as I gave learners and their parents/guardians information letters written in simple English to inform them of the procedures that would be used in the study. I also informed them that three co-researchers would be present to observe during lessons. I further indicated to them that lessons would be tape-recorded and video-recorded, and learners who would choose not to be tape-recorded and/or video-recorded would be placed in a position where the recorder might not reach. I made learners and their parents aware that some learners would be interviewed and the interview would be tape-recorded and video-recorded, and that being interviewed is voluntary. Finally, I verbally explained to learners the nature of the study to ensure that

learners and their parents/guardians understood the contents of the information letter and the consent forms.

3.7.3. The Right to Privacy

Cohen and Manion (1994) suggest two methods that can be used to protect participants' right to privacy. They are discussed below:

Anonymity

The essence of anonymity is that information provided by participants should in no way reveal their identity. As Frankfort-Nachmias and Nachmias (1992) in Cohen and Manion (1994) argue, the protection of research participants' anonymity is an obligation that should be kept at all costs unless there is an agreement made with the participants that their identity could be revealed. This was attended to as participants in the study were assured that any information that may make anyone to guess their identity would be removed and pseudonyms would be used in the research report, and that their faces will be hidden if video-recordings are used for teaching purposes or in conference presentations.

Confidentiality

Researchers can protect participants' right to privacy by promising them that the connection between the participants and the information provided by them will in no way be made publicly known (Cohen and Manion, 1994). As indicated earlier on, participants in this study were informed that they might choose not to be video-recorded during lessons. I also assured them that if video recordings and/or data collected during the research process were used for any other purpose except for the study, permission would be sought from them first.

3.7.4. Issues of Power

Since this was an action research involving learners that I teach, thus unavoidable and unequal power relations existed between us. In my view, learners might have feared not

to give consent to participate for fear of victimization. However, this was addressed when I negotiated with learners where I assured them that no learner would be victimized directly or indirectly for his/her non-participation in the study, and that arrangement would be made to repeat the lessons for those learners who chose not to take part in the study. I further informed them that fellow researchers would be present to video-record lessons and to take notes during lessons. Learners were allowed to ask clarity-seeking questions and to raise concerns about their participation in the study.

3.8. Conclusion

In this chapter, I have elaborated on the methodology, with a focus on the action research approach. The chapter further elaborated on how data collection processes unfolded through the stages of the action research cycles. The main research instrument, the mathematics task, was presented and discussed in the chapter. It was shown in the chapter that the task was a higher-cognitive demands task, which has ability to support the development of learners' proficiency in mathematics, as its features suggest. Furthermore, I elaborated on the way data were analysed in this study and indicated that categories and sub-categories derived from Kilpatrick et al's. (2001) strands of mathematical proficiency were used to analyse transcripts of the four lessons. These categories assisted in exploring the research questions. Finally, I made a presentation of how issues of ethics, validity and reliability were addressed in the study, in relation to the research context, research procedures, data collection methods, type of data collected, data analysis, what will happen to the data collected and analysed, and the nature of the participants.

In the chapter that follows, data analysed using the categories and sub-categories discussed in this chapter and the learners' views and interpretations about the strategy are presented.

CHAPTER 4

DATA ANALYSIS

4.1. Introduction

This chapter presents analysis of data collected. In the presentation of data analysis, the research questions are not dealt with separately but holistically, since the mathematical task set in both English and learners' home language(s) was used for teaching rather than as an assessment tool, the use of languages could not take place in isolation. When learners and I interact with the task and with one another, we did so through language "as an instrument of thought" (Bruner, 1975 cited in Cummins, 2000:61) and as a communication tool. It is likely that the learners' home language(s) may be the language(s) that supports the thinking process (Orton, 1992) and be the legitimate language of interaction (Setati, 2005). As discussed in chapter 3, data collected in this study were analysed and interpreted using categories and sub-categories that were derived from Kilpatrick *et al*'s (2001) strands of mathematical proficiency.

As discussed in the previous chapter, data were derived from video recordings of lessons, which were transcribed and then coded, discussions with observers and interviews with learners. Learner interviews were tape-recorded and video recorded and then transcribed. Data collection took place in four consecutive lessons, and each lesson of eighty minutes was regarded as a cycle. The Action Research cycle was discussed in chapter 3. All four lessons were analysed.

Lesson transcripts were coded using categories described in chapter 3, critical incidents identified, discussed and then analysed. A critical incident is an event during the lesson that had a significant effect, either positive or negative, on task performance or communication, thus affecting learning. For each incident identified, extracts from the lesson transcript were presented to illustrate findings. Data analysis focused on how teaching the way that was different from my usual way of teaching in my Grade 11

mathematics class supported or constrained the development of learners' mathematical proficiency. As mentioned in chapter 1, what was transformed in my teaching for this study was using multiple languages deliberately during lessons, using a mathematical task set in multiple languages for teaching and learning, and taking into consideration the cognitive-level demands of the task as suggested by Stein *et al,* (2000). The main focus of the analysis was on the evidence of each of Kilpatrick et al's (2001) strands of mathematical proficiency in what learners and I, the teacher, were doing or saying, and whether the language(s) used was critical.

My views and those of the observers discussed during the reflection stage of each lesson, and the changes made for the next lesson, are discussed in this chapter. Learners' views about the transformations made in each lesson are discussed later in this chapter after the analysis of data from the four lessons.

4.2. Analysis of lessons

As mentioned earlier, to analyse lesson transcripts utterances were coded using categories and their sub-categories developed as discussed in the previous chapter. Tables 4.1, 4.2, 4.3 and 4.4 were completed for each lesson to identify which languages (Home language - HL and English - Eng) were used and the mathematical strands that were prevalent during teaching and learning, and language(s) that were dominating and associated with the strands. The frequency of each strand and the language used, and the type of interactions during which the dominant strands prevailed, were identified.

From the lesson transcript, learners' home language and English utterances were counted for each lesson, and if home language(s) and English were used within one statement or paragraph, such a statement or paragraph was counted twice, as English and home language utterances as the extract below indicates.

[T – Teacher]

T: So that is question number two. I've, I've seen ukuthi bakhona abanye abase bayiyenzile, but very few, about two … one group ise iyiyenzile. So in … we

are going to do that one, sizoyiyenza nge-two minutes in our groups, question number two… *(Goes to the SeTswana group 1)* Re dira number two ne. Ke le fa metsotso e mebedi fela *(Goes to the Xitsonga group)* Le e entse? *[So that is question number two. I've, I've seen that there are those who have already done it, but very few, about two ... one group has done it. So in ... we are going to do that one, we will do it in two… (Goes to the SeTswana group 1) We do number two. I give you only two minutes. (Goes to the Xitsonga group) Have you done it?]*

In the above extract, I the teacher used three languages, English, IsiZulu and Setswana in a single statement. However, IsiZulu and Setswana are counted as one (home language), hence the statement is counted twice and not three times because the different home languages were not separated in the counting. Table 4.1 below shows the frequency of the use of multiple languages by both learners and I during the implementation stage in each lesson.

Table 4.1 *Frequency of the use of multiple languages by learners and the teacher during each lesson.*

	LESSON 1		LESSON 2		LESSON 3		LESSON 4	
Language	Teacher	Learner	Teacher	Learner	Teacher	Learner	Teacher	Learner
HL	70	52	88	39	66	29	38	35
ENG	100	111	149	75	140	99	77	54

Even though the learners' home languages were encouraged and used deliberately in each cycle, table 4.1 shows the dominance of the use of English by both the teacher and learners across the four lessons. This is not surprising because English is the official LoLT in the school and these learners, while they are not fully fluent in English they have been learning mathematics in English throughout their schooling. Furthermore, in some instances during the four lessons, the learners' home language(s) as a resource became too visible for them as they were sometimes carried away wanting to do or write every word in their home language, as the extract from the lesson transcript below suggests.

Given: Di ya benefita. Hapfa neh, kha summer, kha winter vha badhela seven hundred neh, kha townhouse. Then kha…kha mudi kha winter, kha botshibadhela one-fifty two, kha botshibadhela vhugai, one-forty. So vha benefitha ngavhugai? The amount… *[They benefit. Here, in summer… in winter they pay seven hundred for the townhouse. Then the household in winter they pay one-fifty two, and in summer how much do they pay, one-forty. So, how much do they benefit? The amount…]*.

Patience: *(Interrupts)* Eya, mara I think vha budzisa huri vha kho inkhriza ngavhugai. Apfa vhobadhela one-fifty two and apfa summer vha kho vhadela one-forty. *[Yes but I think what is being asked is by how much will it increase. Here they pay one-fifty two and here in summer they pay one-forty]*.

Given: Ndikhongwala nga Tshivenda zwino. *[I am now going to write in Tshivenda.]*

Sipho: Eya, ngwala nga Tshivenda ngwananga *[Yes, write in Tshivenda baby]*.

Given: *(Writes in tasksheet)* Ndikhoneta nga English. Ritshi…, kana ndimini u…u...u… *[I am tired of English. We say..., by the way what is to…to…to…]*.

Sipho: Khezwo, ngwala nga English *[Aha, write in English]*.

Given: Hae, kana ndimini u… *[No, by the way what is to…]*.

Patience: Kwitani *[To do what]*?

Sipho: Dikhriza *[To decrease]*?

Given: kutanga… kutanganisa, tshitangadzisa mudi kha…kha summer na mudi kha winter, ritshi mini? Mudi… Hu tanganisa ndimini ngaTshivenda *[To add… to add, we add the household in…in summer and in winter, what do we say? Household… What is to 'tanganisa' (add) in Tshivenda]*?

Patience: Ndingutanganisa *[Is to 'tanganisa' (add)]*.

The extract indicates learners in the Tshivenda group interacting with each other and with the task, when attempting to answer question 4 in the task sheet, which required them to do the following: '*In your opinion, what may be the reason for the increase in the average electricity consumption in (3) above?*' The group wants to do and respond to the question in Tshivenda even when it is neither necessary nor required, thus detracting their attention on the task at hand. Given wants to use the group's home language to write their opinion in the task sheet but had difficulty finding the correct Tshivenda word for increase. Her question *"Hu tanganisa ndimini ngaTshivenda?"* meaning *"What is to tanganisa (add) in Tshivenda?"* suggests that she wants a suitable Tshivenda word for 'increase' but instead uses an incorrect Tshivenda word 'hutanganisa' meaning 'to add'. In Tshivenda, the word 'to increase' may be translated as 'huengedza', loosely translated as 'to make more'. Since the question required learners to give reasons for the increase in consumption, based on their daily experience as the phrase "In your opinion" suggests, the question was developing their proficiency in adaptive reasoning. Sipho and Patience's

responses suggest that the group was unable to find a suitable Tshivenda word for 'increase' and had difficulty in writing their opinion in Tshivenda. It is interesting that the learners' insisted on using Tshivenda only even when that was not the requirement for the question. Clearly, their choice to use Tshivenda only was not useful because as a result they were not able to produce a response to the question as this detracted their attention on the mathematics of the task.

The frequency of the use of both English and learners' home languages as shown in table 4.1 indicates that multiple languages were used, but the table does not indicate how these languages were used and whether the use of these languages contributed to the development of learners' proficiency in mathematics. This is shown in tables 4.2 and 4.4 below.

In tables 4.2(4.2.1 – 4.2.5) the prevalence, and the frequency thereof, of the strands of mathematical proficiency and the language associated with each strand in each cycle, as mentioned earlier in this chapter, are shown. Though the prevalence of each strand is shown separately in tables below, this does not mean that each strand was developed independently from others, since the strands of mathematical proficiency are interdependent and interwoven (Kilpatrick *et al*, 2001).

Table 4.2 *Prevalence of strands of mathematical proficiency.*

4.2.1 *Conceptual Understanding*

SUB-CAT.	LANG.	LESSON 1	LESSON 2	LESSON 3	LESSON 4
ECU	H.L.	18	12	07	02
	ENG.	24	15	17	07
CCU	H.L.	23	08	15	04
	ENG.	27	15	31	08
RCU	H.L.	08	09	03	01
	ENG.	07	11	10	01
DCU	H.L.	14	10	04	05
	ENG.	27	19	37	17

4.2.2 *Procedural Fluency*

SUB-CAT	LANG.	LESSON 1	LESSON 2	LESSON 3	LESSON 4
EPF	H.L.	03	06	0	0
	ENG.	02	11	02	01
CPF	H.L.	01	03	0	01
	ENG.	01	07	0	01
RPF	H.L.	02	09	03	09
	ENG.	02	19	04	06
DPF	H.L.	05	05	0	01
	ENG.	10	10	02	02

4.2.3 *Strategic Competence*

SUB-CAT	LANG.	LESSON 1	LESSON 2	LESSON 3	LESSON 4
ESC	H.L.	02	01	01	01
	ENG.	02	0	05	02
CSC	H.L.	07	08	03	04
	ENG.	06	16	09	05
RSC	H.L.	0	01	03	07
	ENG.	01	03	08	06
DSC	H.L.	04	03	0	01
	ENG.	07	04	06	07

4.2.4 *Adaptive Reasoning*

SUB-CAT	LANG.	LESSON 1	LESSON 2	LESSON 3	LESSON 4
EAR	H.L.	03	03	01	02
	ENG.	03	04	02	06
CAR	H.L.	05	07	0	05
	ENG.	03	03	01	08
RAR	H.L.	02	0	01	03
	ENG.	05	04	02	04
DAR	H.L.	02	06	0	03
	ENG.	03	02	03	09

4.2.5 *Productive Disposition*

SUB-CAT	LANG.	LESSON 1	LESSON 2	LESSON 3	LESSON 4
EPD	H.L.				0
	ENG.				0
CPD	H.L.				0
	ENG.				0
RPD	H.L.				01
	ENG.				02
DPD	H.L.				0
	ENG.				01

The above tables show that all of Kilpatrick *et al's* (2001) five strands of mathematical proficiency were attended to and further present an overview of the extent at which each strand was developed and its associated language in each lesson. Table 4.2 shows that generally conceptual understanding was dominant as compared to other strands in all lessons, suggesting that utterances were more conceptual during teaching and learning. In table 4.2.1 it is indicated that conceptual understanding was most frequently displayed (DCU) in English by learners. What is also evident from table 4.2.1 is that I challenged the learners' conceptual understanding (CCU) mainly during the first and the third lessons, which corresponded with a high display of the same strand (DCU) by learners during the same lessons. Conceptual understanding was least frequently displayed during the fourth lesson. In the fourth lesson, learners were already familiar with the concepts involved in the mathematical task and therefore I evaluated, challenged and reinforced conceptual understanding least as compared to previous lessons. The understanding of mathematical concepts and their relationships between them, enabled learners to identify a useful strategy and to use the appropriate procedures to solve problems in the mathematics task (Kilpatrick *et al*, 2001).

Table 4.2.2 shows that the display of procedural fluency by learners prevailed mostly during lesson 1 and lesson 2, and English being the language associated with this prevalence. As explained in chapter 3, during lesson 1 and 2, learners worked on

mathematical problems, which needed them to choose the appropriate procedures in order to be solved. Strategic competence, as shown in table 4.2.3, was displayed most prevalently in lesson 1. Since the procedures to be used for solving question 1 and question 2 were not suggested in the mathematics task, it was important that learners knew, as Kilpatrick *et al.* (2001) suggest different strategies and identify a strategy that might be of use to each problem. Learners used their strategic competence to identify and choose the appropriate procedures to solve questions 1 and 2 in the mathematics task, and therefore developing their procedural fluency, as shown in table 4.2.2.

Table 4.2.4 shows that adaptive reasoning was most frequently displayed (DAR) during the lessons 2 and 4. This was due to working on question 4 and questions 8 and 9 from the task sheet, which were done during the second and the fourth lessons respectively. These types of questions may "demand self-monitoring or self-regulation of one's own cognitive processes" (*Stein et al.*, 2000:16) as they required some explanations and justifications, and therefore supported the development of learners' proficiency in adaptive reasoning. In lesson 2, learners used their home languages most frequently when displaying adaptive reasoning, unlike in lesson 4 were they used English more frequently, as shown in table 4.2.4.

As table 4.2.5 shows, productive disposition, a strand that develops when the other four strands have developed, was only displayed in the fourth lesson. It was not surprising that productive disposition was the least frequent because, according to Kilpatrick *et al* (2001:131), "seeing sense in mathematics, regarding it as both useful and practicable, believing that constant effort in learning mathematics pays off, and seeing oneself as a capable learner and doer of mathematics", is not a once-off thing, but is developed over time.

As the tables above show, all Kilpatrick et al's (2001) strands of mathematical proficiency were attended to in the lessons. They further show that most of the interactions were conceptual. Table 4.3 below gives a summary of the prevalence and frequency of the display of all the strands during the four lessons.

Table 4.3 *Summary of prevalence of the display of strands of mathematical proficiency and associated languages.*

STRAND	LANG.	LESSON 1	LESSON 2	LESSON 3	LESSON 4	TOT
DCU	H.L.	14	10	04	05	33
	ENG.	27	19	37	17	100
	TOT.	**41**	**29**	**41**	**22**	**133**
DPF	H.L.	05	05	0	01	11
	ENG.	10	10	02	02	24
	TOT.	**15**	**15**	**02**	**03**	**35**
DSC	H.L.	04	03	0	01	8
	ENG.	07	04	06	07	24
	TOT.	**11**	**07**	**06**	**08**	**32**
DAR	H.L.	02	06	0	03	11
	ENG.	03	02	03	09	17
	TOT.	**05**	**08**	**03**	**11**	**27**
DPD	H.L.				0	0
	ENG.				01	1
	TOT.				**01**	**1**

Table 4.3 above shows explicitly that the display of conceptual understanding (DCU) was dominant and was largely in English. Furthermore, even though learners were not limited to interacting with each other, the teacher and the mathematical task in English only, but had the benefit of also using their home language(s), the displaying of other strands of mathematical proficiency was mainly in English, as table 4.3 shows.

In the section that follows, I show how multiple languages and the task set in multiple languages were used to support the development of learners' mathematical proficiency.

Table 4.4 below shows an overview the frequency of the use of the learners' home language(s) and English and what they were used for in all four lessons. This occurred when interacting with learners either as a class or as individual groups (TLI) and when

learners were interacting with each other in their groups (LLI) during teaching and learning.

Table 4.4 *How multiple languages were used in interactions (T-Teacher, L-Learner, HL-Home languages, Eng-English).*

Lang.	Interaction	Giving Instructions		Reading		Questioning /Probing		Responding /Explaining		
		T	L	T	L	T	L	T	L	**TOTAL**
HL	TLI	35	0	01	09	165	08	57	93	368
	LLI	0	01	0	05	0	**15**	0	**27**	**48**
Eng	TLI	50	0	05	06	267	08	99	187	622
	LLI	0	0	0	0	0	**08**	0	**13**	**21**

Even though the dominance of the LoLT (English) is again reflected in table 4.3, what is shown in table 4.4 above is that the use of learners' home languages dominated during learner-learner interactions, where they were used most frequently when questioning and/or probing and when responding to questions or when explaining. This is illustrated below.

4.2.1. The Use of the Learners' Home Languages in the Development of Strands of Mathematical Proficiency

In lesson 1, it was crucial that the statement of the problem, *'The Brahm Park electricity department charges R40 – 00 monthly service fees then an additional 20c per kilowatt-hour (kwh). A kilowatt-hour is the amount of electricity used in one hour at a constant power of one kilowatt'*, from the task sheet should be clearly understood by learners before they could represent it mathematically and attempt questions that followed, since without understanding it, they would not have been able to solve the problem. As Kilpatrick *et al* (2001:124) suggest, "With a formulated problem in hand, the student's first step in solving it is to represent it mathematically in some fashion, whether

numerically, symbolically, verbally, or graphically". It was therefore important for learners to understand the mathematical concepts, quantities, ideas and operations involved in the 'statement of the problem' and the relationship between them so that they could develop strategies for solving the problem.

What was most critical in the statement 'of the problem' from the task sheet was 'an additional 20c per kilowatt-hour (kwh)'. While learners understood that '20c' was added, because of the word 'additional', they had difficulty in understanding why it was added, suggesting that they had limited understanding of the relationship between the value or quantity '20c' and the concept 'per kilowatt-hour', as the extract below shows.

> T: Forty rhanda heyi, vhoibadhala when *[When is the forty rand paid]*?
> Sipho: In a month.
> T: Twenty cents yone *[What about the twenty cents]*?
> Given: Twenty cents yo ediwa. *[Twenty cents is added]*.
> T: Why i ediwa *[Why is it added]*?
> Ls: *(Silent)*.
> T: Vhoi edela mini? Twenty cents vhoi edela mini *[Why is it added? Why is twenty cents added]*?
> Ls: *(Inaudible)*.

In the extract, as the knowledgeable other, I (the teacher) mediate learning. Mediation occurs when external assistance is needed by learners and given by the more knowledgeable other (Tharpe and Gallimore, 1991; Scott, 1998). This is Stage 1 of Tharpe and Gallimore's (1991) four-stage model of the transition from assisted performance (interpsychological category) to individual performance (intrapsychological category) taking place in the zone of proximal development (ZPD), discussed in detail in chapter 2. What is interesting is that the learners' home language is the semiotic tool that is used as a mediating agent (Berger, 1998; Vygotsky, 1979) by me where I use probing questions as a 'scaffold', a temporary support to assist learners' performance of the task. Below is a brief description of how learning is mediated in the above extract.

In the extract I use the group's home language to evaluate learners' understanding of the two values, the 'R40-00 service fee' and 'the additional 20c per kwh' through questioning, since the understanding of these values was key in developing a strategy to

come up with solutions for the problems in the given mathematics task sheet. Given's response that *"Twenty cents yo ediwa"* meaning *"Twenty cents was added"*, suggests that the group had some understanding of the concept 'additional 20c', but could not respond when the teacher challenged their understanding by probing further through questioning using their home language. The word 'additional', translated in the Tshivenda version of the task as 'vha engedza', which means 'to increase or to make more by', served as a cue-word, as Kilpatrick *et al* (2001) argues, when students are working with mathematical problems, they tend to focus on numbers and keywords that may cue arithmetic operations appropriate to the given problem. To stimulate learners' thinking, I use a probing question *"Vhoi edela mini?"* meaning, *"Why is it added?"* as a 'scaffold. Furthermore, this question required learners to give reason(s) why 20c is added, therefore supporting the development of learners' proficiency in adaptive reasoning.

Even though the group had limited understanding of the 'additional 20c', the extract below shows that they displayed an understanding of the concept 'R40-00 monthly service fee'.

> T: Okay, if you use electricity ukho bhadala forty rand? *[Okay, if you use electricity will you pay forty rand]*?
> Ls: Yes meneer [sir].
> T: If unga shumisanga electricity ukho bhadala forty rand *[If you did not consume electricity, will you pay forty rand]*?
> Sipho: No, no no …
> Given: Haena, whether ushumisile ore haushumisanga, ukhobhadala forty rhanda *[No, whether you have consumed electricity or not, you pay the forty rand]*.
> T: Whether ushumisile ore haushumisanga *[Whether consumed or not]*.
> Sipho: Eya, yes, it is a must.
> T: It is a must.

As the extract shows, I evaluate and challenge learners' conceptual understanding by provoking them using their home language. Given's *"Haena, whether ushumisile ore haushumisanga, ukhobhadala forty rhanda"*, meaning *"No, whether you have consumed electricity or not, you pay the forty rand"*, and Sipho's *"Eya, yes it is a must"* suggest that he knew and understood that R40-00 is a compulsory monthly fee, therefore displaying conceptual understanding and adaptive reasoning. I further support the development of the group's proficiency in conceptual understanding by revoicing

Given's and Sipho's responses in English or in their home language. Revoicing has the advantage of supporting learners' participation in a mathematical discussion (Moschkovich, 1999).

The two extracts below show learners interacting with each other in their individual language groups. When individual groups are working on the task without teacher assistance, I regard it as individual performance. At this stage, the two groups are working on the task without the assistance of the teacher. This is stage 2 of Tharpe and Gallimore's (1991) four-stage model, referred to as 'Individual performance stage', where learners' home language(s) is used as a tool to assist performance, either when questioning and/or probing each other, and when responding or explaining their thought processes and/or justifying solutions obtained to each other.

In the first extract, Given displays conceptual understanding, procedural fluency and adaptive reasoning using Tshivenda to explain how R40-20 was obtained.

> Given: Hei, nayo … ar … *(Giggles)* … So forty rhanda hi monthly cost ne, then ba yieda nga twenty cents kha kilowatt for one hour. Then after that, angado shumisa …, baibidza mini? Heyi … ndoshumisa one kilowatt nga twenty cents kha one hour *[Hei, this question ... ar ...(giggles) ... So forty rand is the monthly cost, then they add twenty cents per kilowatt-hour. ..., they use…, what do they call it? Heyi ... they use one kilowatt-hour for twenty cents]*.
> Sipho: Eya *[Yes]*.
> Given: Boyieda, maybe boshumisa twenty cents nga one hour *[They add it, maybe they use twenty cents per hour]*.
> Sipho: Eya, yantha *[Yes, one hour]*.
> Given: Iba … *[It becomes…]*.
> Given and Sipho: Forty rand twenty cents.
> Sipho: Yes, vhoibadela monthly, ngangwedzi ya hona. Yo fhelela, yes. Sesiyaqubheka. *[Yes, they pay it monthly, each month. It is complete, yes. We continue]*.

The extract shows Given displaying conceptual understanding by explaining that *"forty rands is the monthly cost"* and that *"they use one kilowatt-hour for twenty cents"* which is added to forty rands. This indicated that Given eventually understood the concepts involved, i.e. 'the R40-00 service fee and the 20c per kilowatt-hour, and how the

concepts are related to each other. By explaining, she was displaying adaptive reasoning as she was justifying how R40-20c was obtained.

In the second extract, the interaction is between learners in the Setswana Group where Gabriel is using the group's home language as a communication tool explaining to others the strategy used to obtain R40.20.

> Ronald: *(Interrupting, but inaudible)*.
> Gabriel: Mamela, ere ke go tlhalosetse. If … if … die ding, wa bona e ne e le disente ne, if ke disente, every time wa e tšhentšha, o e tšhentšhela ko zero comma two zero, then e be o e eda le tšhelete ya diservice, which is forty rands, wa bona *[Listen, let me explain. If ...if ... this thing, it was in cents, if it is in cents, every time you convert it, you convert to zero comma two zero, then you add it to service charges, ..., you see]*. From there you get the answer which is forty rand twenty cents.
> Ronald and Thapelo: Okay.

Gabriel was explaining how R40-20c was obtained, displaying adaptive reasoning. What was interesting in his explanation was that, unlike Given's explanation in the previous extract, he displayed conceptual understanding of like terms and decimals, as he converted 20c to 0,20 as rands to add it to the R40-00 service charge, and further displaying strategic competence and reinforcing procedural fluency.

The two extracts above show that Given and Gabriel were able to display some development in mathematical proficiency through own speech using their home languages. As Tharp and Gallimore (1991) argue, children use self-directed speech as a tool for self-guidance. In Vygotskian terms, the learners have now reached a significant stage in the transition of a skill through the ZPD (Tharp and Gallimore, 1991). But one should note that even at this stage, performance of the task by learners is not yet fully matured or automatized, but still in the process of developing. At this stage, the two learners, Given and Gabriel, have mastered a certain mathematical skill (i.e. knowing and understanding mathematical concepts, quantities, ideas and operations involved in the problem and the relationship between them) and may be in the ZPD of the other skill that needs to be developed (i.e. identifying a number of strategies and choosing a suitable one

for the given problem), since developing mathematical proficiency is not an event but a process.

4.2.2. The Use of and the Interaction with the Task Set in Multiple Languages to Support the Development of Strands of Mathematical Proficiency

Table 4.4 shows that, when reading from the task sheet, learners used their home languages most frequently. This occurred either when learners did not understand the English version or when I instructed them to do so if I thought that learners did not understand the English version, as the extract below shows.

> T: Twenty cents heyi, uyibhadala when? When do you pay this twenty cents?
> Group: (*Read statement in TshiVenda)*.
> Sipho: Hooo …, alright, eya [yes].
> T: Now you understand uma uyifunda ngesiVenda *[Now you understand when you read in Tshivenda]*?
> Sipho: Eya *[Yes]*, okay …
> T: When you read in Venda, you start understanding?
> Sipho: Eya *[Yes]*, we start understanding meneer [sir], alright.
> T: So, in English does it confuse you a little bit?
> Sipho: Eya [Yes], a little bit, a little bit meneer [sir].
> T: So in Venda …, can you explain it because you understand it.
> Sipho: Okay, let me read for them first meneer [sir].
> T: Eya *[Yes]*, can you read it in Venda.
> Sipho: *(Reads the statement in TshiVenda)*. Okay, zwiamba huri er …, athiri ngangwedzi bobhadala forty rhanda, then baengedza nga twenty cent khaawara thihi. Then mudagazi wo shumisiwa ngamanda khaawara thihi *[Okay, it means er… isn't it they pay forty rands per month, then they add twenty cents per hour. Then the electricity consumption is one kilowatt-hour]*.

In the extract, I am interacting with the Tshivenda group 1 in lesson 1. It was after I had initially asked some learners to read the statement to the whole class in English only, and after groups have discussed how they understood it. I then evaluated learners' understanding of the phrase 'additional 20c'. In the extract, Sipho's *'Hoo…, alright, eya'* and explanation in his home language, suggests that he began to understand what the '20c' was for and how it relates to the 'electricity consumption' and the 'forty rands service fee' after having read in their home language. This suggests that interacting with the Tshivenda version supported the development of Sipho's conceptual understanding,

the ‘additional 20c’, and adaptive reasoning, since he was able to explain what the 20c is for after reading in his home language.

When interacting with the Tshivenda group, I read the Tshivenda version and then explained to the group the two phrases, ‘R40-00 service fee’ and the ‘additional 20c’. The reading and the explanation in the learners’ home language was used as a ‘scaffold’, as Jarwoski (1994) suggests, ‘scaffolding’ “promotes movement across the ZPD” (p.109).

> T: For that month *(Turns to the TshiVenda version)*. Where’s the Venda version? *(Reads TshiVenda version)*. So, forty rhanda iyashumelo, athiri, iyashumelo forty rhanda. Twenty cents kha kilowatt-hour thihi idoba ya mudagasi wo shumiswaho, athiri? Zwino what I am saying is, suppose ndishumisa mudagasi wa one kilowaat-hour for that month, that one kilowatt-hour per month, zwino rho badhala vhugai for that month? *[For that month (Turns to the TshiVenda version). Where’s the Venda version? (Reads TshiVenda version).So, forty rand is for services, isn’t it? Forty rand is for services. The twenty cents per kilowatt-hour will be for electricity consumption, isn’t it? Now what I am saying is, suppose I use one kilowatt-hour for that month, that one kilowatt-hour per month, now how much will we pay for that month?]*

At this stage, the group was struggling to continue with the task even though Sipho and I explained the two phrases ‘R40-00 service fee’ and the ‘additional 20c per kilowatt-hour’. Since movement through the ZPD is cyclic and repetitive and recursion is required from time to time (Tharp and Gallimore, 1991), external mediation from capable others, either from me the teacher or from other members of the group or class was required. In such instances, where either the learners’ limited comprehension of concepts, relations and values in the task made it difficult if not impossible for them to do required calculations, or when they struggled to continue with the task, I offered guidance and assistance by using an example similar to the one in the mathematical task as temporary support given to learners to simplify their role in performing the task (Tharp and Gallimore, 1991), but changed the context. To illustrate this, lesson extracts from lesson 1 and lesson 2 are used.

> T: Lets use this example ye *[of]* cellphone contract. Let us say the contract is hundred and thirty-five rand, ye *[for the]* contract. Does that hundred and thirty-five rand include calls? Imali ye contract ye cellphone, bathi kuwe ‘Weekender Plus’ is hundred and thirty-five rand per month that you pay. Does that hundred

and thirty-five rand include imali ozoisebenzisa for the calls? *[The cost for the cellphone contract, they say to you 'Weekender Plus' is hundred and thirty-five rand per month tat you pay. Does that hundred and thirty-five rand include the money that you will use for the calls?]*

Verda: No.

T: Ya macalls izoba … *[The cost for the call will be…]*, when do you pay for the calls? Suppose you don't use that phone for the month, how much do you pay?

Verda: Hundred and thirty-five rand.

T: Hundred and thirty-five rand?

Verda: Yes.

T: Suppose you don't use that phone for the month, how much do you pay? Do I still pay that hundred and thirty-five rand?

Sipho and Verda: Hundred and thirty-five rand plus di-calls tse o di yuzitseng *[Hundred and thirty-five rand plus the cost for the calls made]*.

In the above extract, I am interacting with the Tshivenda group during the first lesson using IsiZulu and English, where the group is struggling with the phrase "additional 20c". I use the context that I assumed the group might be more familiar with, the 'cellphone contract' context, and use probing questions as a 'scaffold' when interacting with the group. My *"Does that hundred and thirty-five rand include the money that you will use for the call?"* evaluates the group's conceptual understanding. The extract shows that I probe further by challenging Verda's conceptual understanding and evaluating her strategic competence, as the questions *"Suppose you don't use that phone for the month, how much do you pay? Do I still pay that hundred and thirty-five rand?"* suggest. The question challenges the learner's understanding of the constant or fixed value R135-00 which is paid regardless of having made calls or not and paid additional to the cost of the calls made.

In the extract below, through the statements *"You said they add the twenty cents. So, what do you think?"* and *"You said I still pay the forty rand, and then I use the one kilowatt-hour. Then how much are you gonna pay?"*, I refer the group back to the mathematical task used and reinforces their conceptual understanding and strategic competence, to assist learners to see the similarities between concepts, i.e. between the R135-00 for the cellphone contract and the R40-00 electricity monthly service fee, and between the cost for calls made and the additional 20c per kilowatt-hour.

T: Yes. Zwino hapfa *[now here]*, then if I use one kilowatt-hour, how much will I pay for that month?
Ls: *(Silent)*.
T: You said they add the twenty cents. So, what do you think?
Sipho: Hooo … *[Okay]*.
Patience: You still pay the forty rand.
T: Then I use the one kilowatt-hour. You said I still pay the forty rand, then I use the one kilowatt-hour. Then how much are you gonna pay?
Sipho and Verda: Forty rand twenty cents.

Verda's and Sipho's responses in the two extracts above suggest that the use of a context similar to the one used in the mathematical task used in this study supported their development of conceptual understanding and strategic competence, because they displayed their understanding of the connections and relations between the "hundred and thirty-five rand per month for the cellphone contract" and the "cost per calls made". The "R135-00 per month" is similar to the "R40-00 service fee per month" and the "cost per calls made" is similar to the "additional 20c per kilowatt-hour" in the mathematical task. As Kilpatrick *et al* (2001) argues, if one makes small changes either in the wording of the problem, context, or representation, dramatic changes in learners' success can be offered. This is evident in the extracts above as Verda's and Sipho's responses to my questions suggest.

Learners also switched between the home language version and the English version when working on the task in their groups, reading one version first and then switched to the other. Below is an extract from the lesson transcript were learners in the Tshivenda group are working on question 3 on their own during lesson 2. Question 3, which was as follows, '*In winter the average electricity consumption increases by 20%, what would the monthly bills be for the family home in (1) above and for the townhouse?'* required learners to work out the monthly bill if there was a 20% consumption increase. This was one of the 'critical incidents' in lesson 2 since the calculation of percentage was challenging to learners.

Sipho: Ba engedza nga twenty rhanda, one-sixty ore bare one-fifty *[Have they increased by twenty rand, one-sixty or are they saying one-fifty]*?
Verda: Ba engedza nga twenty rands *[They increase by twenty rands]*.

In the extract, learners are trying to work out twenty percent of the original monthly electricity consumption for the household and the townhouse, and seem to be having difficulty in understanding what percentage means and how to work it out. Sipho's and Verda's *"Ba engedza nga twenty rhanda… [They increase it by twenty rand, …]*", suggests that they have limited understanding of the concept 'percentage' as they think that 20% is the same as R20-00. To try to actively make sense of the mathematical problem in the task "to guide his knowledge construction" (Jaworski, 1994:27), Sipho uses both English and his home language as resources since he switches between both versions of the mathematical task, as the extract below shows.

> Sipho: No, not like that. Listen, they use seven hundred kilowatt-hours. They use seven hundred kilowatt-hours ne, in winter, ne. In winter they use, ikhuphuka nga vhugai? *[…, it increases by how much]*? Twenty percent ne. So *(reads TshiVenda version)* … shikoloto swa vhona … *[… their monthly bill…] (has two versions next to each other and switches between the two versions)*.

In this instance, switching between the two versions of the task is not so much resourceful to assist in understanding the concept 'percentage'. Below is an extract where I provide external mediation where the context was changed.

> T: *(Writes down on paper)* A re re test ke fifty marks, now thitšhere are o bone hundred percent. O kreile bokae? Hundred percent ya fifty marks ke bokae *[Let us say a test is out of fifty marks, now the teacher says you have obtained hundred percent. How much have you obtained? What is hundred percent of fifty marks]*?
> Verda: Ke *[Is]* fifty.
> T: Fifty ke hundred … ya hundred percent. So fifty percent e tla nna bokae mo fifty *[Fifty is hundred … of hundred percent. So what is fifty percent of fifty]*?
> Verda: Twenty-five.
> T: Twenty-five, okay, akere *[isn't it]*?
> Ls: yes.

Hatano (1996: 212) suggests that the teacher can mediate learning by, "presenting various models to enhance students' understanding". In the above extract, I used the context of 'marks obtained in a test' as a 'model', which I also refer to as a tool, for mediation of learning. Teachers may use prompts, confirmations and probing questions as a scaffold to assist learners to reach a higher conceptual level. I then reinforced and evaluated learners'

conceptual understanding of 'percentage' and their strategic competence of calculating 20% R112-00 by again referring the group to the mathematical task.

T: So, le tlo etsa yang? Mo ke twenty percent of sixty, so wena o batla twenty percent of one-one two, o tlo etsa yang? Ngwala mo fatshe *[So, how are you going to do it? This is twenty percent of sixty, so you have to find twenty percent of one-one two, how are you going to it? Write it down]*.
Given: *(Writes on paper)*.
T: You always divide by the total percentage, the maximum percentage, which is hundred percent. You always divide by hundred percent, times what?
Patience: *(Uses calculator)* Twenty-two comma four.
T: Twenty-two comma four … twenty-two comma four. Bo ngwala vhugai *[How much have you written]*?
Given: Twenty-two rands four cents.
T: Twenty –two rand forty.
Given: Hoooo *[Okay]* .., forty.

In the extract, the Tshivenda group succeeded in calculating the required percentage, suggesting that the use of a different context as mediation enhanced their comprehension of 'percentage' and how it is calculated. What is interesting in the extract is that three languages, Setswana, English and Tshivenda, are used in the process of guiding the learners' constructions. This is indcative of the multilingual nature of the class. While this is a Tshivenda group, they still draw on other languages to make meaning of the mathematics presented in the task.

In the section that follows, I use extracts from the interview transcript to analyse learners' reflections and interpretations about the transformation made in their classroom are discussed.

4.3. Learners' Reflections and Interpretations About the Lessons.

To recap, as indicated in chapter 3, learners were divided into home language groups. There were two Setswana groups, two Tshivenda groups, two IsiZulu groups and one Xitsonga group. Four learners, one per different home language group were selected for the individual interview. A fellow researcher who was not present during the lessons conducted the interview. She is a former senior mathematics teacher in the school where

the study was conducted and learners knew her. The purpose of the interview was to get the learners to reflect on the strategy used, that is the changes made in their classroom. The two changes made, as discussed in chapter 1, were using a well-selected mathematical task that was in multiple languages as an instructional tool instead of using it as an assessment tool, and deliberately using multiple languages during teaching and learning.

At the beginning of the interview, each learner interviewed was asked his or her language of preference for purposes of the interview. The interviewer was giving learners an opportunity to choose the language that they would be fluent in so that they can express themselves easily for the flow of the interview. Sindiswa indicated that she preferred both English and Setswana, and the interview was successfully conducted in both languages. Colbert preferred that the interview be done in both his home language, Tshivenda and English. Sipho, whose home language is Xitsonga but is doing Tshivenda as a subject at first language level, preferred the interview to be done in any language. The two learners, Sipho and Colbert, were also fluent in Setswana and IsiZulu. Colbert's interview was conducted in IsiZulu and Sipho was interviewed in Setswana throughout.

Nhlanhla was the only one who preferred to be interviewed in English. What was interesting is Nhlanhla's response, especially when considering his language of choice at the beginning of the interview and how he proceeds.

(I – Interviewer)

I: Nhlanhla Zondi, okay. What's your home language Nhlanhla?
Nhlanhla: Zulu.
I: Which language do you prefer we conduct this interview?
Nhlanhla: English.
I: Are you comfortable with it?
Nhlanhla: Yes.
I: Ok. I understand the whole of this week you had visitors coming to your class, what was happening? Can you explain?
Nhlanhla: We were learning about how to calculate …er…er… kilowatts of the electricity, how do we … like … how can we calculate them and when … at …, nnga khuluma ngeSiZulu *[may I speak in IsiZulu]*?
I: Eya, o right. O ka bua ka SeZulu *[Yes, alright. You may speak in IsiZulu]*.

Initially Nhlanhla said he wanted to be interviewed in English and quickly changed his mind and requested to respond in IsiZulu and proceeded in his home language for the rest of the interview. Even though he indicated that he was comfortable with English, in my view, he realised after saying a few English words that he would express himself better in his home language than in English.

Even though in the extract above Nhlanhla requested to switch to his home language, generally the four learners interviewed have conversational fluency in English. Cummins (2000) makes a distinction between conversational and academic aspects of language proficiency that he refers to as basic interpersonal communicative skills (BICS) and cognitive academic language proficiency (CALP)**.** BICS is the language proficiency needed for general highly contextualized everyday conversational interactions and/or thought. This is the kind of proficiency that Gibbons (1999), cited in Cummins (2000), refer to as 'Playground language', 'language' which cannot be used for or coupled with learning any subject that may require the higher order thinking skills (e.g. generalizing, evaluating, hypothesizing, etc.) as required in mathematics and physical sciences. It is the 'language' that learners use in their day-to-day interactions. On the other hand, CALP is defined as "expertise in understanding and using literacy-related aspects of language" (Cummins, 2000:70). It is the language proficiency used for relatively less contextualized but more abstract classroom interactions. As Gibbons (1999) in Cummins (2000) suggests, it is the 'language' needed in the classroom for academic purposes. This is the kind of 'language' that is required for and linked with successful learning of mathematics. In my view, it is the learners' familiarity with and their understanding of the mathematics register and the ability to express it linguistically and use it effectively.

Nhlanhla's request to switch from English to his home language suggests that, like any learners in my class, he has basic interpersonal communicative skills rather than cognitive academic language proficiency. This is not surprising. In an ethnographic study of a program serving second generation Salvadorean students in Washington DC, Vincent (1996) in Cummins (2000) observed that learners frequently lacked academic language

even though they seemed to have much greater English proficiency. This is typical of learners in this study.

In the section that follows, I discuss the three main issues in the learners' reflection on the new approach used, namely,

- the nature of the mathematical task used in this study,
- the deliberate use of multiple languages, and
- learner participation.

4.3.1. Nature of the Mathematical Task Used

In chapter 3, the features of the mathematical task used in this study were discussed. Since the task features determine its level cognitive demand (Stein *et al.*, 2000), features in the task used suggested that it was of a high-level cognitive demand. Such tasks, according to Stein *et al*., (2000) form the basis of learners' opportunities to learn mathematics. The task had features that would create an opportunity for learners to develop their mathematical proficiency, i.e. an opportunity to develop proficiency in Kilpatrick *et al*'s (2001) strands of mathematical proficiency discussed in chapter 2.

All learners interviewed indicated that the four lessons conducted during this study were different from their normal (daily) mathematics lessons. When responding to the interview question "What was different about the lesson?" all but one learner began by referring to the nature of the mathematical task used. I thought that learners would talk about the use of home language(s) as it was in my view, the most visible or discernible change in my teaching. The expectation was that all the learners interviewed would begin by pointing to the use of their home language(s) as something that was different about the lessons, since one of the things that are generally viewed as factors that may prohibit or enhance mathematical comprehension in multilingual classrooms is language. This was not the case, as the extracts below show.

(I – Interviewer)

I: What … what was so special about the lesson? Why do you say you learnt about electricity? Isn't it something that you normally do? What was so special about it?
Sindiswa: It's a different way of the lesson.
I: How different? What do you mean when you say it is a different way?
Sindiswa: It does not include those Maths … maths. It is not different, but those words used in Maths didn't occur, didn't occur but we weren't using them.
I: Which words, mantswe a feng, mantswe a feng *[which words, which words]*?
Sindiswa: Er … 'simplifying', 'finding the formulas', 'similarities' …
I: Hoooo …, yana mo textbukung? E ne e sa tshwane le mo textbukung ntho e nne le e etsa? *[Okay…, just like in the textbook? What you did was not like in the textbook?]*
Sindiswa: Yes.
I: Ya bo 'simplify', 'solve for x'… *[That of 'simplify', 'solve for x' ...]*
Sindiswa: Yes.

For Sindiswa, what was different about the lessons was the kind of task used for teaching. She focuses on the mathematics of the task. One interesting point she makes about the task is the language of the task, which is different from the type of language used in their mathematics textbooks. She says words like 'simplify', 'finding the formula', 'similarities', which is terminology found in mathematics textbooks, were not used in the task. She further points to how the phrasing of questions in the task made a difference for understanding of the task, as the extract below shows.

I: What is it that you liked about it?
Sindiswa: The way the questions were coming, the way the questions were asked, it doesn't … it doesn't … is not the same as those we used in er… textbooks.
I: So, ntho e oe ratileng gagolo ke eng? Ke eng e e etsang gore ore "it was fine"? It can be "fine", but specifically ke eng e e entseng gore e be … *[So, what did you like most? What made you say "it was fine"? It can be "fine", but specifically what made it to be ...]*
Sindiswa: (Interrupting) Ke gore, the way ne diquestion di ne di botswa ka teng *[I mean, the way the questions were asked]*, it was easy for the whole … for all of us, for all the students to understand and answer all the questions.

Sindiswa argues that it was easy for learners to understand and therefore answer question in the task, and she attributes that to the phrasing of questions, which was different from the way they are phrased in mathematics textbooks. This suggests that even with the

English version of the task used, the language was made more accessible and the task enjoyable as it was less threatening for learners.

As was the case with Sindiswa, when asked what they were doing during the week and what was different about it, Nhlanhla first mentions the nature of the task. He mentions how different the mathematics in the task was.

I: Ok. I understand the whole of this week you had visitors coming to your class, what was happening? Can you explain.
Nhlanhla: We were learning about how to calculate …er…er… kilowatts of the electricity, how do we … like … how can we calculate them and when … at …, nnga khuluma ngeSiZulu *[may I speak in IsiZulu]*?
I: Eya, o right. O ka bua ka SeZulu *[Yes, alright. You can speak in IsiZulu]*.
Nhlanhla: Besifunda mem ukuthi ugesi udleka kakhulu nini, yes mem *[Mem, we were learning about when is electricity consumption more, yes mem]*.
I: Yini into eyenza ukuthi, naba abantu bayasuka nje bazo khuluma ngo-gesi we electricity, kanti anifundi lokho eklasini *[What make that, people just come and talk about electricity, isn't it that you learn about it in class]*?
Nhlanhla: Hayi, no mem, ku-different *[No, no mem, it is different]*.
I: Ku-different. Yini into eyenza kube different *[Is it different. What makes it different]*?
Nhlanhla: Okokuqala mem, ilokhuza, la sidila ngama-calculations awemali, manje ku-maths asisebenzi ngemali *[Firstly mem, the.., here we work with calculations that involve money, now in maths we do not work with money]*.
I: Hooo…, benidila ngama-calculations awemali? Ku-maths anisebenzi ngemali. So, la bekunemali *[Okay.., you were working with calculations involving money? In maths you do not work with money, so, here there was money]*?
Nhlanhla: Yes mem.

The first thing that was different about the lessons for Nhlanhla was that the mathematics in the task was different from the mathematics that they normally do in their class. Even though the task was about linear graphs, which is a section in the grade 10 and 11 curriculum, for Nhlanhla the use of context makes the mathematics in the task to be different as they *"were learning about when is electricity consumption more"* and they *"work with calculations involving money"*. He points to the fact that in mathematics they usually do not deal with calculations involving money whereas these lessons involved money calculations. This means that for Nhlanhla the use of the electricity context in the task was crucial for understanding of the task and made the lessons special.

I: Uma ubhekile, uthandeni? Yini into oyithandile *[In you view, what did you like? What is that that you liked]*?

Nhlanhla: Mina ngithande ukuthi lo gesi sengiyazi ukuthi abantu ba-ukhalkhuleitha kanjani. If like kufika i … yini lento lena, niyibizani *[I liked that I now know how people calculate this electricity. If like when er….comes, what is this thing, what do you call it]*?

I: Le … electricity bill?

Nhlanhla: Yes mem. Sengibone ukuthi ba ikhalkhuleitha kanjani. Kusho ukuthi manje nasekhaya akukho … nnga khona ukwiyenza. Nnga khomphera ukuthi iyafana na le siyenzile *[Yes mem. I now know how they calculate it. It means that now even at home there is no… I can be able to do it. I can compare if is it the same as the one we have done]*.

One thing that Nhlanhla mentions in the above extract, which Sindiswa did not indicate, is how interacting with the task has provided him with a skill that he can use, as he now knows how the monthly electricity bill is calculated. Nhlanhla's response in the extract above indicates that the nature of the task has made him to see how classroom mathematics is connected to and can be used in his everyday life. This means that he displays some proficiency in productive disposition as he sees sense and realises the importance of mathematics in solving real-world problems (Kilpatrick *et al.*, 2001).

The third learner, Colbert, like the other two learners mentioned earlier on, started by pointing to the nature of the task as a change in the way of teaching and not the use of home language, as the extract shows.

I: Ok, thank you so much. Eya, I understand this week you had visitors in class, what was happening?

Colbert: Er …we were just solving for electricity, kilowatt per hour, for comparing if they are using card or the meter, which is both, I think are the same.

I: Eya, so beyikhuluma ngani le lesson? Yini into eyenza ukuthi ibe i-lesson? Akhona mos ama-electricity, niyakwenza loku, niyakwazi *[Yes, so what was the lesson all about? What made it to be a lesson? Electricity is always there, you all know that, you do know]*.

Colbert: Iya, basenzele in order to … ukuthi ibe simple and easy to us, because most of people, uyabona, aba-understendi like i … like i-card ne meter. Abanye bathi i-meter is … i-price yakhona i-much uyabona, i-card iless i-price yakhona, that's why uyabona. So, abantu abana-knowledge, uyabona, bakhuluma just for the sake of it. So, I think for us, because we have learnt something, both are the same. *[Yes, they did it in order to ...so that it should be simple and easy to us, because most of people, you see, they do not understand like a… like a card and a meter. Some say a meter is ... costs more you see, the cost of a card is less, that's why you see. So people do not*

have knowledge, you see, they talk just for the sake of it. So, I think for us, because we have learnt something, both are the same.]

Like Nhlanhla, when asked what the lesson was all about, Colbert mentions the context used in the task, which is the calculations on electricity consumption in order to make a comparison between a prepaid system and a metered system. When the interviewer challenged him that *"What made it to be a lesson? Electricity is always there, you all know that, you do know"*, he focuses on the value of the task beyond this study since it was about clarifying a real life situation that he never understood and is a point of discussion and disagreement in his context. As he says, most people out there do not understand. Colbert points to the fact that this was different because the way the task was set, it made it easier for them to understand the mathematics in the task, and has provided them with knowledge of how the two electricity-costing structures work. This means that nature of the task, the language and the context used, made the mathematics of the task more interesting and accessible to them, and as in Nhlanhla's case, the context used has made him see how classroom mathematics can be used to solve daily-life problems. This suggests that he also sees sense in mathematics and therefore displays proficiency in productive disposition.

4.3.2. The Deliberate Use of Multiple Languages

According to Jaworski (1994), one of the things that Vygotsky places a greater emphasis on is linguistic influences on learning. The role that language can play during teaching and learning was discussed in detail in chapter 2. In this case, language refers to the LoLT (English) and learners' home language(s). As Berger (1998) argues, language plays an important role as it serves as a cognitive re-organiser that aims at transforming the quality of teaching and therefore helps in developing thinking. This means that language is an important tool for thinking and learning and is the "major tool for mediating the interaction between learners and between the teacher and learners" (Setati, 2005). Furthermore, the use of learners' home language(s) during teaching and learning can play an important role as Zevenbergen (2000) argues that the learner's home language and the way in which it is used can be a form of capital. This means that learners' home

language(s), if used appropriately, can be an effective resource and tool for accessing the social good that is mathmatics knowledge. The learners' views about the use of multiple languages during lessons are illustrated below.

4.3.2.1. Language as a Resource

When the interviewer asked about the approach at the beginning of the interview, Sipho was the only learner who started his response by referring to language as something that was different about the lessons. The other learners, Nhlanhla and Colbert, only pointed to the language when the interviewer explicitly asked about the use of the home language(s) in the task. Below is an extract showing Sipho's response.

> I: Okay. I understand this week you had visitors coming to your school. What was happening?
> Sipho: Er, the visitors they were doing research. Gošho gore ba sheba gore bothata … bothata ba rona bo mo kae, ka … ka … maths, then they found out that er… ba bang ha ba understende dilanguage, like English so, then ha ba botsa karabo then they can't find the answer. So Mr Molefe then decided to … to … make it in … in English and vernacular language to … to …, for us to understand. *[Er, the visitors were doing research. It means that they check where our problem is regarding maths, then they found out that er ... some do not understand languages like English so, then when an answer is required, then they can't find the answer. So Mr Molefe then decided to ... to ...make it in ... in English and vernacular language to ... to ..., for us to understand]*

Unlike the other three learners, this learner did not at all mention the use of the mathematical task. As the extract shows, Sipho mentions the use of home language in addition to English as something different about the lessons. What is interesting is that he even mentions what he thinks are the reasons why I the teacher decided to using the learners' home languages in the lessons in this study. Sipho argues that their lack of understanding of mathematics is due to their limited fluency in English. Furthermore, when asked what he liked about the new approach, he again mentions the use of home language and points to lack of understanding of English terms or words. His *"ba bang ha ba understende dilanguage, like English so, then ha ba botsa karabo then they can't find the answer"* meaning *"some do not understand languages like English so, then when an answer is required, then they can't find the answer"* suggests that in his view, their

difficulty in finding the required answers when working on mathematics task is due to the exclusive use of English which makes the task incomprehensible to most learners. What it more interesting is that Sipho does not say "they *do not know* the answer" but says "they *can't find* the answer". This implies that even if learners may know the answer, they have difficulty in finding it because of their limited fluency in English (LoLT), which is the language in which tasks or tests are set in their mathematics class. Sipho's view further suggests that if tasks can be set in the language(s) that learners understand and are fluent in, they may find it easier to find required answers. He therefore likes the idea of using their home language(s) in addition to English in the teaching and learning of mathematics in their class as the extract below shows.

> I: Go tlhalosa, okay. So, lesson ena e ne e sa tshwane le dilesene tse ding, akere, so ha o shebile, ke eng e oe ratileng mo leseneng *[To explain, okay. So, this lesson was different from the previous ones, isn't it, so in your view, what did you like in this lesson]*?
> Sipho: Mo leseneng e nne re e etsa *[The lessons that we have done]*?
> I: Iya *[Yes]*.
> Sipho: Ntho e ke e ratileng ke gore, yona the lesson was very good ne, because like bo-ditest soo, se ditla, ne ditla ka English, o thole gore ha re understende, wa bona mem. Ene o thole gore go na le mantswe a mang a English a e leng gore a difficult for us gore re understende. So, they did gore at least ba etse ka vernac le English, so re bale ka English then we go to vernac language then re tlo kgona go understenda, to get the answer *[What I liked is that, the lesson was very good because, like tests, are in, were in English, then you find that we do not understand, you see mem. And you find that there are English words that are difficult for us to understand. So, they did that at least in home language and English, so we read in English then we go to home language then we will be able to understand, to get the answer]*.

Sipho does not refer to the mathematical task used in this study but refers to previous tests that they wrote outside this study. He points to some difficult English words as a reason for not understanding questions in those tests. For him, the use of English only makes mathematics incomprehensible. This learner sees the use of home language(s) as a solution, because its presence gives them an opportunity to switch to it as it makes a difference for understanding of the task.

What is more interesting regarding the use of multiple languages in the lessons, is that the three learners, Nhlanhla, Colbert and Sindiswa, only pointed to language when the interviewer explicitly asked about its use, as the extracts below show.

I: Ngizwa bathi lama-tasks lawo abaniphe wona, ama-exercise baniphe wona, bewabhalwe nge-Zulu, English …, awungitshele ukuthi osebenze kanjani ngaleyo ndlela *[I heard that the tasks that they gave you, the exercises that they gave you, were written in IsiZulu, English …, tell me how did you use them]*?

Nhlanhla: I think mem leyo kusinikeza amaphepha o i-two kuya nceda mem, ngoba, like mina, kukhona amanye ama-questions bengingawa-understandi, i-home language iyakhona ukusiza ukuthi ngiwa understande *[I think mem having both papers is helpful mem, because, like myself, there were questions that I did not understand, the home language is able to help me to understand them]*.

I: Hooo…, uyewathi mawubona ungathi awu understandi ngeEnglish, waya ngapha ku home language yakho *[Okay…, you saw that when you did not understand the English version, then you switched to you home language version]*?

Nhlanhla: Yes.

Nhlanhla explicitly explains how using home language was helpful for him. The advantage he mentions of using home language is that if he did not understand questions in the task in English, home language helped him understand them better, which is the same as the one Sipho mentioned. Colbert shares the similar view as Nhlanhla and Sipho. While Nhlanhla specifically pointed to 'understanding of questions', Colbert points to what Sipho has mentioned, 'understanding of English words' and further points to 'understanding of mathematical terms'.

I: Okay, ngizwa bathi ama-tasks wenu bewabhalwe ngesiZulu, I mean Zulu, Venda, or English. Uyibona kanjani leyo ndaba *[I heard that your tasks were written in IsiZulu, I mean Zulu, Venda, or English. What is your view about this]*?

Colbert: Iya yes, I think is a good idea, uyabona, ngoba iyenza ukuthi … iyenze izinto zibe simple, ngoba if singa-understendi ngeEnglish, sicheka ku … our languages, aba simple bese siyakhomphera *[Yes, I think is a good idea, you see, because what it does … it makes things to be simple, because if we do not understand in English, we check in…our languages, they become simple and then we compare]*.

I: Niyenzani, niqala nifunde nge-English *[What do you do, do you read in English first]*?

Colbert: Iya, if … iya, siqala ngokufunda nge-English, but if sibona kunenye i-term we don't understand, siyaya ku-mother tongue yethu bese siya-solver *[Yes, if …yes, we first read in English, but if we see that there is a term that we do not understand, we switch to our mother tongue and then solve]*.

I: So, kusho ukuthi ma uyenze nge-mother tongue yakho uyi-solver, usizwa yini? Se kwenze njani *[So, that means if you do it in your mother tongue and solve it, what helps you? What happens]*?
Colbert: Iya, se ngiyabona, iba simple for thina *[Yes, it makes me to understand, it becomes simple for us]*.

Colbert liked the idea of having both languages in the task. He also mentions that home language helped in understanding of the task. He views home language as a resource as *"it makes things to be simple"*. For him, home languages simplified the English and the mathematics in the task since it made it easy for them to "solve". This means that since the home language version was readily available and accessible, it was easy for them to switch to it if they did not understand some terminology in the English version to check what it means in their home language. The inclusion of the home language in the task was an advantage to this learner. It is interesting to see how Colbert further points to the language of mathematics.

I: So, kusho ukuthi ma uyenze nge-mother tongue yakho uyi-solver, usizwa yini? Se kwenze njani *[So, it means when you do it in your mother tongue and solve it, what helps you? What happens]*?
Colbert: Iya, se ngiyabona, iba simple for thina *[Yes, I understand, it becomes simple for us]*.
I: Okay, kusho ukuthi uyenzani, uya understenda *[Okay, what does it mean, you do understand]*?
Colbert: Iya, because i-maths inamanye ama-terms la angathi a-difficult for us, because asi- mother tongue yethu. That's why sometimes sistragela, uyabona *[Yes, because maths has some terms that are difficult for us, because is not our mother tongue. That is why we struggle, you see]*.

In this extract, Colbert is further explaining the advantage of having home language in the task. Earlier on in the previous extract, he mentioned that home language helped them to understand the English terminology. He is now specifically referring to mathematical terminology, which sometimes makes them to struggle with mathematics. As mentioned in chapter 3, when translating the task to learners' home languages, mathematical technical terms were not translated. What Colbert is referring to in his *"because is not our mother tongue"*, are the mathematical technical terms that were still in English in the home language version of the task. This is interesting because the decision not to translate mathematical terms was influenced by the assumption that if they are translated,

the mathematics may be 'lost' in the translations and may therefore create confusion and lack of understanding of the task, and by the fact that mathematics is increasingly regarded as a language with specialised vocabulary and syntax (Pimm, 1981, 1987, 1991; Pirie, 1998; Herbel-Eisenmann, 2002). It must be noted that mathematical technical terms cannot make sense if used in isolation. They should be used within a particular language in a particular context. For the technical terms to make more sense to learners, their use within the language(s) that learners understand most is significant. In Colbert's view, if mathematical technical terms are used in a task set in English only it becomes difficult for them to make sense of the problem. For him, home language simplified the mathematical language and enabled them to make sense of the problem, which is important for understanding of the task.

Colbert's views above suggest that he interpreted the use of home language(s) as translating everything, mathematical technical terms included. This implies that I need to be explicit with learners about not translating technical mathematical terms when using the strategy.

4.3.2.2. Switching Between the Two Versions of the Mathematical Task

As discussed earlier on, during lessons, when interacting with the task, learners switched between the home language version and the English version of the task. In some questions, learners' responses were written in their home language(s). As the interview progressed, the interviewer asked a probing question wanting to know why some answers were written in the learner's home language (IsiZulu) while other responses were in English.

> I: Kodwa ngibone uma ngibheka amanye amaphepha weSiZulu, kukhona amanye ama-questions babuza nge-English, kodwa ngibone abanye baphendule ngeSiZulu. Uma ubhekile, kwenzwa yini lokho? *[But when I look at some task sheets that are in IsiZulu, there are some questions that were asked in English, but I saw some have answered in IsiZulu. In your view, what lead to that?]*
> Nhlanhla: (Silent, seem not to understand).
> I: Kusho ukuthi, angithi babuze ngeSiZulu nangeEnglish, uthole kwenye indawo niphendule ngeEnglish, kwenye indawo niphendule ngeSiZulu. Uma ubhekile, ku yenziwa yini ukuthi niphendule ngeSiZulu nangeEnglish *[What I mean is, isn't it they asked in IsiZulu and in English, then you find that somewhere you*

answered in English, and somewhere you answered in IsiZulu. In your view, what leads to answering in IsiZulu and in English]?

Nhlanhla: Maybe like uma unga-understandi ngeEnglish, i-answer uyibhala nge language yakho, uma unga-understandi ngeSiZulu, uyibhala ngeEnglish *[Maybe like if you do not understand in English, you write the answer in your home language, if you do not understand in IsiZulu, you write it in English]*.

I: Kwenzekani uma ubhala nge-home language yakho *[What happens when you write it in you language]*?

Nhlanhla: Ukuthi kube easy *[So that it can be easy]*.

I: Hooo…, kuba easy *[Okay…, it becomes easy]*.

Nhlanhla: Yes.

In the extract, the interviewer refers the learner to what they have written in the task sheet in their group, where some answers were written in the English version and some in the IsiZulu version, especially when explanations were required. The interviewer was particularly referring to learners' written responses for questions 4, 9 and 10 in the task sheet. Nhlanhla explains how and why the two languages were used. For Nhlanhla, writing answers in his home language was easier than writing them in English. His "... *uma unga-understendi ngeEnglish, i-answer uyibhala nge language yakho ...*" meaning "*...if you do not understand in English, you write the answer in your home language ...*" suggests that if they find it difficult to phrase their answers in English, they then write it in their home language. In interacting with the mathematical task, the two languages have become resourceful to this learner since he could switch between the two versions of the task as and when he needed to. Sipho also shares the same sentiments.

I: So, ke gore ka mantswe a mang o re maths, ntho e e etsang gore o seka wa e understenda ke gobane ba e kwetse ka English fela, so ha ba ka qala ba e ngwala ka Venda le English o tla e understenda *[So, you mean that what makes you not to understand maths is that it is written in English only, so if they can begin to write it in Tshivenda and English you will understand it]*?

Sipho: Eya mem, ka gobane akere le yona vernac e na le gore le rona e re … e re tšhape mem, so we go to English, then you find gore okay, mo English ke ya understenda, then we can work the sum out mem. *[Yes mem, it is because isn't it vernac is sometimes difficult for us mem, so we go to English, then you find that* okay, *in English I understand, then we can work the sum out mem.]*

I: Hoo…, ke gore le ko vernac ha ona le bothata o kgona go ya le ko English? *[Okay…, which means if you have difficulty with vernac, you are able to switch to English*?*]*

Sipho: Eya, ko English mem *[Yes, to English mem]*.

I: So, e le thusa jwang? *[So, how does it help you?]*

Sipho: Gai-two *[Twice]*, both … both ways.

Sipho also points to the resourcefulness of the use of both languages in the two versions of the task. His response that they sometimes find 'vernac' incomprehensible suggests that there were instances where learners did not understand the home language version of the task and then switched to the English version. The word 'vernac' is an acronym for 'vernacular', which refers to learners' home language(s). He argues that English can be used as a resource for understanding of mathematical tasks when they lack understanding in their home language. In his view, the use of both languages can be resourceful as it helps them in *"both ways"*. This means that the using of the two languages enabled them to switch between the two if there was limited understanding in either of them. Sipho and Nhlanhla's views are an indication of what it means to be multilingual. Multilingualism is not a sum of two or more monolinguals. It is the proficiency "in more than one language" (Moschkovich, 2002:6) or the ability "to use two or more languages" not only for speaking, but also for listening, reading and writing (Setati, 1998:40). The unique capability of these learners lies in the fact that they can draw on multiple languages at the same time.

While Colbert, Sipho and Nhlanhla explicitly explained that having their home languages was helpful during lessons, the use of home language(s) was not so much of an issue for Sindiswa.

I: So, ha o e shebile wena lesson e, ka gobane e ne e sa tshwane le ya mo bukeng, ke eng gape o e boneng okare e ne e le different *[So, what do you think, because the lesson was not the same as in the textbook, what else seemed to be different]*? What is that different from what you have learnt?
Sindiswa: Nothing else was different.
I: Nothing else was different?
Sindiswa: Yes.
I: Ok. Er … I understand that er … the tasks that were given were written in both your home language and English. How did you do the tasks?
Sindiswa: It was fine. It was just the same. It was the same as doing it in English, because I understand both languages.
I: Oh, you understand both languages?
Sindiswa: Yes.
I: So, you mean whether it was written in English or home language …
Sindiswa: (Interjecting) It was the same.

For Sindiswa, interacting with the task set in multiple languages was not different from interacting with the task set in English only as she is fluent in both languages (English and Setswana), which is a strength that a multilingual possesses. As mentioned earlier on, the only different thing that she mentioned about the strategy used in this study was the nature of the mathematical task used. What is interesting is that when Sindiswa is asked what else was different about the lessons she did not mention at all the fact that home language(s) were used.

It is evident from the learners' views that the use of their home language(s) was useful for them. Due to the deliberate use of the learners' home languages the learners were able at any given time to switch to either the home language version or the English version of the task and had access to clearer information, as their responses above suggest. Furthermore, the learners' responses highlight the significance of the kind of the mathematical task used to support the development of their mathematical proficiency. In their view, the nature of the task, that is the cognitive level, the languages used to present the task and the context used in the task has made the mathematics more accessible and interesting. This in turn encouraged learner participation.

4.3.3. Learner Participation

When the interviewer asked learners to give their views about the new teaching strategy and whether it has made any difference or whether it will work in their class, learners stressed the fact that it works because it encouraged learner-participation.

> I: uMr Molefe ungitshele ukuthi kule vike beka fundisa completely different, ubona ukuthi izo …iyasebenza le ndlela ayisebenzisa manje *[Mr Molefe told me that this week he was teaching completely different, do you think it will… does the approach he uses now work]*?
> Nhlanhla: Yes mem, I think iyasebenza, ngoba ama-learners amaningi, maybe like, uma ungasebenzise ama-home language wabo, abaphathisipheiti kakhulu. Mabanikezwa ama-home language abo, I think bazokhona ukuphathisipheita *[Yes mem, I think it works, because most learners, maybe like, if you do not use their home languages, they do not participate that much. If they are given their home languages, I think they will be able to participate]*.

In Nhlanhla's view, using learners' home languages encouraged most learners to participate in class. He does not say that if learners' home languages are not used, they will not participate at all, but he says there will be limited participation. What is interesting is that he does not attribute participation or non-participation to the nature of the task used, as the extract below shows.

> I: Okay. Why ubona ungathi uma basebenzisa ama-home language abo bazo phathisipheitha? Why bangaphathisipheiti ngeEnglish *[Okay. Why do you think if they use their home languages, they will participate? Why don't they participate when using English]*?
>
> Nhlanhla: I think mem, English inokuba i-problem ngoba nami eish … hae … inokunginikeza i-problem, uthole ukuthi, maybe kukhona igama ongali-understendi, bese ugcina ubhale izinto ezi-wrong. Manje mangabe uzo yenza nge-home language yakho, igama ongali-understendi uzolibheka nge-home language yakho bese ugcina wenza izinto ezi-right *[I think mem, English is sometimes problematic because even myself eish,…hae…it sometimes gives me a problem, you find that, maybe there is a word that you do not understand, then you end up writing wrong things. If now you do it in your home language, you will check the word that you do not understand in your home language then you will ultimately do the right things]*.

Nhlanhla mentions limited fluency in English as a source for limited participation by learners. He again points to lack of understanding of some English words that causes them to write incorrect answers. He further sees their home languages as a resource that can make a difference in understanding of the task. His response that *"... you find that, maybe there is a word that you do not understand, then you end up writing wrong things"* suggests that misinterpretation of a single English word or phrase in the task may lead to learners giving incorrect answers. Therefore, for fear of giving incorrect answers and maybe embarrassing themselves, learners' participation becomes limited. What this means is that for Nhlanhla, for learners to participate fully in class, they must first understand the mathematical task, and the home languages will be helpful in that regard as it is useful in making sense of the problem.

When responding to the same question, Colbert also mentioned 'participation by most learners' as reason why he thought that the strategy worked.

> Colbert: Iya *[Yes]*, it works a lot.

I: Yini into eyenza ukuthi isebenze? Yini into eyenza ukuthi ubone ungathi iyasebenza *[What makes it work? What makes you think it works]*, 'it works a lot'?
Colbert: Because most of us we are … be baphathisipheita *[Because most of us we are ... they were participating]*.
I: Hoooo…, be-niphathisipheitha *[Okay, they were participating]*?
Colbert: The whole class, I think be-iphathisipheitha *[The whole class, I think they were participating]*.
I: Hoooo….
Colbert: But before beyiyenza ukuthi like, beyi … bebabona nje i-class, kukuthishwa maybe four learners uyabona others … (Inaudible) *[But before it made that like, it was... they would just notice the class, during teaching maybe four learners you see*, others … (Inaudible)].

What we see in the extract is Colbert bringing in his previous experience of and knowledge about learners in his class where learner participation was limited, and compares it with what he experienced during the implementation of the new strategy. It is very interesting to see what Colbert thinks is the reason why only few learners participated in their previous lessons.

I: Ma ubhekile laba abayifour, why be-baphathisipheitha laba abanye banga phathisipheithi *[What do you think why this four was participating and others did not]*?
Colbert: I think because uyabona, bona maybe ba-understenda better than us uyabona *[I think because you see, maybe they understand better than us you see]*.
I: Okay.
Colbert: Thina besinga-understendi, still if bebasifundisa, besinga-understendi fast like laba- abanye, uyabona *[We did not understand, even when we were taught, we did not understand as fast as they did, you see]*.
I: Iya. So, manje ukuthi uma-ayenza this new approach … *[Yes. So, now when you use* this new approach …]?
Colbert: (Interjecting) Sibe sonke si-pullup our socks, uyabona *[Then we all pull-up our socks, you see]*.
I: Au *[Really]*!
Colbert: Because it was good.

Colbert does not explicitly point to the use of English only as the reason for limited learner participation in their previous lessons, but to the understanding of mathematics by few learners. His "*We did not understand, even when we were taught, we did not understand as fast as they did, you see"*, suggests that the four learners mentioned in the extract were generally mathematically strong and/or were fluent in LoLT, and whether using English or home language(s), they would still participate. The use of home

language(s) and changing the type or nature of the mathematical tasks used made a difference for Colbert.

The other learner who liked the new teaching approach was Sipho, all because learners were participating.

> Sipho: Eya! E sebediste gagolo mem *[Yes! It worked a lot mem]*.
> I: Ehe *[Really]*?
> Sipho: Because kaofela digroup they were participating, wa utlwisisa mem. Le bane ba sa phathisipheiti ko klaseng, ne setse ba phathisipheita. Nna ke maketse gore 'he banna, mothaka o kajeko ke ena oe arabang so maths' *[Because all the groups were participating, do you understand mem. Even those who used not to participate in class were now participating. I was surprised that 'oh man, this guy today is the one who answers so much in maths']* (Clicking fingers).
> I: Ka nnete *[Really]*?
> Sipho: Yes! Yes mem.
> I: Ao, that sounds nice.
> Sipho: Yes mem!
> I: Eya *[Yes]*, what else do you wanna tell me about the approach? Tell me more.
> Sipho: Er … the approach mem, er … ke gore, yona e good. Is good because ba bangata this time ba ithutile dilo tse ngata ka … ka … ka … maths, wa bona *[Er ... the approach mem, is that, it is good. It is good because this time most of us have learnt a lot about… maths, you see]*.
> I: Eya *[Yes]*.
> Sipho: And le gore nna ke thabile gagolo gore ke bone some of my friends, le bona baba matured ka maths, yes mem *[And I am vey happy to see that some of my friends are also becoming mathematically matured, yes mem]*.

Sipho was one of the most passionate about this new strategy. According to Sipho, the manner that the teacher used home language(s) encouraged more learners to participate productively. Unlike Nhlanhla and Colbert, Sipho points to participation of all groups, rather than to participation of some learners, to justify his view that the strategy worked. His comments suggest that he was very excited to see some of his friends who had limited motivation and participation in mathematics calling for the teacher's attention during the lessons. For Sipho, there was some positive change that was brought by the strategy in their class because effective mathematical learning has taken place.

The above extracts from the learners' interview have shown some interesting views. In some questions, learners had similar views and very few were contrasting. While Sindiswa and Colbert did not seem to be indicating that they would like the same strategy

to be used in future, Nhlanhla indicated that the new way of doing the mathematical tasks should be kept. Sipho mentioned that if the teacher can begin to use the strategy in future their problems with mathematics would be minimised. Sipho was the only learner who pointed to the use of home language(s) as something different about the strategy at the initial stages of the interview while other learners pointed to the use of home language(s) when they were explicitly asked about it. While Colbert, Nhlanhla and Sindiswa also pointed to the context used in the task, Sipho was the only one who said nothing about the nature of the task but mentioned the advantages of using home language(s) in the way they were used by the teacher. All learners interviewed, except Sindiswa, saw value in having both languages in the task. Both languages, as these learners suggested, are resourceful because they (learners) were able to switch between the two versions of the task and that the inclusion of their home languages encouraged learner participation. The extracts have also shown that Sindiswa was the only learner who focused mainly on the nature of the task used by pointing to the 'language' of the task that was different from the type of 'language' used in mathematics textbooks. For her the inclusion of the home language(s) version was a non-issue.

4.4. Conclusion

In this chapter, a detailed data analysis and research findings were presented**.** Data analysed were derived from video recordings of lessons and individual learner interviews that were transcribed. Lesson transcripts were then coded using sub-categories as used in Langa (2006). The categories used to analyse and interpret data collected were derived from Kilpatrick *et al*'s (2001) strands of mathematical proficiency. The chapter presented the frequency of the use of multiple languages by learners and I the teacher, and how those languages were used, the prevalence, and the frequency thereof, of the strands of mathematical proficiency and the language associated with each strand in each lesson during learner-learner interaction or teacher-learner interaction when interacting with the mathematical task. Finally, analysis and interpretation of learners' responses and reflections on the new strategy used, that is, the deliberate use of their home language(s)

in addition to English and using a mathematically challenging task set in multiple languages for teaching and learning, were presented in this chapter.

In the next and final chapter, an overview of research findings and analysis is presented, discussed and concluded.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

5.1. Introduction

The purpose of this study was to investigate how multiple languages could be used to support the development of learners' proficiency in mathematics. As indicated in chapter 1, this action research was guided by the following questions:

- How can the learners' home language(s) be used to support the development of learners' proficiency in mathematics?
- To what extent can tasks set in multiple languages support the development of learners' proficiency in mathematics?
- To what extent can learners' interactions with the tasks in multiple languages support the development of learners' proficiency in mathematics?

The aim was to research my own practice in order to transform it, through using a strategy in which I deliberately use the learners' home languages for teaching and learning in my class. The strategy had two main characteristics: first, a well-selected mathematical task given to learners in multiple languages was used as an instructional tool instead of using it as an assessment tool; second, the deliberate use of the learners' home language(s) in addition to English, which is the LoLT during teaching and learning.

The use of learners' home language(s) was deliberate in the sense that it was planned and used in a strategic and proactive manner. Learners were encouraged to use their home language(s) during interactions. The study was conducted in Soweto, a township south-west of Johannesburg, in a Grade 11 multilingual mathematics classroom that I teach.

In this chapter, an overview of the research findings and analysis is discussed. Since research questions mentioned in chapter 1 were not dealt with individually, but

holistically in analysis of results, as indicated in chapter 4, the following headings are used to guide the discussion:

- Use of languages
- Prevalence and frequency of strands of mathematical proficiency
- Learners' reflections on the new approach (nature of the task used and use of home language(s))

5.2. Use of Languages

The findings further reveal that the use of English by learners and I dominated across the four lessons, even though the use of learners' home language(s) was deliberate and encouraged. This is not surprising because the LoLT in the school is English and the learners in this study are used to being taught mathematics in English, and until now the use of their home languages, as in other studies (Khisty, 1995; Moschovich, 1999, 2002; Setati and Adler, 2000) cited in Setati *et al.* (2007), was through code-switching. It was for the first time that the learners experienced a situation where their home languages were used in written tasks and its use in oral conversations encouraged. The analysis in Setati's paper presented at the 15th Annual Conference of the Southern African Association for Research in Mathematics, Science and Technology Education held in Mozambique, January 2007, shows the dominance of English in multilingual classrooms and that the learners and teachers who prefer English as LoLT in mathematics classrooms are informed by the political nature of language - the fact that English in South Africa is generally viewed as the language of power, the vehicle to be used to access education, careers, jobs, etc. I therefore assume that the dominance of the use of English by both the teacher and learners in this study might have also been influenced by this general view and by English being the LoLT in the school.

From Vygotsky's theory of socio-cultural development, a teacher as a knowledgeable other is considered to be playing an important role as a learning mediator (e.g. Scott, 1998; Wertsch, 1985; Vygotsky, 1979; Gorgorio and Planas, 2001) using language as a mediating tool (Berger, 1998; Ginsberg, 1985; Setati, 2005; Jaworski and Despina, 1997;

Brodie, 1996). The findings of this study show that I used languages (both English and learners home languages) most frequently for mediating learning by probing or questioning learners, especially when a particular group, individual learners or the whole class needed some assistance. The findings further show that the probing or questioning of learners was done mostly in English in order to assess, stimulate, provoke, encourage and motivate them when I either evaluated, challenged or reinforced their capacity to: understand mathematical concepts, ideas, operations and relations; use various strategies in order to formulate, represent and solve mathematical problems and identify a more suitable strategy for a given mathematical problem; perform procedures flexibly, accurately and efficiently; and justify mathematical ideas and explain how the solution to a specific mathematical problem was obtained. It is therefore evident from the findings of the study that the use of multiple languages, and the manner in which they were used contributed to the development of learners' proficiency in mathematics.

5.2.1. Use of Learners' Home Languages

What is also shown by the findings of the study is how the learners' home languages were used. While English was generally dominant, the findings indicate that the learners' home languages were resourceful to both the teacher and the learners. For example, during group discussions (i.e. during learner-learner interaction), when learners were interacting with the mathematical task in their groups, the use of the their home language(s) dominated where they either questioned or probed each other's understanding of the mathematical task, or responding to questions and explaining to each other. When learners found 'the statement of the problem' or a particular question in the English version of the task to be incomprehensible, they would switch to their home language version. The findings of the study indicate that the availability and accessibility of the learners' home language(s) version of the task gave learners an opportunity to draw on it as and when they needed to and to have a better understanding if they found that the English version was not that helpful. While most research and literature has argued for the use of the learners' home languages as a resource for teaching and learning in multilingual mathematics classrooms (Adler, 2001; Moschkovich, 1996, 1999, 2002;

Setati, 2005; Zevenbergen 2000), none has argued for the use of or rather used mathematical tasks set in multiple languages as used in this study.

Recent research in mathematics education shows that most mathematics teachers in multilingual classrooms draw on learners' home languages through code-switching (e.g. Setati, 1998; Adler, 2001, Moschkovich, 1996) which sometimes creates dilemmas for teachers (not knowing when and when not to code switch), and through other strategies like using several expressions for the same concept, using prompts for clarification and revoicing learners' responses (Moschkovich, 1999). While previous research shows that the learners' home languages is normally used by the teacher as a resource in the form of code-switching, this manner of using the learners' home languages is "spontaneous and reactive" (Setati *et al.*, 2007), in this study the strategy I used goes beyond code-switching since the learners' home languages are used deliberately and proactively as a mediating agent. Probing questions, prompts and revoicing using learners' home languages deliberately, as the findings show, were used as a 'scaffold', a temporary support to stimulate learners' thinking, to supporting learners' participation in a mathematical discussion (Moschkovich, 1999), and to assist their performance of the task, therefore supporting the development of their proficiency in mathematics.

5.3. Prevalence and Frequency of Strands of Mathematical Proficiency

As discussed in chapter 3, Kilpatrick *et al*'s (2001) interwoven and interdependent strands of mathematical proficiency were used to explore whether and how the use of multiple languages contributed to the development of learners' mathematical proficiency. The findings of this study show that all the five strands prevailed across all lessons, except productive disposition, which was only attended to in the last lesson, and was the least displayed by learners. In Kilpatrick *et al*'s (2001) view, learners can only be proficient in productive disposition once they are proficient in the other four strands of mathematical proficiency, hence its prevalence in the last lesson. What the findings also show is that conceptual understanding was dominant across all lessons as compared to other strands and was most frequently displayed (DCU) in English. This suggests that

most of the interactions were conceptual. In my view, supporting the development of the learners' proficiency in conceptual understanding was critical since understanding of mathematical concepts in the 'statement of the problem' and in the related questions in the mathematical task used was crucial in solving the task successfully. As Gorgorio and Planas (2001) argue, it only takes a single word to obstruct a learner's process of thinking. It was therefore important that learners understand the mathematical concepts, quantities, ideas and operations involved in the 'statement of the problem' or in the related questions, and the relationship between them so that they could develop strategies and procedures for solving the problem (Kilpatrick *et al.*, 2001), as the findings of this study show.

The use of learners' home languages to assist them with the comprehension of concepts is not new. In studies conducted in South Africa and elsewhere (e.g. Moschkovich, 1999; Setati, 1998; Adler, 2001), teachers in mathematics classrooms were observed using the learners' home languages, through code-switching, to introduce learners to mathematical concepts and terms, to facilitate learners' understanding of concepts and when introducing a new lesson to ensure that learners understand a new section of work. In contrast, Setati (2005) found that in the primary multilingual mathematics classroom that she observed, where tasks set in English only were used, procedural discourse dominated. In this study, procedural discourse is found to be second in terms of dominance and was displayed (DPF) mostly during lesson 1 and lesson 2. This is different from Setati's (2005) finding and I argue that the dominance of conceptual understanding in this study is largely due to the deliberate use of the learners' home language where the tasks were presented in both English and the languages that learners understand.

5.4. Learners' Reflections on the Strategy

As discussed in previous chapter, after the last lesson in which I implemented the strategy, reflective individual learner interviews were conducted and later analysed. The objective of analysing the learner interviews, as indicated in chapter 4, was to identify learners' views, focusing on the two main changes made, the nature of the mathematical

task used in this study, and the deliberate use of multiple languages. The findings of this study show that all learners interviewed consider the four lessons conducted during this study as being different from their normal (daily) mathematics lessons and they generally gave an indication that they liked the new strategy. What learners pointed to is the nature of the task used in the study, the resourcefulness of multiple languages when interacting with the task and learner participation during lessons. This is discussed in the sub-sections below.

5.4.1. Nature of the Task

Findings of the study show that when learners were reflecting on the strategy, language was not pointed to as the major thing that was different in their lessons. Only one learner pointed to language at the initial stages of the interview. What the other learners found to be the major thing that was different about the lessons was the mathematical task. When the interviewer asked them an open question about what occurred in their class, three out of four learners interviewed pointed to the mathematical task they were working on. The assumption was that learners would point to the use of their home language(s) as being a major difference in the lessons. However, what the findings of this study show are the learners' focus was on the nature of the task, particularly the context used (cost of electricity). Other things that were prominent about the nature of the task and of value for learners are the 'language' of the task which is different from the one used in mathematics textbooks (e.g. 'simplify', 'find the formula'), the type of questions asked in the task and the way they were phrased which differs from the type of questions asked in textbooks, the type of calculations in the task (calculations involving money) which enables them to calculate monthly electricity bill in their daily life and are not the same as those that they (learners) usually deal with in mathematics, and the clarity that the task provides about a real life situation that was initially never understood, that is, how the two different electricity costing structures function and are used (a comparison between a prepaid system and a metered system).

The findings of this study therefore suggest that the nature of the task has made the mathematics of the task more interesting for learners and they now realise the importance of and see sense in mathematics in solving real-world problems (Kilpatrick *et al.*, 2001).

5.4.2. Use of Home Language(s)

The findings show that the use of home language(s) was the most prominent thing that Sipho noticed, as he pointed to language when responding to the interviewer's open question of what happened in their class. For the other three learners, Nhlanhla, Sindiswa and Colbert, the use of their home language(s) was not central as they only pointed to it when the interviewer explicitly asked about it.

It is evident from the findings that learners found the use of their home language(s) unproblematic. They did not experience it as a barrier or a constraint as their responses suggest that they did not focus on it but on the mathematics of the task. The translated task and the availability of learners' home language(s) for teaching and learning, from the learners' reflections, was advantageous since they used them as a useful resource for comprehension as it made information more clearer, that is, to help them have a better understanding of what they are required to do in the task. In the learners' views, their home languages 'simplified' the English version of the task, the 'language' of the task and the mathematics language, and as a result, they were able to attend to the mathematics of the task.

The findings further show that what learners liked most about the strategy is the fact that there was more learner-participation during learning and teaching. What is interesting is that they point to the use of home language(s) as having encouraged more learners to participate productively in class. Their reflections show that the manner in which the teacher used learners' home language(s) was effective since in their view, learners who initially had limited motivation and participation in mathematics were calling for the teacher's attention during the lessons. This deliberate use of learners' home languages for teaching and learning facilitated task-focused learner-participation.

5.5. Challenges

The strategy used in this study was not without challenges. In the sub-sections that follow, challenges which go with the strategy used in the study and suggested solutions for such challenges are discussed.

5.5.1. Task Selection

Literature suggests that well-selected tasks can provide learners with an opportunity to gain mathematical power, that is, to be mathematically competent (Stein *et al.*, 2000). The analysis in this study indicates that the nature of the mathematical task used plays an important role in supporting the development of learners' proficiency in mathematics. However, finding real world, interesting and challenging tasks is not an easy and quick exercise. Researchers and practitioners should not expect to find such tasks only from mathematics textbooks. As indicated in chapter 3, the task used in this study was selected from Malati Draft Materials (30-04-2005). It is therefore important for one to think deeply about the nature of the tasks that one would prefer to use in one's class in supporting the development of learners' proficiency in mathematics. Otherwise, the desired outcome may not be realised.

5.5.2. The Deliberate Use of Learners' Home language(s)

While using learners' home language(s) deliberately was helpful as the findings of this study show, it is definitely labour intensive. First, the tasks used in class have to be translated into the different home languages and translation, in and of itself, is complex. The translation of tasks is a process with quite a number of steps that should be done by different people with different but complementary expertise. As explained in chapter 3, the selected task was in English (LoLT) and for purposes of accuracy, was translated, in the first level, into the learners' home languages by colleagues who teach mathematics and are first language speakers of those particular languages so that the mathematics in the task remained unaltered. I did the Setswana translation, since my first language is

Setswana. Since mathematics teachers are not necessarily linguists, in the second level of translation, the translated tasks were given to language teachers who are experts in the respective languages and who teach those languages at first language level to check the translations and make language corrections where necessary. In the third and last level of translation, the translated tasks were then given back to mathematics experts who are also speakers of the languages to ensure that the mathematics was not 'lost' during language corrections. It should be realised that if these steps are not followed correctly, problems may arise. For example, in the findings of a similar study, where the teacher was trying the same strategy of deliberately using learners' home language(s) to teach Grade 11 learners linear programming, Nkambule and Setati's (2007) analysis revealed that the mathematical symbolic representations 'x' and 'y' which were also translated into IsiZulu as 'esingazazi' and 'ezingadalulwanga' meaning 'unknown' and 'anonymous' respectively, caused confusion for learners as they were unable to relate the symbols to their translated descriptive meanings.

This shows the complexity that goes with task translation. In this study, mathematical symbolic representations and technical words (e.g. formula, variables, graph, and units) were not translated. However, it emerged during individual learner interviews that the use of learners' home language(s) was interpreted as translating everything while some mathematical technical terms in the translated version of the task were in English whereas the context was in the home languages. In my view, mathematical technical terms in their own do not make sense or the understanding. It was therefore significant for me that such terms were not translated but only the context, because my assumption was that they (technical terms) would make more sense and understood better if the context is in the learners' home languages. The implications then is that I need to be explicit with learners about not translating technical mathematical words, terms and symbolic representations so that they can know and understand from the beginning that the use of their home languages does not necessarily mean translating everything.

The second challenge is the manner in which tasks are implemented during lessons. The way the two versions of the task were implemented in the similar study, as revealed by

Nkambule and Setati's (2007) analysis, "did not encourage learners to draw on their multiple language skills" (p.75) and the learners' home language(s) was not resourceful. In this study, learners were given two versions of the task simultaneously, which enabled them to draw on both languages as and when the need aroused. This manner of using multiple languages encourages learners to switch between the two versions of the task and use their home languages as a resource.

5.5.3. Time Constraint

One important factor that needs to be considered when implementing the strategy is the length of time needed for selecting relevant tasks, translation process, planning of lessons and the implementation stages. As indicated earlier on, it is clear that it will take a great amount of time to search for high cognitive demand tasks that are interesting and challenging and to find mathematics teachers and language teachers who can translate tasks. While there are mathematics textbooks that are already translated in other languages at primary school level, at the moment mathematics textbooks translated in learners' home languages for secondary school level are not yet available. Therefore, the problem of task translation can be dealt with by getting publishers on board to have translated material readily available for teachers teaching in multilingual mathematics classrooms at secondary school level. This would make it easier for the selection of tasks by teachers and less time would be spent on the planning stage.

5.6. Implications for Research and Teaching

While this was a small-scale study done in one classroom, of which one may argue that its findings may not be generalised to other multilingual mathematical classrooms, it provides one with some ideas of transformations that one can make in one's classroom in order to assist learners to gain mathematical power. Other practitioners can learn from this study as it provides an important contribution for those who teach in multilingual classrooms and may encourage practitioners to research their own practice. Findings of this study provides teachers in South Africa, particularly those who are multilingual, with

an opportunity to try the strategy in order to use their multilingual abilities and skills in their mathematics classrooms to assist learners to access mathematics and that may lead to them being mathematically proficient.

One critical question that could be asked is whether the strategy would work in a multilingual classroom if the teacher were not multilingual. In my view, in a multilingual setting similar to the one in this study, where most learners can speak more that three or even four languages, the strategy can still work even if the teacher is not multilingual. During interactions, the teacher can use more capable learners to translate other learners' responses and questions to the teacher or the teacher's utterances to group members or to the whole class.

The availability of the findings of this research report will ensure that policy-makers, curriculum-developers and publishers are challenged not only to encourage multilingualism in South African classrooms, but also to ensure its full implementation by providing human resource and skills, translated material and support. Researchers whose main focus is in the learning and teaching of mathematics in multilingual classrooms are encouraged to take this study further by using a bigger sample where tasks in multiple languages are used for teaching and learning. It would be interesting to see findings of such studies because they may give mathematics teachers in multilingual classrooms a clear picture of whether the strategy is effective or not.

While the strategy worked well in its first implementation in my class, it should be realised that no one strategy can work for all kinds of multilingual classrooms and all learners. Different strategies are suitable for different classroom settings, contexts, situations, learning styles and abilities, content knowledge and learners' backgrounds (Hayes *et al.*, 2006 cited in Setati *et al.*, 2007). Therefore, researchers or practitioners who would like to do a further study or implement this strategy in their classes should first consider the context of my school and classroom in which I implemented the strategy as well as the nature of the task I used, all of which contributed to whatever success emerged from this implementation.

5.7. Conclusion

The findings of this study explicitly show the resourcefulness of language in the teaching and learning of mathematics. While research in mathematics and language shows that code-switching is used as one of the strategies by mathematics teachers to mediate learning in multilingual classrooms (Adler, 2001; Setati, 1998, 2002; Moschkovich, 1999), findings from this study show that the deliberate use of learners' home languages in addition to English, that is giving learners mathematics tasks set in multiple languages and encouraging them to use their home languages during teaching and learning, can be resourceful in facilitating the development of learners' proficiency in mathematics. What is shown by the findings is that Kilpatrick *et al*'s (2001) five strands of mathematical proficiency prevailed across all four lessons and English dominating in all lessons. The strand that prevailed most frequently in the four lessons is conceptual understanding, suggesting that interactions during lessons were mostly conceptual.

Even though the results of the study show that the use of English dominated, learners' reflections on the strategy indicate that using the learners' home languages in presentation of the tasks supported the learners in the comprehension of the mathematical task, and encouraged learners to participate more effectively during lessons. The analysis has further shown that multiple languages were resourceful during teaching and learning, that is, learners had an opportunity to draw on them when necessary (e.g. switch between the two versions of the task) and they (multiple languages) did not disturb their focus on mathematics. What I see about the strategy is that it increased learners' participation during teaching and learning and they had an opportunity to use a high cognitive demand task.

In my view, what contributed to the success of the strategy was the nature of the task especially its relevant context, which was interesting and familiar to the learners. This is a view shared by Gorgorio and Planas (2001) since they suggest that when teachers use mathematical activities that are situated in contexts near learners' interests and realities, that could enable second language learners "to communicate and engage in collaborative

work" (p.26). In addition, the learners' home languages were not functioning as an obstacle or an impediment. As Cummins (2000) asserts, for 'language' and content to be acquired most successfully, learners in multilingual settings must be cognitively challenged during teaching and learning, but at the same time be provided with linguistic and contextual resources that would serve as 'scaffolds' for successful task completion. This means that mathematical activities or tasks given to learners must be cognitively demanding but linguistically supported for active participation in mathematical discussions that may lead to successful mathematics learning. Therefore, the use of the high-level cognitive demand mathematical task set in multiple languages and the inclusion of learners' home language(s) in addition to English (LoLT) in this study, were key components in supporting the development of learners' proficiency in mathematics. Finally, while this kind of study goes with many challenges, doing it was worthwhile as it provides one with lenses through which imperfections in one's practice can be improved on if not corrected.

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APPENDIX A: HOME LANGUAGE VERSIONS OF THE MATHEMATICAL TASK

SETSWANA

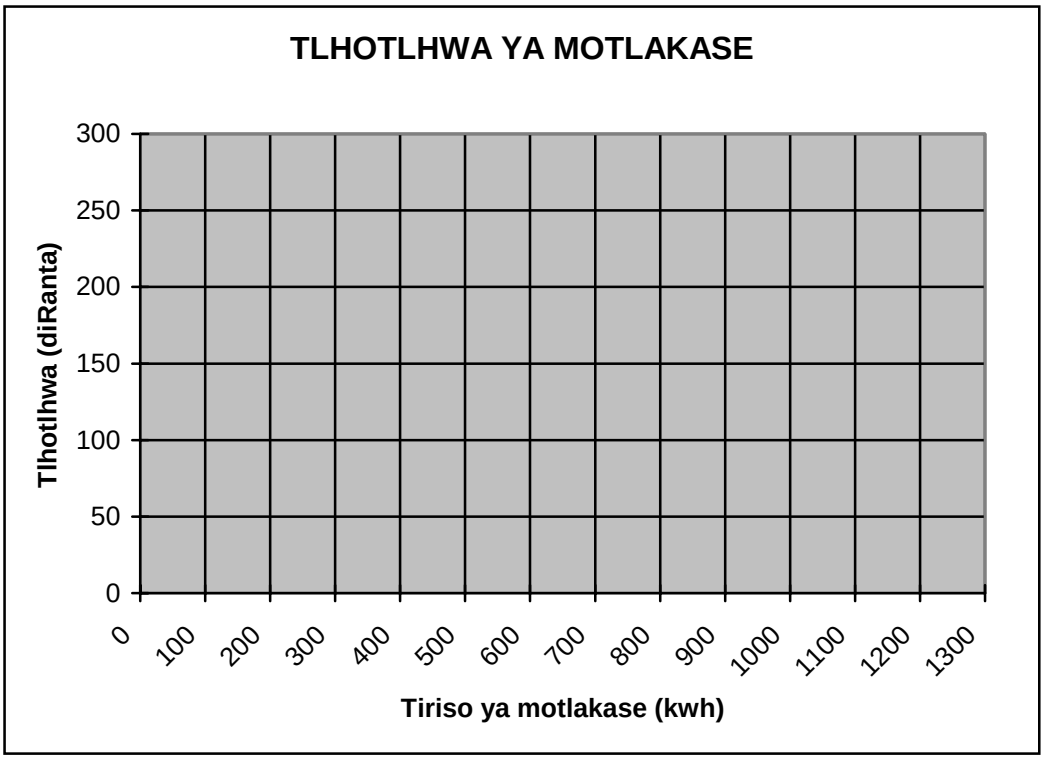
TLHOTLHWA YA MOTLAKASE

Lefapha la motlakase la Brahm Park le duedisa R40 – 00 ka kgwedi, e leng madi a ditirelo, le duedise gape 20c fa o dirisitse motlakase wa kilowatt-hour (kwh) e le nngwe. Kilowatt-hour ke selekano sa motlakase o o dirisitsweng ka ura ka matla a a sa fetogeng a kilowatt e le nngwe.

1. Go lekanyediwa gore lelapa le dirisa 560 kwh tsa motlakase ka kgwedi. Lekanyetsa gore madi a dituelo tsa motlakase e ka nna bokae ka kgwedi.
2. Batho ba le bararo ba nna mo ntlosetoropong. Dituelo tsa bona tsa motlakase ke R180 – 00 ka kgwedi. Ke dikilowatt-hour di le kae tse ba di dirisang ka kgwedi?
3. Fa e le mariga, tiriso ya motlakase e oketsega ka 20%. Dituelo tsa motlakase tsa lelapa mo (1) fa godimo le tsa ntlosetoropo mo (2), e ka nna bokae ka kgedi?
4. Fa o akanya, koketsego e e dirwa kgotsa e tlholwa ke eng?
5. Neelana ka fomula e e ka e lefapha la motlakase le ka e dirisang go e thusa go balela dituelo tsa motlakase tsa ntlo nngwe le nngwe ka kgwedi. Bolela gore divariable le diuniti tse o di dirisitseng di emetseng.
6. a). Feleletsa lenane le le latelang lele bontshang tlhotlhwa ya motlakase ka go farologana ga tiriso:

Tiriso ya motlakase (kwh)	0	100	200	300	400	500	600	700	800	900
Tlhotlhwa (diRanta)										

b). Thala kerafo mo seteng ya molagare e e fa tlase go bontsha ditlhotlhwa tsa tiriso e e farologaneng ya motlakase e lefapha la motlakase la Brahm Park le e duedisang.



Morago ga kakanyo e e tseneletseng, lefapha la motlakase le ne la tsaya tshwetso ya go fetola mokgwa o ba o dirisang wa go duedisa dituelo tsa motlakase. Le ne la swetsa gore ga le kitla le duedisa R40 – 00, e leng madi a ditirelo mme kilowatt-hour e le nngwe e tla duelwa 25c.

7. Dituelo tse diša tsa motlakase tsa lelapa le tsa ntlosetoropo jaanong e tla nna bokae ka kgwedi?
8. a). Dirisa mokgwa o moša wa dituediso mme o feleletse lenane le le latelang le le bontshang tlhotlhwa ya motlakase ka diRanta ka go farologana ga tiriso:

Tiriso ya motlakase (kwh)	0	100	200	300	400	500	600	700	800	900
Tlhotlhwa (diRanta)										

b). Thala kerafo mo seteng ya molagare e e mo (6b) go bontsha ditlhotlhwa tsa tiriso e e farologaneng ya motlakase fa go dirisiwa mokgwa o moša wa dituediso.

9. Aa mokgwa o moša o, o tswela lelapa le ntlosetoropo mosola? Tlhalosa.
10. Fa badirisi ba motlakase ba ne ba na le tšhono ya go ka itlhopela nngwe ya mekgwa e mebedi e e diritsweng ya dituediso tsa motlakase, o ka baeletsa gore ba tlhope ofeng? Naya tlhaloso e e tlhamaletseng mme o dirise manaane a mo go (6a) le (8a) le dikerafo tse o di thadileng mo (6b) le (8b).

ISIZULU

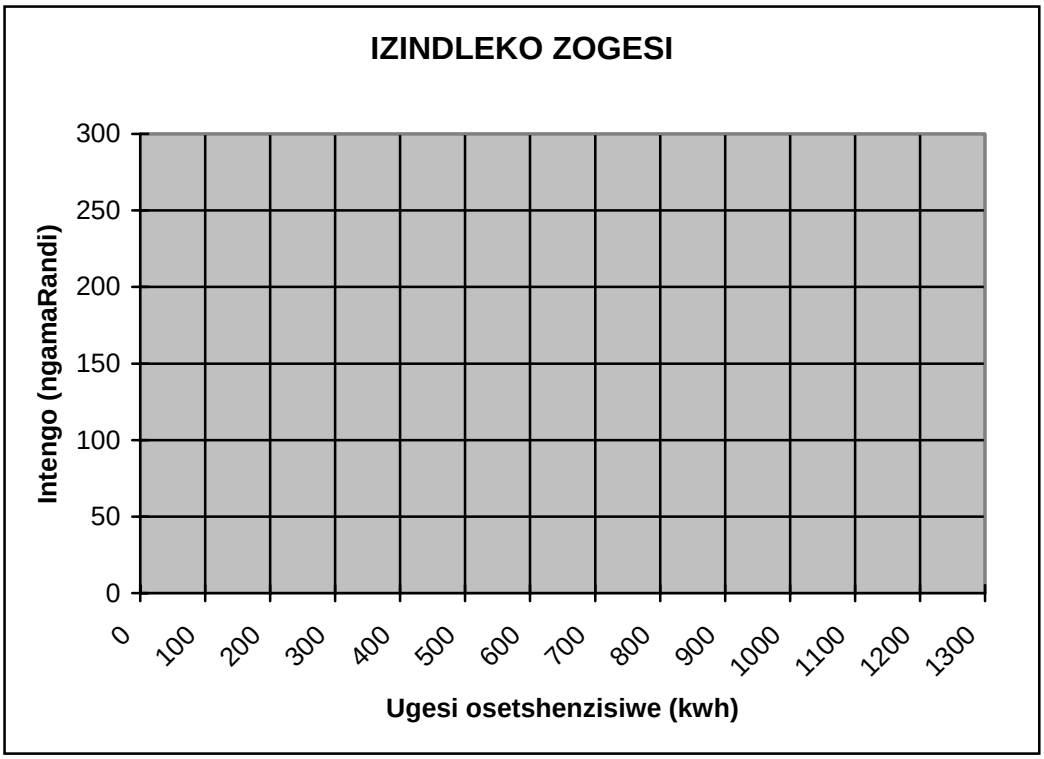
INTENGO ZOGESI

Umnyango woGesi we Brahm Park ukhokhisa u-R40 – 00 ngenyanga wezindleko, bese ukhokhisa u-20c ngaphezulu nge kilowatt-hour (kwh). I-kilowatt-hour inani logesi olusetshenzisiwe ngehora uma amandla angashintshi ekhilowathi elilodwa.

1. Ugesi osetshenziswa emndenini ubalelwa ku-560 kwh ngenyanga. Bala ukuthi lingaba yimalini intengo zogesi emndenini ngenyanga.
2. Abantu abathathu bahlala kwi-townhouse. I-akhawunthi yabo yogesi ngenyanga ingabalelwa ku R180 – 00. Amakhilowathi amangaphi asetshenziswayo ngenyanga?
3. Ebusika ugesi osetshenziswayo ukhuphuka ngo 20%. Ingabe izoba yimalinmi i-akhawnthi ngenyanga yomndeni neye-townhouse ebusika?
4. Ngombono wakho iyini imbangela yalokukhuphuka kogesi ebusika?
5. Nikezela ngefomyula enganceda uMnyango woGesi ukubala intengo zogesi ngenyanga noma iyiphi indlu. Usho kucace wonke ama-variable asetshenzisiwe ukuthi ameleni nama unithi asetshenzisiwe.
6. a). Qedela uhlu (ithebuli) elilandelayo elibonisa ngamaRandi intengo zogesi zenani ezihlukahlukene ezisetshenzisiwe:

Ugesi osetshenzisiwe (kwh)	0	100	200	300	400	500	600	700	800	900
Intengo (ngamaRandi)										

b). Dweba igrafu eqenjini yama eksizi elandelayo, ebonisa intengo zamaunithi ogesi ahlukehlukene ngenani elikhokhiswa uMnyango woGesi weBrahm Park.



Emva kokucabangisisa, uMnyango woGesi unqume ukushintsha uhlelo lwabo lwamanani ezindleko. Banqume ukuthi azisezukhokhwa izindleko zanyanga ezingu R40 – 00, kodwa I-kilowatt-hour isizobiza u-25c.

7. Isizoba yimalini I-akhawthi entsha ngenyanga yomndeni neye townhouse?
8. a). Qedela uhlu (ithebuli) elilandelayo elibonisa ngamaRandi intengo zogesi zenani ezihlukahlukene ezisetshenzisiwe. Usebenzise indlela entsha yokubala amanani:

Ugesi osetshenzisiwe (kwh)	0	100	200	300	400	500	600	700	800	900
Intengo (ngamaRandi)										

b). Dweba igrafu eqenjini eyodwa yama eksizi oyisebenzise kumbuzo (5b), ebonisa intengo zamaunithi ogesi ahlukehlukene ngenani elikhokhiswa uMnyango woGesi weBrahm Park usebenzisa uhlelo olusha lokubala ugesi.

9. Ingabe umndeni ne-townouse bayazuza yini kulolu hlelo olusha lokubala inani logesi? Chaza.
10. Uma abantu aba sebenzisa ugesi bangazukhethela kulezi nhlelo ezimbili zokubala ugesi, iyiphi inhlelo ongayiphakamisa? Chaza impendulo yakho usebenzise amathebuli owaqedelele nama-grafu owadwebile kumbuzo 6(a) no 6(b) kanye no 8(a) no 8(b).

XITSONGA

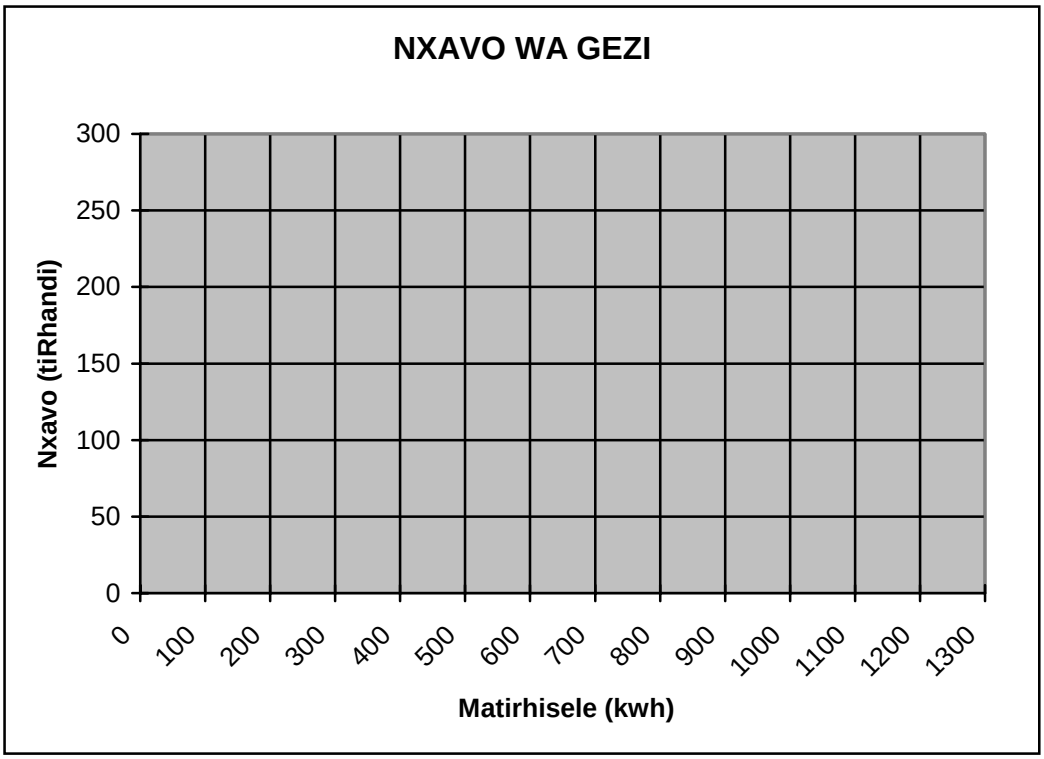
NXABO WA GESI

Ndzawulo ya Gezi ya Brahm Park yi hlawurisa mpimo wo ringana na R40 – 00 hi nh'weti, wu tlhela wu tlhandlekela 20c kilowatt-hour (kwh). Kilowatt-hour I mpimo wa gezi leri tirhisi weke hi awara yi'nwe ku ngari ni ku cinca eka kilowatt yi'nwe.

1. Mpimanyeto wa gezi leri tirhisiweke hi ndyangu hi nh'weti hi 560 kwh. Bvumba leswaku xikweleti xa gezi ra nh'weti xi ta va mali muni?
2. Vanhu vanharhu va tshama eka townhouse. Xikweleti xa gezi xa vona hi nh'weti xi pamanyetiwa R180 – 00. Xana va tirhisa tikilowatt-hour ti ngani hi ntolovelo enhwetini?
3. Hi xixika matirhiselo ya gesi ma gonya hi 20%, xana xikweleti xa nh'weti xa ndyangu lowu vuriwe ke laha henhla eka (1) xi ta ba yini, na xa townhouse?
4. Hi ku ehlekata ka wena xana ku gonya loku ku vangiwe hi yini?
5. Nyika ndlela leyi nga pfunika va ndzawulo wa Gezi ku hlayelela xikweleti xa nh'weti xa ndyangu wihi ni wihi. Kombisa leswi xiyimela ndzhawu xi yimelaka swona ni ti uniti leti tirhisiweke.
6. (a). Hetisa tafula leri kombisaka nxalo wa gezi hi tiRhandi wo hambana ka mtsengo wa gezi leri tirhisiweke:

Gezi leri tirhisiweke (kwh)	0	100	200	300	400	500	600	700	800	900
Nxavo (hi tiRhandi)										

(b). Mpfampfarhuta girafu eka sete ya tiekizisi laha hansi ku komba nxavo wo hambana wa tiuniti ta gezi eka mpimo lowu xavisiwaka hi ndzawulo ya Gezi ya Brahm Park.



Endzhaku ka ku langutisisa, ndzawulo ya Gezi yi boha kungu ra ku cinca xivunbeko xa nxavo. Va ni makungu ya leswaku ku havi na ku hakela hi nh'weti ka R40 – 00, kambe kilowatt-hour yi'nwe yi ta vitana 25c.

7. Xana nxavo wa xikweleti lexintsha hi nh'weti xa ndyangu xi tava malimuni ni xa townhouse.
8. (a). Hetisa tafula leri kombisaka nxalo wa gezi hi tiRhandi ta ku hambana - hambana ka ntsengo wa gezi leri tirhisiweke, ku tirhisiwa xiyimeko lexintshwa xa nxavo:

Gesi leri tirhisiweke (kwh)	0	100	200	300	400	500	600	700	800	900
Nxavo (hi tiRhandi)										

   (b). Mpfampfarhuta girafu eka sete ya tiekizisi ta muhlovo wu'nwe ku funa ni le ka xivutiso 6(b) ku komba nxavo wa gezi tiuniti to hambana, u tirhisa xivumbeko lexintshwa xa nxavo.
9. Xana ku ni ku vuyeleriwa eka vandyangu nile ka lava tshamaka eka townhouse eka xivumbeko lexintshwa xa nxavo? Hlamusela.
10. Loko vanhu lava tirhisaka gezi va ri hava ndlela yi'nwana ya ku hlawula eka leswi swivumbekan leswimbirhi leswintshwa, hi xihi lexi u nga xihlawulaka? Hlamusela nhlamulo ya wena hi ku hetiseka hi ku tirhisa tafula leri u ri hetiseke ni girafu leyi u yi mpfampfarhuteke eka xivutiso 6(a) na 6(b), na 8(a) na 8(b).

TSHIVENDA

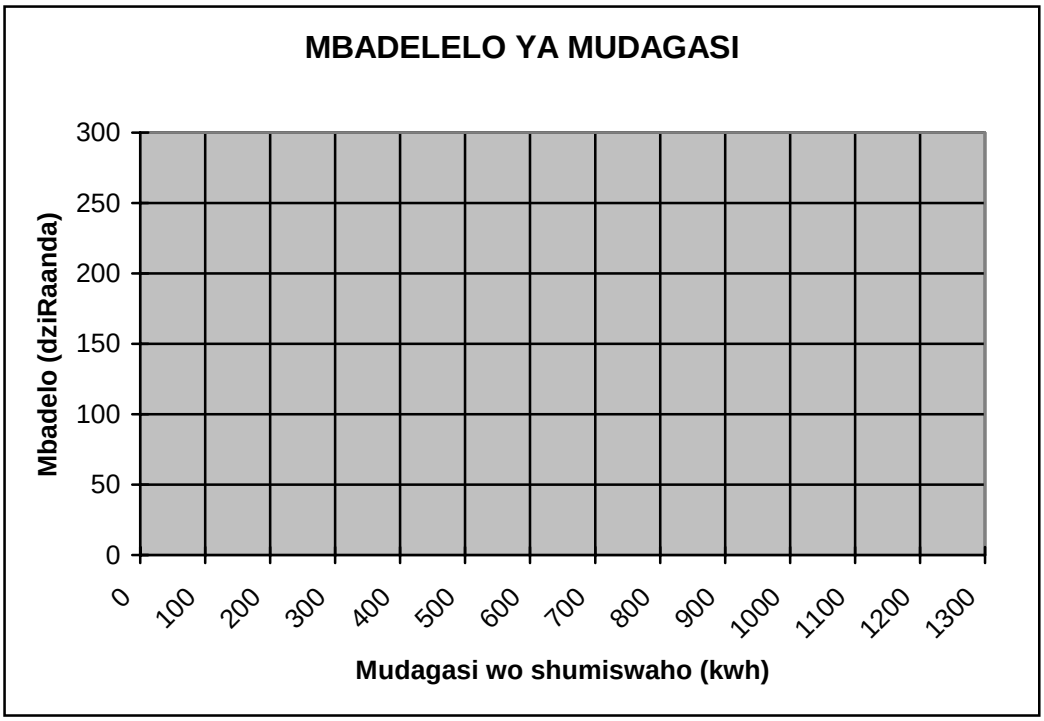
MBADELO YA MUDAGASI

Vhamuhasho wa Mudagasi wa ha vha-Brahm Park vho ta R40 – 00 ya tshumelo, vhadovha vha engedza 20c kha kilowatt-hour (kwh) nthihi. Kilowatt-hour ndi mbadelo ya mudagasi wo shumiswaho kha awara nthihi nga manda a kilowatt nthihi.

1. Ho gaganyiwa uri mudi muthihi nga ńwedzi u shumisa mudagasi une wa lingana 560 kwh. Angenyelani uri ni nga badela tshikolodo tshingafhani nga ńwedzi?
2. Vhathu vhararu vha dzula kha townhouse. Tshikolodo tsha vho tsha ńwedzi tsha mudagasi tshilingana dana na R180 – 00. Vha shumiŝa dzi-kwh nngana nga ńwedzi ńwedzi?
3. Vhuria kushumisele kwavho kwa mudagasi ku a gonya nga 20%. Ni vhona u ngari tshikolodo tsha mudi ni tsha townhouse tsha ńwedzi ndi vhugai?
4. Nga muhumbulo wanu ni vhona u nga tshiitisi ndi tshifhio tsha u gonya ha kushumisele kwa mudagasi?
5. Wanani ndila ya u thusa muhasho wa zwa mudagasi kha u tanganyela zwikolodo zwa zwishumiŝwa zwa mudagasi zwa hayani ińwe na ińwe nga ńwedzi. Bviselani khagala phambano na dzi unithi dzo shumiswaho.
6. (a). Fhedzisani tabulu iyi ire afha fhasi I khou sumbedzaho mbadelo ya mudagasi nga dziranda, zwi tshi fhambana nga mudagasi wo shumiswaho:

Mudagasi wo shumiswaho (kwh)	0	100	200	300	400	500	600	700	800	900
Mbadelo (dziRannda)										

(b). Olani girafu ine ya sumbedza mbadelo ya kushumiŝele kwa mudagasi uya nga he vha muhasho wa mudagasi wa vha Ha-Brahm park vha ta ngaho, no sedza kha girafui tevhelaho:



Nga murahu ha tsedzuluso ya mudagasi yo itwaho nga vha muhasho nga ha ku badelele vho tshentsha. Vho humbula uri hunga si tsha vha na mbadelo ya tshumelo ya ńwedzi ine ya vha R40 – 00, fhedzi kwh ińwe I dura 25c.

7. Tshikolodo tshiswa tsha ńwedzi tsha mudagasi tsha mudi uyu ure na townhouse tshi dura vhugai?
8. (a). Fhedzisani tabulu iyi ire afha fhasi I khou sumbedzaho mbadelo ya mudagasi nga dzirannda, zwo fhambanyiswa nga kushumisele kwa mudagasi hu tshi khou shumiswa kubadelele ukwo kuswa:

Mudagasi wo shumiswaho (kwh)	0	100	200	300	400	500	600	700	800	900
Mbadelo (dziRannda)										

(b). Olani girafu ino fana na ye na ola kha 5(b) ikhou sumbedza kubadelele kwa mudagasi zwi tshi ya nga kushumisele kwa mudagasino lavhelesa kubadelele kuswa.

9. Inwi ni tshi sedza ni vhona unga uyu muta wa hayani na townhouse tshi nga kona u thusalea naa kha ukwo kubadelele kuswa? Talutshedzani.
10. Arali vhathu vha khou shumisàho mudagasi vha tshi khou humbula u nanga kha idzi ndita mbili dza kubadelele. Inwi ni nga vha tutuwedza u nanga ifhio? Talutshedzani phindulo yanu no shuma tafula ye nafhedzisa na girafu ye na ola kha 6(a) na 6(b), na 8(a) na 8(b).

APPENDIX B: THE INTERVIEW TRANSCRIPT

Transcription conventions used

( ) – Learner action

[ ] – English translations

[I – Interviewer; S – Sindiswa; N – Nhlanhla; C – Colbert; Sp – Sipho].

SINDISWA – S

I: Good day Sindiswa.
S: Good day.
I: I just want to find out, which language to you prefer we conduct this interview?
S: English and Tswana.
I: English and Tswana, ok, you don't have a problem. Ok Sindiswa, I understand this week you had visitors, what was happening?
S: Er…, we were learning a lesson in which we can calculate electricity er …. amount … er … the way in which the electricity department can calculate the amount of electricity unit per household.
I: What … what was so special about the lesson? Why do you say you learnt about electricity? Isn't it something that you normally do? What was so special about it?
S: It's a different way of the lesson.
I: How different? What do you mean when you say it is a different way?
S: It does not include those Maths … maths. It is not different, but those words used in Maths didn't occur, didn't occur but we weren't using them.
I: Which words, mantswe a feng, mantswe a feng? *[Which words?]*
S: Er … 'simplifying', 'finding the formulas', 'similarities', …
I: Hoooo …, yana mo textbukung? E ne e sa tshwane le mo textbukung ntho e nne le e etsa? [*Okay…, just like in the textbook? What you did was not like in the textbook?]*
S: Yes.
I: Ya bo 'simplify', 'solve for x', …. *[That of 'simplify', 'solve for x' ...]*
S: Yes.
I: So, ha o e shebile wena lesson e, ka gobane e ne e sa tshwane le ya mo bukeng, ke eng gape o e boneng okare e ne e le different? *[So, what do you think, because the lesson was not the same as in the textbook, what else seemed to be different?]* What is that different from what you have learnt?
S: Nothing else was different.
I: Nothing else was different?
S: Yes.
I: Ok. Er … I understand that er … the tasks that were given were written in both your home language and English. How did you do the tasks?
S: It was fine. It was just the same. It was the same as doing it in English, because I understand both languages.
I: Oh, you understand both languages?
S: Yes.
I: So, you mean whether it was written in English or home language …
S: (Interjecting) It was the same.
I: Alright, and then er… do you like this approach, the way, the manner in which things were taught at all?
S: Yes.
I: What is it that you liked about it?
S: The way the questions were coming, the way the questions were asked, it doesn't … it doesn't … is not the same as those we used in er… textbooks.
I: Ok. So did you manage, o kgonne go di araba? *[So did you manage to answer them?]*
S: Yes.

I: Jwang? *[How?]*
S: (silent).
I: Ke eng ntho e e entseng gore o kgone go di araba? *[What enabled you to answer the questions?]*
S: The calculations, ne di le *[were]* easy. Everything was just easy.
I: So wena, ha go katla motho a re mo go wena o ithutile eng ka this new approach e o e entseng ko klaseng, o tla re o ithutile eng? *[So, if someone can come to your class and ask you what have you learnt about this new approach, what will you say?]*
S: Ke ithutile …er…di …gore nka etsa yang diformula. Ke ithutile ntho kaofela. Any way, ntho tse ke di ithutileng ke ntho tse re di etsang everyday, mara ke gore fela, we didn't approach them ka tsela e ya the first time. *[I have learnt ...er... that how can I write formulae. I have learnt everything. Any way, what I have learnt is what we do everyday, but it is just that we did not approach them the way we did them the first time.]*
I: Ok. Mr Molefe o mpolella gore this week a ne a teacher completely different from matsatsi a mang. Ke eng ntho e o sa e ratang mo that approach?
S: Mo e e ntšha?
I: Eya.
S: It was fine. Haeyo ntho e ke sa e ratang. It was just fine.
I: So, ntho e oe ratileng gagolo ke eng? Ke eng e e etsang gore ore "it was fine"? it can be 'fine', but specifically ke eng e e entseng gore e be … *[So, what did you like most? What made you say "it was fine"? It can be "fine", but specifically what made it to be ...]*

S: (Interrupting) Ke gore, the way ne diquestion di ne di botswa ka teng *[I mean, the way the questions were asked]*, it was easy for the whole … for all of us, for all the students to understand and answer all the questions.
I: Ok. So home language …
S: (Interrupting) The same.
I: Ke ya leboga. O ne o etsa ka language efeng? *[Thank you. Which language version were you using?]*
S: Setswana.
I: Setswana le English?
S: Eya. *[Yes]*

NHLANHLA – N

I: Good afternoon, what's you name?
N: My name is Nhlanhla Zondi
I: Nhlanhla Zondi, ok. What's your home language Nhlanhla?
N: Zulu.
I: Which language do you prefer we conduct this interview?
N: English.
I: Are you comfortable with it?
N: Yes.
I: Ok. I understand the whole of this week you had visitors coming to your class, what was happening? Can you explain.
N: We were learning about how to calculate …er…er… kilowatts of the electricity, how do we … like … how can we calculate them and when … at …, nnga khuluma ngeSiZulu *[may I speak in IsiZulu]*?
I: Eya, o right. O ka bua ka SeZulu. *[Yes, alright. You may speak in IsiZulu]*.
N: Besifunda mem ukuthi ugesi udleka kakhulu nini, yes mem. *[Mem, we were learning about when is electricity consumption more, yes mem]*.
I: Yini into eyenza ukuthi, naba abantu bayasuka nje bazo khuluma ngo-gesi we electricity, kanti anifundi lokho eklasini? *[What make that, people just come and talk about electricity, isn't it that you learn about it in class?]*
N: Hayi, no mem, ku-different. *[No, no mem, it is different]*.
I: Ku-different. Yini into eyenza kube different? *[Is it different? What makes it different?]*

N: Okokuqala mem, ilokhuza, la sidila ngama-calculations awemali, manje ku-maths asisebenzi ngemali. *[Firstly mem, the.., here we work with calculations that involve money, now in maths we do not work with money]*.

I: Hooo…, benidila ngama-calculations awemali? Ku-maths anisebenzi ngemali. So, la bekunemali *[Okay.., you were working with calculations involving money? In maths you do not work with money, so, here there was money]*?

N: Yes mem.

I: Ngizwa bathi lama-tasks lawo abaniphe wona, ama-exercise baniphe wona, bewabhalwe nge-Zulu, English …, awungitshele ukuthi osebenze kanjani ngaleyo ndlela *[I heard that the tasks that they gave you, the exercises that they gave you, were written in IsiZulu, English …, tell me how did you use them]*?

N: I think mem leyo kusinikeza amaphepha o i-two kuya nceda mem, ngoba, like mina, kukhona amanye ama-questions bengingawa-understandi, i-home language iyakhona ukusiza ukuthi ngiwa understande *[I think mem having both papers is helpful mem, because, like myself, there were questions that I did not understand, the home language is able to help me to understand them]*.

I: Hooo…, uyewathi mawubona ungathi awu understandi ngeEnglish, waya ngapha ku home language yakho *[Okay…, you saw that when you did not understand the English version, then you switched to you home language version]*?

N: Yes.

I: Kodwa ngibone uma ngibheka amanye amaphepha weSiZulu, kukhona amanye ama-questions babuza nge-English, kodwa ngibone abanye baphendule ngeSiZulu. Uma ubhekile, kwenzwa yini lokho? *[But when I look at some task sheets that are in IsiZulu, there are some questions that were asked in English, but I saw some have answered in IsiZulu. In your view, what lead to that?]*

Nhlanhla: (Silent, seem not to understand).

I: Kusho ukuthi, angithi babuze ngeSiZulu nangeEnglish, uthole kwenye indawo niphendule ngeEnglish, kwenye indawo niphendule ngeSiZulu. Uma ubhekile, ku yenziwa yini ukuthi niphendule ngeSiZulu nangeEnglish *[What I mean is, isn't it they asked in IsiZulu and in English, then you find that somewhere you answered in English, and somewhere you answered in IsiZulu. In your view, what leads to answering in IsiZulu and in English]*?

N: Maybe like uma unga-understandi ngeEnglish, i-answer uyibhala nge language yakho, uma unga-understandi ngeSiZulu, uyibhala ngeEnglish *[Maybe like if you do not understand in English, you write the answer in your home language, if you do not understand in IsiZulu, you write it in English]*.

I: Kwenzekani uma ubhala nge-home language yakho *[What happens when you write it in you language]*?

N: Ukuthi kube easy *[So that it can be easy]*.

I: Hooo…, kuba easy *[Okay…, it becomes easy]*.

N: Yes.

I: Lento ebeniyenza bekade ikhona? *[What you were doing, is it what you usually do?]*

N: No, intsha. *[No, it is new.]*

I: Anikaze niyenze? *[You did not do it before?]*

N: No.

I: Uma ubhekile, uthandeni? Yini into oyithandile *[In you view, what did you like? What is that that you liked]*?

N: Mina ngithande ukuthi lo gesi sengiyazi ukuthi abantu ba-ukhalkhuleitha kanjani. If like kufika i … yini lento lena, niyibizani *[I liked that I now know how people calculate this electricity. If like when er….comes, what is this thing, what do you call it]*?

I: Le … electricity bill?

N: Yes mem. Sengibone ukuthi ba ikhalkhuleitha kanjani. Kusho ukuthi manje nasekhaya akukho … nnga khona ukwiyenza. Nnga khomphera ukuthi iyafana na le siyenzile *[Yes mem. I now know how they calculate it. It means that now even at home there is no… I can be able to do it. I can compare if is it the same as the one we have done]*.

I: Okay, so yini into ongayithandanga kule-approach le yabo-home language, English? *[Okay, what is it that you did not like about this approach of home language, English?]*
Yini into nje ongayithandanga, ore into ongayinthandanga nje elesinini, ore i-approach nje uthishara ayi sebezisile? *[Anything you did not like in the lesson or about the approach?]*
N: Hayi mina, konke bekukahle mem. *[No, everything was okay.]*
I: Bekukahle? *[Was I okay?]*
N: Yes mem.
I: uMr Molefe ungitshele ukuthi kule vike beka fundisa completely different, ubona ukuthi izo …iyasebenza le ndlela ayisebenzisa manje *[Mr Molefe told me that this week he was teaching completely different, do you think it will… does the approach he uses now work]*?
N: Yes mem, I think iyasebenza, ngoba ama-learners amaningi, maybe like, uma ungasebenzise ama-home language wabo, abaphathisipheiti kakhulu. Mabanikezwa ama-home language abo, I think bazokhona ukuphathisipheita *[Yes mem, I think it works, because most learners, maybe like, if you do not use their home languages, they do not participate that much. If they are given their home languages, I think they will be able to participate]*.
I: Okay. Why ubona ungathi uma basebenzisa ama-home language abo bazo phathisipheitha? Why bangaphathisipheiti ngeEnglish *[Okay. Why do you think if they use their home languages, they will participate? Why don't they participate when using English]*?
N: I think mem, English inokuba i-problem ngoba nami eish … hae … inokunginikeza i-problem, uthole ukuthi, maybe kukhona igama ongali-understendi, bese ugcina ubhale izinto ezi-wrong. Manje mangabe uzo yenza nge-home language yakho, igama ongali-understendi uzolibheka nge-home language yakho bese ugcina wenza izinto ezi-right *[I think mem, English is sometimes problematic because even myself eish,…hae…it sometimes gives me a problem, you find that, maybe there is a word that you do not understand, then you end up writing wrong things. If now you do it in your home language, you will check the word that you do not understand in your home language then you will ultimately do the right things]*.
I: Okay. Ngiyabonga kakhulu. Thanks.

COLBERT – C

I: Good day. What's your name?
C: Colbert, I represent the Venda group.
I: Which language do you prefer we do this interview?
C: I think both languages, English and my home language.
I: My Venda is a bit bad. Do you know Zulu?
C: Yes, I know Zulu and Tswana.
I: So, you can mix whatever, Tswana ….
C: (Adding)… Zulu, Venda, ….
I: Ok, thank you so much. Eya, I understand this week you had visitors in class, what was happening?
C: Er …we were just solving for electricity, kilowatt per hour, for comparing if they are using card or the meter, which is both, I think are the same.
I: Eya, so beyikhuluma ngani le lesson? Yini into eyenza ukuthi ibe i-lesson? Akhona mos ama-electricity, niyakwenza loku, niyakwazi *[Yes, so what was the lesson all about? What made it to be a lesson? Electricity is always there, you all know that, you do know]*.
C: Iya, basenzele in order to … ukuthi ibe simple and easy to us, because most of people, uyabona, aba-understendi like i … like i-card ne meter. Abanye bathi i-meter is … i-price yakhona i-much uyabona, i-card iless i-price yakhona, that's why uyabona. So, abantu abana-knowledge, uyabona, bakhuluma just for the sake of it. So, I think for us, because we have learnt something, both are the same. *[Yes, they did it in order to …so that it should be simple and easy to us, because most of people, you see, they do not understand like a… like a card and a meter. Some say a meter is … costs more you see, the cost of a card is less, that's why you see. So people do not have knowledge, you see, they talk just for the sake of it. So, I think for us, because we have learnt something, both are the same.]*
I: Okay, ngizwa bathi ama-tasks wenu bewabhalwe ngesiZulu, I mean Zulu, Venda, or English. Uyibona kanjani leyo ndaba *[I heard that your tasks were written in IsiZulu, I mean Zulu, Venda, or English. What is your view about this]*?

C: Iya yes, I think is a good idea, uyabona, ngoba iyenza ukuthi … iyenze izinto zibe simple, ngoba if singa-understendi ngeEnglish, sicheka ku … our languages, aba simple bese siyakhomphera *[Yes, I think is a good idea, you see, because what it does ... it makes things to be simple, because if we do not understand in English, we check in…our languages, they become simple and then we compare]*.

I: Niyenzani, niqala nifunde nge-English *[What do you do, do you read in English first]*?

C: Iya, if … iya, siqala ngokufunda nge-English, but if sibona kunenye i-term we don't understand, siyaya ku-mother tongue yethu bese siya-solver *[Yes, if ...yes, we first read in English, but if we see that there is a term that we do not understand, we switch to our mother tongue and then solve]*.

I: So, kusho ukuthi ma uyenze nge-mother tongue yakho uyi-solver, usizwa yini? Se kwenze njani *[So, that means if you do it in your mother tongue and solve it, what helps you? What happens]*?

C: Iya, se ngiyabona, iba simple for thina *[Yes, it makes me to understand, it becomes simple for us]*.

I: Okay, kusho ukuthi uyenzani, uya understenda *[Okay, what does it mean, you do understand]*?

C: Iya, because i-maths inamanye ama-terms la angathi a-difficult for us, because asi- mother tongue yethu. That's why sometimes sistragela, uyabona *[Yes, because maths has some terms that are difficult for us, because is not our mother tongue. That is why we struggle, you see]*.

I: Okay. So, awu-ngitshele ukuthi le yona i-approach leya this week, uzizwa kanjani ngayo, uyayithanda na? *[So, tell me, this week's approach, how you feel about it. Do you like it?]*

C: Iya, ngiyayithanda. Ngibona ungathi yona uma sisebenzisa yona most of the time, I think singayiphasa iMaths. Singaba ne-higher grades kuMaths. *[Yes, I like it. I think if we can use it most of the time, we can pass mathematics. We may obtain higher grades in mathematics.]*

I: Yini into enganenza niphase? *[What can make you pass?]*

C: Ukuthi, uyabona, i …. i … amamethods wakhona, the way ba-explaina ngakhona, uyabona, nge-mother tongue yethu, iba simple for us, i-explaina kahle, siya-understenda. *[You see, the methods, the way it was explained, you see, in our mother tongue, it becomes simple for us. It explains very well, we understand.]*

I: Okay. So yini into ongayithandanga nje kule-approach yokusebenzisa imother tongue, ore i-lesson nje as a whole? *[Okay. So what is that which you did not like in this approach of using mother tongue, or in the whole lesson?]*

C: Hayi, i-lesson, I think akukho into engayithandanga, because it was good. *[No, in the lesson, I think there is nothing that I did not like because it was good.]*

I: It was good. Okay, uMr Molefe ungitshele ukuthi this week nje uqale ukuyenza a new approach completely. Ma ubhekile, iyasebenza lento? *[Okay, Mr Molefe tells me that this week he started with a completely new approach. In your view, is it working?]*

C: Iya *[Yes]*, it works a lot.

I: Yini into eyenza ukuthi isebenze? Yini into eyenza ukuthi ubone ungathi iyasebenza *[What makes it work? What makes you think it works]*, 'it works a lot'?

C: Because most of us we are … be baphathisipheita *[Because most of us we are ... they were participating]*.

I: Hoooo…, be-niphathisipheitha *[Okay, they were participating]*?

C: The whole class, I think be-iphathisipheitha *[The whole class, I think they were participating]*.

I: Hoooo….

C: But before beyiyenza ukuthi like, beyi … bebabona nje i-class, kukuthishwa maybe four learners uyabona others … (Inaudible) *[But before it made that like, it was… they would just notice the class, during teaching maybe four learners you see*, others … (Inaudible)].

I: Ma ubhekile laba abayifour, why be-baphathisipheitha laba abanye banga phathisipheithi *[What do you think why this four was participating and others did not]*?

C: I think because uyabona, bona maybe ba-understenda better than us uyabona *[I think because you see, maybe they understand better than us you see]*.

I: Okay.

C: Thina besinga-understendi, still if bebasifundisa, besinga-understendi fast like laba- abanye, uyabona *[We did not understand, even when we were taught, we did not understand as fast as they did, you see]*.

I: Iya. So, manje ukuthi uma-ayenza this new approach … *[Yes. So, now when you use* this new approach …]?
C: (Interjecting) Sibe sonke si-pullup our socks, uyabona *[Then we all pull-up our socks, you see]*.
I: Au *[Really]*!
C: Because it was good.
I: It was good?
C: Eya.
I: Ok, thank you so much.

SIPHO – Sp

I: What's your name?
Sp: Sipho.
I: Hi Sipho. What's your home language?
Sp: My home language, I am a Tsonga but I am doing a Venda language.
I: Oh, okay. So, which language do you prefer we use for this interview?
Sp: We can … even English and …, any language.
I: Okay, good. You are comfortable with Zulu, Sotho …
Sp: Anything.
I: Okay, I am comfortable with Zulu, Sotho, so I will use any language.
Sp: Okay, alright mem.
I: Okay. I understand this week you had visitors coming to your school. What was happening?
Sp: Er, the visitors they were doing research. Gošho gore ba sheba gore bothata … bothata ba rona bo mo kae, ka … ka … maths, then they found out that er… ba bang ha ba understende dilanguage, like English so, then ha ba botsa karabo then they can't find the answer. So Mr Molefe then decided to … to … make it in … in English and vernacular language to … to …, for us to understand. *[Er, the visitors were doing research. It means that they check where our problem is regarding maths, then they found out that er ... some do not understand languages like English so, then when an answer is required, then they can't find the answer. So Mr Molefe then decided to ... to ...make it in ... in English and vernacular language to ... to ..., for us to understand]*
I: Au, did you understand because o e entse ka *[you did it in your*] home language?
Sp: Iya, I did understand in English and vernac. I did benefit.
I: So, if … if it was written only in English, o ne o tlo ba le bothata *[were you going to have a problem]*?
Sp: Iya [Yes], somewhere, somewhere moo le moo *[here and there]*.
I: Why moo le moo? Ke eng 'moo le moo'? [Why here and there? What is 'here and there'?]
Sp: Ke gore mem, wa bona English le yona phela nou, we are not matured enough ka English. *[That is mem, you see English is also ..., we are not matured enough with English.]*
I: Iya, iya … iya. *[Yes]*.
Sp: So, re understenda bonnyane boo ka … ka English. *[So, we only understand a little in English]*.
I: Hoo … Okay. So, ke bone dipampiri tse ngata tse ngwetsweng ka Venda le Tsonga, ba bangata le arabile ka Venda rather than ka English … *[Okay. So, I saw a number of answer sheet written in Tshivenda and Xitsonga, most of you answered in Tshivenda rather than in English…]*.
Sp: Iya, yes.
I: Ke eng ntho e e entseng le … le … le seke la folowa trend? Wa itse motho kaofela 'English', 'English', ke eng ntho e e entseng le arabe ka SeVenda? *[What made you not to follow the trend? You know that everybody 'English, English, what made you to answer in Tshivenda?]*
Sp: Akere as a group, re ile ra diskhasa gore lets give the answers in Venda language. *[Isn't it as a group we decided that lets give the answer in Venda language]*.
I: Why?
Sp: Eish mem … (Silent for a while). Moo nka se kgone go e tlhalosa. *[I am unable to explain]*.
I: Go tlhalosa, okay. So, lesson ena e ne e sa tshwane le dilesene tse ding, akere, so ha o shebile, ke eng e oe ratileng mo leseneng *[To explain, okay. So, this lesson was different from the previous ones, isn't it, so in your view, what did you like in this lesson]*?
Sp: Mo leseneng e nne re e etsa *[The lessons that we have done]*?
I: Iya *[Yes]*.

Sp: Ntho e ke e ratileng ke gore, yona the lesson was very good ne, because like bo-ditest soo, se ditla, ne ditla ka English, o thole gore ha re understende, wa bona mem. Ene o thole gore go na le mantswe a mang a English a e leng gore a difficult for us gore re understende. So, they did gore at least ba etse ka vernac le English, so re bale ka English then we go to vernac language then re tlo kgona go understenda, to get the answer *[What I liked is that, the lesson was very good because, like tests, are in, were in English, then you find that we do not understand, you see mem. And you find that there are English words that are difficult for us to understand. So, they did that at least in home language and English, so we read in English then we go to home language then we will be able to understand, to get the answer]*.

I: So, ke gore ka mantswe a mang o re maths, ntho e e etsang gore o seka wa e understenda ke gobane ba e kwetse ka English fela, so ha ba ka qala ba e ngwala ka Venda le English o tla e understenda? *[So, you mean that what makes you not to understand maths is that it is written in English only, so if they can begin to write it in Tshivenda and English you will understand it]*?

Sp: Eya mem, ka gobane akere le yona vernac e na le gore le rona e re … e re tšhape mem, so we go to English, then you find gore okay, mo English ke ya understenda, then we can work the sum out mem. *[Yes mem, it is because isn't it vernac is sometimes difficult for us mem, so we go to English, then you find that* okay, *in English I understand, then we can work the sum out mem.]*

I: Hoo…, ke gore le ko vernac ha ona le bothata o kgona go ya le ko English? *[Okay…, which means if you have difficulty with vernac, you are able to switch to English*?*]*

Sp: Eya, ko English mem *[Yes, to English mem]*.

I: So, e le thusa jwang? *[So, how does it help you?]*

Sp: Gai-two *[Twice]*, both … both ways.

I: Gai-two, okay. Mara Maths ke dipalo mos, ha e na language, ke dipalo… *[Twice, okay. But mathematics is numbers, it does not have language, it is numbers…]*

Sp: (Interrupting) Mara mem, maths e na le bothata, ke bothata mem. Rona erefa headache ko klaseng. Bongata ba ko klaseng ebafa bothata mem, like nna soo … *[But mem, mathematics is problematic, it is a problem. It gives us a headache in class. It gives most of us in class a problem, like me…]*

I: So, o bona okare ha re ka … ha o ka etsa … teacher Molefe a ya ka system e na … *[So, do you if we… if you can do…. teacher Molefe can continue with this system…]*

Sp: (Interrupting) … Ka system a qalang ka yone e? *[The system that he has just started with?]*

I: Eya *[Yes]*.

Sp: Haa…haa…(Clicking fingers) … the top mem!!!

I: Ka nnete *[Really]*?

Sp: Haa… the top… the top, the top!!!

I: Yanong, ke eng o e sa e ratang ka the whole thing, the new approach? *[Now, what is that which you did not like about the whole thing, the new approach?]*

Sp: The approach of …

I: E le ne le e etsa this week. *[The one you used this week.]*

Sp: No, ha gona ntho e e leng gore ha ka e rata mem *[No, there is nothing that I did not like mem]*. Everything was fine.

I: Mmmmm.

Sp: Eya *[Yes]*.

I: Mr Molefe o mpolella gore o yuzitse er … a completely new approach all-together, jaaka le wena o ne ocho. Ha o shebile, did it work? *[Mr Molefe tells me that he used er… a completely new approach all together, like you have just mentioned. In your view, did it work?]*

Sp: Eya! E sebediste gagolo mem *[Yes! It worked a lot mem]*.

I: Ehe *[Really]*?

Sp: Because kaofela digroup they were participating, wa utlwisisa mem. Le bane ba sa phathisipheiti ko klaseng, ne setse ba phathisipheita. Nna ke maketse gore 'he banna, mothaka o kajeko ke ena oe arabang so maths' *[Because all the groups were participating, do you understand mem. Even those who used not to participate in class were now participating. I was surprised that 'oh man, this guy today is the one who answers so much in maths']* (Clicking fingers).

I: Ka nnete *[Really]*?
Sp: Yes! Yes mem.
I: Ao, that sounds nice.
Sp: Yes mem!
I: Eya *[Yes]*, what else do you wanna tell me about the approach? Tell me more.
Sp: Er … the approach mem, er … ke gore, yona e good. Is good because ba bangata this time ba ithutile dilo tse ngata ka … ka … ka … maths, wa bona *[Er ... the approach mem, is that, it is good. It is good because this time most of us have learnt a lot about… maths, you see]*.
I: Eya *[Yes]*.
Sp: And le gore nna ke thabile gagolo gore ke bone some of my friends, le bona baba matured ka maths, yes mem *[And I am vey happy to see that some of my friends are also becoming mathematically matured, yes mem]*.
I: Eya, eya. Ok, thank you so much.

APPENDIX C: TRANSCRIPT OF THE LESSONS

Transcription conventions used

( ) – Learner or teacher action

[ ] – English translations

T - Teacher
Ls - Learners

LESSON 1

TEACHER-LEARNER INTERACTION (CLASS)

T: Our lesson is going to be in all languages. So, re tlo bua Setswana, rhiambe Tshivenda, ri valavhule Xitsonga, sikhulume IsiZulu, and … and … this lesson is going to …, by eleven o' clock we must have finished, and the lesson will still continue tomorrow and the other day. Er … what I am going to give you, I am going to give you tasks that are going to be based on the lesson, and I will explain after giving tasks. *(Distributes task sheets to learners who have divided into different language groups)*. Tswana, Motswana ha o emisi letsogo monna *(Refers to one learner in the Setswana group).* Vha hina vhakweru *(Refers to the Xitsonga group). [Our lesson is going to be in all languages. So, we are going to speak in Setswana, Tshivenda, Xitsonga and IsiZulu, and … and … this lesson is going to …, by eleven o' clock we must have finished, and the lesson will still continue tomorrow and the other day. Er … what I am going to give you, I am going to give you tasks that are going to be based on the lesson, and I will explain after giving tasks (Distributes task sheets to learners who have divided into different language groups). Tswana, Motswana don't you raise your hand young man (Refers to one learner in the Setswana group).* Vha hina vhakweru *(Refers to the Xitsonga group).]* **TLI/***E-HL***/EXPL**

Ls: Hilava *[We are here] (Laughter)*. *HL***/TLI/RESP**

T: Vha hashu VhaVenda. BaseMgugundlovu *(Refers to the IsiZulu groups)*. Right, with these tasks, ngalawa maphepha, we are going to do i-lesson yethu. Re tlile go dirisa these papers for lesson ya rona. Yaanong, what I want you to do now, let us all look at the English version of this page, all of us. Er … on the first page of the English version, we are going to use these papers to answer the questions as we work on them, okay. And at the back, ka mo morago, is your language, o a e bona akere. Right, yaanong ha o araba dipotso tse in your groups, go tla tswa gore o dirisa this paper, osebenzisa this paper, ushumisa this paper, okay, to answer questions in your groups. When we work in our groups, we all work. First you discuss the questions then I 'll be moving around ke utlwella gore what are you talking about, ask questions if necessary, if you don't understand, ha o sa tlhaloganye o botsa dipotso. Ma ungazwisisi uyabuza, ausabe, okay. Uvhutiso Nkateko. Now I want that all of us turn to the English version, so that we can get the feel of the whole thing. Can one of us read the first statement there. Who volunteers to read? Sipho can you read. **TLI/***E-HL***/EXPL-INST**

Sipho: *(Reads the first statement in English)*. *E***/READ**

T: Thank you. Nkateko can you read. **TLI/***E***/INST**

Nkateko: *(Reads the first statement in English)*. *E***/READ**

T: Right, manje ke, for two minutes, just two minutes, ngifuna ukuthi in your groups, read the statement, the statement only, in your groups, and discuss what the statement means, what you understand. If there is something ongaizwisisi kahle, ubuze. I'll be moving in your groups listening to your discussions. Remember, ngapha kune ilanguage yakho, ngapha kune English *(Shows learners the two versions of the task).* Motswana, ke tla be ke le botsa gore ke eng se le se tlhaloganyang ka polelo eo. *[Right, now for two minutes, just two minutes, I want that in your groups, read the statement, the statement only, in your groups, and discuss what the statement means, what you understand. If there is something that you don't clearly understand, ask. I'll be moving in your groups listening to your discussions. Remember, this side is in your language, and this side is in English (Shows learners the two versions of the task). Motswana, I will be asking you what is that that you don't understand about the statement of the problem.]* **TLI/***E-HL***/INSTR**

(Groups read the statement and discuss. One observer and I, move around groups listening to their discussions).

TEARCHER-LEARNER INTERACTION (GROUP)

(Teacher with TshiVenda group 1)
Sipho: *(Explains but Inaudible)*.
T: Forty rhanda heyi, vhoibadhala when? *[When do you pay this forty rand?]* **CCU/ECU/***HL***/TLI/QUEST**
Sipho: In a month. **DCU/***E***/TLI/RESP**
T: Twenty cents yone? *[What about the twenty cent?]* **CCU/***HL***/TLI/QUEST**
Given: Twenty cents yo ediwa. *[Twenty cents is added]* **DCU/***HL***/TLI/RESP**
T: Why i ediwa? *[Why is it added?]* **CCU/ECU/***HL***/TLI/PROBE**
Group: *(Silent)*.
T: Vhoi edela mini? Twenty cents vhoi edela mini? *[Why is it added? Why is twenty cent added]* **CCU/ECU/***HL***/TLI/PROBE**
Group: *(Inaudible)*.
T: Forty rhanda heyi uyibhadala when? When do you pay this forty rand? **CCU/ECU/***HL-E***/TLI/PROBE**
Sipho: Nga ngwedzi. In a month. **DCU/***HL-E***/TLI/RESP**
T: Okay, if you use electricity ukho bhadala forty rand? *[Okay, if you use electricity, will you pay the forty and?]* **CCU/ECU/***E-HL***/TLI/ PROBE**
Group: Yes meneer.
T: If unga shumisanga electricity ukho bhadala forty rand? *[If you did not use electricity will you pay the forty rand?]* **CCU/ECU/***HL***/TLI/ PROBE**
Sipho: No, no no … *E***/TLI/RESP**
Given: Haena, whether ushumisile ore haushumisanga ukhobhadala forty rhanda. *[No, whether you have used it or not, you still pay the forty rand]* **DCU/***HL***/TLI/RESP**
T: Whether ushumisile ore haushumisanga. *[Whether you have used it or not.]* **RCU/***HL***/TLI**
Sipho: Eya, yes, it's a must. **DCU/***E***/TLI/RESP**
T: It's a must. **RCU/***E***/TLI**
Group: yes.
T: Right, twenty cents? **CCU/ECU/***E***/TLI/PROBE**
Sipho: They add it. **DCU/***E***/TLI/RESP**
Verda: Twenty cents yo ediwa. *[Twenty cents is added]* **DCU/***HL***/TLI/RESP**
T: Vha engedza nga twenty cents athiri? *[They increase by twenty cents, isn't it?]* **RCU/***HL***/TLI/CONFIRM**
Group: Eya *[Yes]*.
Sipho: Eya *[Yes]*, per hour. **DCU/***E***/TLI/RESP**
T: Why? **CCU/***E***/TLI/PROBE**
Sipho: Eish …
T: Twenty cents heyi, uyibhadala when? When do you pay this twenty cents? **CCU/ECU/***E-HL***/TLI/PROBE**
Group: (*Read statement in TshiVenda)*. *HL***/READ**
Sipho: Hooo …,alright, eya.
T: Now you understand uma uyifunda ngesiVenda? *[Now you understand when you read in Tshivenda?]* **CCU/***HL-E***/TLI/QUEST**
Sipho: Eya, okay …
T: When you read in Venda, you start understanding? **CCU/***E***/TLI/QUEST**
Sipho: Eya, we start understanding meneer, alright. *E***/RESP**
T: So, in English does it confuse you a little bit? *E*/**QUEST**
Sipho: Eya, a little bit, a little bit meneer.*E*/**RESP**
T: So in Venda …, can you explain it because you understand it. **CCU/ECU/***E***/INST**
Sipho: Okay, let me read for them first meneer. *E***/RESP/TLI**
T: Eya, can you read it in Venda. **RCU/***E***/TLI/INST**

Sipho: *(Reads the statement in TshiVenda)*. Okay, zwiamba huri er …, athiri ngangwedzi bobhadala forty rhanda, then baengedza nga twenty cent khaawara thihi. Then mudagazi wo shumisiwa ngamanda khaawara thihi. *[Okay, it means er …, isn't it they pay forty rand per month, then they add twenty cent per kwh. Then the electricity is consumed with a power per a hour]* **DCU**/*HL*/**TLI/READ-EXPL**

T: Zwino that forty rand, whats that forty rand? **CCU/ECU**/*HL-E*/**TLI/PROBE**

Given: Ndiya shumelo. *[Is for services]*. **DCU**/*HL*/**TLI/RESP**

Sipho: That forty rand ndiya ushumisa ne, er …electricity. *[That forty rand is for using er…electricity]* **DCU**/*HL-E*/**RESP**

T: Ya mudagazi. *[For electricity]*. *HL*

Sipho: Ya mudagazi. *[For electricity]*. *HL*

T: If you did not use electricity, do you still pay that forty rands? **ECU**/*E*/**TLI/QUEST**

Sipho: Eya, you still pay the forty rands. **DCU**/*E*/**TLI/RESP**

T: Now twenty cents? **CCU/ECU**/*E*/**TLI/QUEST**

Group: *(Silently reads TshiVenda version)*. *HL*/**READ**

T: What is the twenty cents for? **CCU/ECU**/*E*/**TLI/PROBE**

Sipho: I think twenty cents eyauongedzwa, eyauongedzwa kha mudagazi uwashumisiwa. *[I think twenty cent is added for electicity consumed]*. **DCU**/*HL*/**TLI/RESP**

Given: *(Inaudible)*.

T: Do you understand what she is saying? **ECU**/*E*/**TLI/QUEST**

Sipho: Eya, we understand it meneer. *E*/**TLI/RESP**

T: She says forty rand you pay it regardless of whether you used electricity or not, uyaibadhala. *E-HL*/**TLI/EXPL**

Group: Eya, yes.

T: Twenty cents uyibadhala *[paid]*… **CCU/ECU**/*HL*/**TLI/PROBE**

Sipho: Nga awara ithihi. *[Per kwh]*. **DCU**/*HL*/**TLI/RESP**

T: When do you pay it? Suppose you did not use electricity, le twenty cents uyayibadhala *[do you pay this twenty cent]*? Suppose for that month hausebenzisanga i-electricity *[you did ot use electricity]*, … **ECU**/*E-HL*/**TLI/PROBE**

Sipho: No no, no, if you did not use electricity, you can't pay it meneer. **DCU**/*E*/**TLI/RESP**

T: So, when do you pay the twenty cents? **ECU**/*E*/**TLI/PROBE**

Given: Er… when you have used er … the electricity. **DCU**/*E*/**TLI/RESP**

T: So, suppose you …, suppose …, lets say for that month I used … electricity ye one kilowatt-hour, how much am I going to pay for that month? **ECU**/*E*/**TLI/QUEST**

Group: Twenty cents. *E*/**TLI/RESP**

T: For that month *(Turns to the TshiVenda version)*. Where's the Venda version? *(Reads TshiVenda version)*. So, forty rhanda iyashumelo, athiri, iyashumelo forty rhanda. Twenty cents kha kilowatt-hour thihi idoba ya mudagasi wo shumiswaho, athiri. Zwino what I am saying is, suppose ndishumisa mudagasi wa one kilowatt-hour for that month, that one kilowatt-hour per month, zwino rho badhala vhugai for that month *[So, forty rand is for services. Twenty cent is for one kilowatt-hour for electricity consumed, isn't it. Now, what I am saying is, suppose I consume one kilowatt-hour of electricity for that month, that one kilowatt-hour per month, now how much are going to pay for that month]*? **CCU**/*HL-E*/**TLI/READ-PROBE**

Group: *(silent)*.

T: One kilowatt-hour ndivhugai *[How much is one kilowatt-hour]*? **CCU/ECU**/*HL*/**TLI/QUEST**

Group: Twenty cents. **DCU**/*E*/**TLI/RESP**

T: Tshelede ya shumelo ndivhugai *[How much is the service fee]*? **CCU/ECU**/*HL*/**TLI/QUEST**

Group: Forty rhanda *[Forty rand]*. **DCU**/*HL*/**TLI/RESP**

T: Zwino if I use one kilowatt-hour for that month, ndobadala vhugai for that month? *[Now if I use one kilowatt-hour for that month, how much will I pay for that month?]* **ECU**/*E-HL*/**TLI/PROBE**

Patience: Twenty cents. *E*/**TLI/RESP**

T: Only twenty cents? *E*/**TLI/PROBE**

Group: Yes.

T: Tshelede ya shumelo yone? *[What about the service fee?] HL*/**TLI/PROBE**

Given: Tshelede ya shumelo athiri vhoibadala yone, …ar … ar … *(giggles)* … hai … *[the service fee will be paid, …ar …ar… (giggles) … hai …] HL*/**TLI/EXPL**

T: Lets use this example ye cellphone contract. Lets say the contract is hundred and thirty-five rand, ye contract. Does that hundred and thirty-five rand include calls? **ECU**/*E*/**TLI/EXMPL/QUEST**
Group: *(Silent)*.
T: Imali ye contract ye cellphone, bathi kuwe 'Weekender Plus' is hundred and thirty-five rand per month that you pay. Does that hundred and thirty-five rand include imali ozoisebenzisa for the calls? *[The cost for the cellphone contract, they say to you 'Weekender Plus' is hundred and thirty-five rand per month. Does that hundred and thirty-five rand include charges per call?]* **ECU**/*E-HL*/**TLI/PROBE**
Verda: No. **DCU**/*E*/**TLI/RESP**
T: Ya macalls izoba …, when do you pay for the calls? Suppose you don't use that phone for the month, how much do you pay? **CCU/ECU**/*E*/**TLI/PROBE**
Verda: Hundred and thirty-five rand. **DCU**/*E*/**TLI/RESP**
T: Hundred and thirty-five rand.
Verda: Yes. *E*/**TLI/RESP**
T: Suppose now I use the phone for that month, how much am I gonna pay? Do I still pay that hundred and thirty-five rand? **CCU**/*E*/**TLI/PROBE**
Sipho and Verda: Hundred and thirty-five rand plus di-calls tse o di yuzitseng *[calls made]*. **DCU/DPF**/*HL-E*/**TLI/RESP**
T: Now, hundred and thirty-five rhanda ndi tshelede ya shumelo *[is for services]*. *E-HL*/**TLI/GUIDE**
Sipho: Okay, eya.
T: Ndi tshelede ya shumelo hundred and thirty-five rhanda. Whether I have phoned or not, I will still pay them hundred and thirty-five rand. Then when I start using my phone what happens? **CCU/ECU**/*E-HL*/**TLI/GIUDE/PROBE**
Sipho: They add twenty cents on top. **DCU/DPF**/*E*/**TLI/RESP**
T: Yes. Zwino hapfa *[Now here]*, then if I use one kilowatt-hour, how much will I pay for that month? **CCU/ECU**/*E-HL*/**TLI/QUEST**
Group: *(Silent)*.
T: You said they add the twenty cents. So, what do you think? **RCU**/*E*/**TLI/GUIDE**
Sipho: Hooo …
Patience: You still pay the forty rand. **DCU**/*E*/**TLI/RESP**
T: Then I use the one kilowatt-hour. You said I still pay the forty rand, then I use the one kilowatt-hour. Then how much are you gonna pay? **RCU/CCU**/*E*/**TLI/GUIDE/PROBE**
Sipho and Verda: Forty rand twenty cents. **DCU**/*E*/**TLI/RESP**
T: Forty rand twenty cents.
Sipho: Eya, thank you meneer. *E*/**TLI**
T: Do you get it? *E*/**TLI/QUEST**
Group: Yes. *E*/**TLI/RESP**
Sipho: Eya, I get it. *E*/**TLI/RESP**
T: Boivhona athiri? *HL*/**TLI/QUEST**
Group: Yes, eya.

LEARNER-LEARNER INTERACTION (GROUP)

Given: Hei, nayo … ar … *(giggles)* … So forty rhanda hi monthly cost ne, then ba yieda nga twenty cents kha kilowatt for one hour. Then after that, angado shumisa … baibidza mini? Heyi … ndoshumisa one kilowatt nga twenty cents kha one hour. *[Hei, this .... ar....(giggles) .... So forty rand is the monthly cost, then they add twenty cents for a kilowatt-hour]*. **DCU/DPF**/*HL-E*/**LLI/EXPL**
Sipho: Eya *[Yes]*.
Given: Boyieda, maybe boshumisa twenty cents nga one hour. *[It is added, maybe they use twenty cent for one hour]*. *HL-E*/**LLI/EXPL**
Sipho: Eya, yantha. *[Yes, for one hour]*. *HL*/**TLI/RESP**
Given: Iba … *[It becomes…]*
Given and Sipho: Forty rand twenty cents. **DCU/DPF**/*E*/**LLI**
Sipho: Yes, vhoibadela monthly, ngangwedzi ya hona. Yo fhelela, yes. Sesiyaqubheka. *[Yes, they pay*

it per month. That is all, yes. Let us continue]. *HL*/**LLI/EXPL**

Patience: *(Using calculator)* … er … five sixty times four … *E*/**TLI**

Sipho: Arebeng matured guys. Hapfa vha fhonire badela forty rand nga ngwedzi, ne athiri, and khanoshumisa er… er… mudagazi ngamanda vha engedza ngabogai …? *[Let us be matured guys. Here they want us to pay forty rand per month, isn't it, and if we use er…er… electricity with a power they increase by how much…?]* **RCU/CCU**/*HL*/**LLI/GUIDE-EXPL-QUEST**

Group: Nga twenty cents. **DCU**/*HL*/**LLI/RESP**

Sipho: Hu sala four weeks, hafhi … *(silent)*. Zwino nga ngwedzi hu shumiswa mudagazi wa five hundred and sixty ne *(Reads question in TshiVenda)*, "ambelakuri unga badala tshigolodo tshabugai nga ngwedzi". Athiri huna four week kha ngwedzi? *[Four week remain, then… (silent). Now five hundred and sixty of electricity is consumed (Reads question in TshiVenda), "calculate how much will you pay per month". Isn't it there are four week a month?]* **RCU**/*HL*/**LLI/READ/GUIDE-EXPL**

Verda: *(Inaudible)*.

Sipho: Eya *[Yes]*, … er …

Given: Forty rand and twenty cents. *E*/**TLI/RESP**

Patience: *(Explains how she has calculated, but inaudible)*.

Given: *(Seems surprised)* Forty rand imainasa *[minus]* five hundred and sixty? **CCU**/*HL-E*/**LLI/QUEST**

Sipho: *(Raises his hand for teacher's attention)*.

Group: *(Reads the question silently in TshiVenda, waiting for the teacher)*. *HL*/**READ**

TEACHER-LEARNER INTERACTION (GROUP)

T: Right, do you have a problem? Is there a problem? *E*/**TLI/QUEST**

Group: Yes.

Sipho: Okay meneer, they say … *E*/**TLI**

(The teacher then attends to the whole class)

TEACHER-LEARNER INTERACTION (CLASS)

T: Okay, let me disturb you a little bit. I have moved around the groups and noticed most groups do not understand the statement. Angeke uphendule *[You will not answer]* this questions before you understand the statement, angithi *[isn't it]*? *E-HL*/**TLI/EXPL/QUEST**

Class: Yes.

T: Okay, a re emeng gannyane. Right, the first statement *(writes 'Statement' on chalkboard)*, the first statement, masibhekeni i-statement, a re shebelleng statement. Akere mo steitmenteng, i-statement, we got two values. Ha o lebella foo, there are two values. Kona tivalues timbere. *[Okay, let us wait a bit. Right, the first statement (writes 'Statement' on chalkboard), the first statement. Let us look at the statement. In the statement, the statement, we have two values. When you check there, there are two values]*. **CCU**/*HL-E*/**TLI/INSTR**

Class: Yes.

T: There's how much? *E*/**TLI/QUEST**

Class: Forty rand.

T: *(Writes 'R40-00' on chalkboard)* Then. *E*/**TLI/PROBE**

Class: Twenty cents.

T: *(Writes '20c' on chalkboard)* This forty rand and this twenty cents, now just one of you, what is this forty rand? Sipho. **CCU/ECU**/*E*/**TLI/PROBE**

Sipho: This forty rand is the …er… is the money that you pay every month, eya, is the fee, fee. **DCU**/*E*/**TLI/EXPL**

T: *(Writes 'monthly fee')* Every month. What is it for? **CCU**/*E*/**TLI/PROBE**

Class: For services. **DCU**/*E*/**TLI/RESP**

T: Who's giving the services? *E*/**TLI/PROBE**

Class: Brahm Park Municipality. *E*/**TLI/RESP**

T: Okay, the twenty cents? **CCU**/*E*/**TLI/PROBE**

Gabriel: The unit, kilowatt. If you use … if you use … *E*/**TLI/RESP**
T: Ha o dirisa … *HL*/**TLI/PROBE**
Gabriel: Hooo …, twenty cents ke … per unit one. If you use one unit, you pay twenty cents. If you use two units you pay forty cents, and on … **DCU**/*E*/**TLI/EXPL**
Steve: Meneer, the twenty cents is the money that you have to pay after one hour, one kilowatt. **DCU**/*E*/**TLI/EXPL**
T: The money that you pay … *E*/**TLI**
Steve: After one hour meneer. *E*/**TLI/RESP**
T: So, is the money that you pay after one hour *E*/**TLI**
Steve: Yes, for one kilowatt. *E*/**TLI/RESP**
T: For one kilowatt *(writes '1kwh' on chalkboard)* kilowatt-hour. Okay, lets say for that month you use *(writes '2 kwh/month' on chalkboard)* two kilowatt-hours for that month only, usebenzisa two kilowatt-hours, zwino ukhobhadala bugai nga ngwedzi *[you use two kilowatt-hours, now how much will you pay per month]*? **CCU/ECU**/*E-HL*/**TLI/QUEST**
Some learners: Forty rand forty cents. **DCU**/*E*/**TLI/RESP**
T: Forty rand forty cents *(writes 'R40,40c' on chalkboard)*.
(Sounds of someone knocking at the door. Goes to the door. Too much noise from outside. One observer closes windows. Teacher attends to someone at the door and comes back). Where does it come from? Uyithole kanjani? Angithi ngithe because its two kilowatt-hours per month, yena uthi sizobadala forty rand forty cents, manje ngifuna ukuyazi ukuthi le forty rand forty cents ibuya kuphi *[How did you get it? I said because it is two kilowatt-hours per month, he said we will pay forty rand forty cents, now I want to know how did you get forty rand forty cents]*. Nkateko. **CSC/CAR/EAR**/*E-HL*/**TLI/PROBE**
Nkateko: Forty rand hiya tiservice, forty cents hile ya tikilowatt letingwani … *[Forty rand is for services, forty cents is for the kilowatts…]* **DAR**/*HL*/**TLI/EXPL**
T: Forty cents wikume njani *[How did you get forty cents]*? **CSC/ESC**/*HL*/**TLI/PROBE**
Nkateko: Aniri hi awara ba teka twenty cents, so ene o tirhise for two hours, tiawara timbere. *[Isn't it it cost twenty cents per hour, so he used it for two hour.]* **DSC**/*HL*/**TLI/EXPL**
T: Tiawara o re tikilowatt-hour? *[Hours or kilowatt-hour?]* **CCU**/*HL*/**TLI/PROBE**
Class: Kilowatt-hours. *E*/**TLI/RESP**
Steve: *(Raises hand).*
T: Okay, yes, questions? *E*/**TLI**
Steve: No. *E*/**TLI/RESP**
T: Ufuna ukusho *[Do you want to say]* something? *HL-E*/**TLI/QUEST**
Steve: Mina bengithi, I think le forty cents meneer, angithi basinigeze itwo kilowatt-hours for one month? *[I am saying, I think this forty cents sir, they gave us tow kilowatt-hours for one month?] E-HL*/**TLI/QUEST-EXPL**
T: Eya *[Yes]*.
Steve: So ngizothi *[So I will say]*, twenty cents times two kilowatts for that month, which is equals to forty cents, plus forty rands. **DSC/DPF/DAR**/*HL-E*/**TLI/EXPL**
T: Plus forty rand for the service *(writes on the board)*. *E*/**TLI/ASSIST**
Class: Yes.
Steve: Sizobadala …, imali esizoibadala per month. *[It is the money that we ill pay per month.] HL*/**TLI/RESP**
T: Questions? Do you have questions? Le ne le na le question *[Do you have questions?] (to the Setswana group)*? *HL-E*/**TLI/QUEST**
Group: No.
T: Le siame jaanong? *[Are you okay now?] HL*/**TLI/QUEST**
Group: Yes. *E*/**TLI/RESP**
T: Right, a re berekeng number one ge *[Let us do number one now]*. Questions? You seem to be having a question *(Looking at the IsiZulu group1)*. *HL-E*/**TLI/INSTR**

TEACHER-LEARNER INTERACTION (GROUP)

(Some groups have already done question 1, and IsiZulu group 2 calls the teacher).
T: Can you explain how you have done it *(Referring to question 1)*. **CSC/RAR**/*E*/**TLI/INSTR**

Steve: *(Explains but inaudible)*.
T: Now do number two. *E*/**TLI/INSTR**

(Teacher goes to the Venda group 2).
Colbert: *(Explains but inaudible)*.

(Teacher goes to the Setswana group 1).
Gabriel: This amount *(referring to the '20c' written on the sheet)* meneer …, *E*/**TLI/EXPL**
T: This amount, yes twenty cents. *E*/**TLI/ASSIST**
Gabriel: Times this amount, five hundred and sixty, e tlo refa this amount *(Pointing at 'R11200' written on the sheet)*. *E-HL*/**TLI/EXPL**
Ronald: This amount ebe setse re eda le forty … forty ranta. *[This amount and then we add forty rand]* **DSC/DPF**/*HL-E*/**TLI/EXPL**
T: Alright, now akere Electricity Department e chacha ka diranta not ka disente, akere? *[Alright, now isn't it the Electricity Department charges in rands and not in cents?]* **RCU**/*HL*/**TLI/ASSIST**
Group: Yes.
T: Mara ba chacha *[But they charge]* one kilowatt-hour … **RCU**/HL-E/**TLI/PROBE**
Group: Ka *[For]* twenty cents. *HL*/**TLI/RESP**
T: Now, ha o maltiplaya *[if you multiply]*, if you say you multiply that … twenty cents …, now if… if you multiply cents …, if you use cents to multiply, are you going to get rands? You get what? **CCU/CSC**/*E*/**TLI/QUEST**
Group: Cents. **DCU**/*E*/**TLI/RESP**
T: Cents. How many cents? **CCU**/*E*/**TLI/PROBE**
Group: Eleven thousand two hundred cents. **DCU**/*E*/**TLI/RESP**
T: Then you need to convert to what? **RCU**/*E*/**TLI/PROBE**
Gabriel and Pontsho: To rands. *E*/**TLI/RESP**
T: How are you going to convert this to rands? **EPF/ESC**/*E*/**TLI/QUEST**
Group: *(Silent)*.
T: Because if you add this, you are saying if we add this forty rand, this is forty rand and these are cents, eleven thousand two hundred cents per … *E*/**TLI/PROBE**
Gabriel and Pontsho: Kilowatt-hour. *E*/**TLI/RESP**
T: Okay, you have to convert this to … *E*/**TLI/ASSIST**
Group: Cents. *E*/**TLI/RESP**
T: These are cents, this are rands, can you add …, these are unlike terms. You can … you can … If you say cents plus this hundred … eleven thousand two hundred cents plus forty rand, you can't get it. You either convert this forty rand to cents or this *(referring to 11200c)* to rands so that you can add like terms. So, you need to convert this *(referring to R40-00)*. The other alternative is to do what if you do not convert that? **RPF/RSC**/*E*/**TLI/EXPL-ASSIST-QUEST**
Gabriel: To change this *(referring to 20c)*. *E*/**TLI/RESP**
T: Into what? *E*/**TLI/PROBE**
Gabriel and Pontsho: Into rands. **DSC**/*E*/**TLI/RESP**
T: Eya, that's the other alternative. *E*/**TLI**
Gabriel: Okay.
T: To change that *(referring to '20c')* into rands is going to be what? *E*/**TLI/QUEST**
Pontsho: Zero comma two zero.
T: How many rands? *E*/**TLI/PROBE**
Group: Zero rands. *E*/**TLI/RESP**
T: How many cents? *E*/**TLI/PROBE**
Group: Twenty cents. *E*/**TLI/RESP**

(Teacher leaves the group to continue on their own and goes to the Setswana group 2).

LEARNER-LEARNER INTERACTION (GROUP)

(The Setswana group 1 discussing on their own):
Gabriel: Ke gore every time ntho enngwe le enngwe o e tšhentšha ko disenteng e tlo ba ... *[That is*

every time you convert anything to cents it becomes …] HL/**LLI/EXPL**

Thapelo: E tlo ba ranta. *[It becomes rand] HL*/**LLI/RESP**

Gabriel: Ore if … if ke disente tse baie ne, wa itse o tlo etsang, o tlo re … o tlo re twenty, wa bona, every time if … *[Or if ... if there are many cents, do you know what to do, you will say… you will say, you see, every time if …] HL*/**LLI/EXPL**

Ronald: *(Interrupting, but inaudible)*.

Gabriel: Mamela, ere ke go tlhalosetse. If … if … die ding, wa bona e ne e le disente ne, if ke disente, every time wa e tšhentšha, o e tšhentšhela ko zero comma two zero, then e be o e eda le tšhelete ya diservice, which is forty rands, wa bona. *[Listen let me explain. If ...if this thing, can you see it was cents, if it is cents, every time you change it, you change it to zero comma two zero, then you add it to service charges, which is forty rands, you see]*From there you get the answer which is forty rand twenty cents. **RPF/***HL-E*/**LLI/EXPL**

Ronald and Thapelo: Okay.

Ronald: So hierso vele setse re e shaile *[So this one is complete]*? *HL*/**LLI/QUEST**

Gabriel: Eya, re e shaile. This ke disente. *[Yes it is complete. This are cents.] HL-E*/**LLI/RESP**

Ronald: Mo o ne o setse o e khonvetile? *[Have you already converted this one?] HL*/**TLI/QUEST**

Gabriel: Eya, re e khonvetile *[Yes, we have converted it] (writes on the sheet)*. *HL*/**TLI/RESP**

TEACHER-LEARNER INTERACTION (CLASS)

(Teacher goes to the front and attends to the whole class)

T: Right, masibhekeni number one kahle, masibhekeni number one kahle, ngoba ama-groups amanye ayastraglisha ngale twenty cent. Masibhekeni inumber one kahle, okay. *(Reads question 1 in English)* Le five sixty, yini amakilowatt-hour? *(Writes '560 kwh' on the board)* Yini le five sixty? *[Right, let us carefully look at number one, because some groups are still struggling with this twenty cent. Let us look at number one, okay. (Reads question 1 in English) This five sixty, is it kilowatt-hours? (Writes '560 kwh' on the board)What is this five sixty?]* **CCU/ECU/***HL-E*/**TLI/INSTR-READ-QUEST**

Steve: Hile basisaplaya ngayo meneer. *[That is what they supply us with sir.] HL*/**TLI/RESP**

T: He?

Steve: Monthly fee. *E*/**TLI/RESP**

Mulalo: No, estimated consumption. **DCU***/E*/**TLI/RESP**

T: What does that mean? **ECU/***E*/**TLI/PROBE**

Mulalo: The amount basebenzise yone *[used]*. **DCU/***HL-E*/**TLI/EXPL**

T: Used, angithi *[isn't it]*? *HL-E*/**TLI**

Class: Yes.

T: Per month, for the whole month. Lets say for January o sebenzisa five sixty, estimated, five hundred and sixty kilowatt-hours per month. Obadala malini *[How much do you pay]* for one kilowatt-hour? *E-HL*/**TLI/QUEST**

Class: Twenty cents. *E*/**TLI/RESP**

T: Twenty cents *(writes '20c' on the board).*Yini futhi oyibadalayo *[What else do you pay]*? **CCU/***HL*/**TLI/PROBE**

Class: Forty rands. *E*/**TLI/RESP**

T: Forty rand *(writes 'Service fee: R40-00')*. Manje ke, ngifuna ukuyazi ukuthi *[Now I want to know that]* five hundred and sixty kilowatt-hours, when you use it for the whole month, to calculate the total amount, tšhelete e tlo e patelang ka kgwedi, o tlo e khalkhuleita yang *[how will you calculate the monthly cost]*? Steve. **ESC/EPF/EAR/***HL-E*/**TLI/QUEST**

Steve: Ningaza ebodini *[Can I come to the board]*? *HL*/**TLI/QUEST**

T: Eya, umauza ebodini u-expleine *[Yes, if you come to the board, you must explain]*. **CAR/***HL*/**TLI/INST**

(Steve goes to the chalkboard)

Steve: Twenty cents times five sixty *(writes 'R0,20c x 560 kwh' on the board)*, aungiboleke ikhalkhuleitha *[please lend me your calculator]*, one one two *(writes 'R112')*. After that you say plus *(writes '+R40', then uses calculator and writes 'Total R152,00')*. **DSC/DPF/***E-HL*/**TLI/EXPL**

T: Manje ngifuna ukuyazi *[Now I want to know]*, why is this zero comma two? Mazibandela. **RAR/ECU**/*HL-E*/**TLI/QUEST**
Ronald: I think sir er … because he has no rands. *E*/**TLI/EXPL**
T: Ya …
Ronald: That is why is zero comma two, just cents. *E*/**TLI/EXPL**
T: Cents. So, lana ke, ukhonvete icents into rands *[So. here you converted cents into rands]*. Questions, Thamsanqa? Nina beniyenzeni *[How did you do it] (referring to the Setswana group 2)*? **CSC/CAR/***HL-E*/**TLI/CONFIRM-QUEST**
Thamsanqa: Si thaemse *[We multiplied] … (inuadible)*. *HL*/**TLI/RESP**
T: Uthaemse *[You multiplied] … HL*/**TLI**
Thamsanqa: Twenty cents times twenty-four hours *E*/**TLI/EXPL**.
T: *(Writes '20c x 24 hours' on chalkboard)* Twenty cents times twenty-four hours. *E*/**TLI**
Thamsanqa: Ra thola *[We got]* er… er… four eighty …four rand eighty. *E-HL*/**TLI/EXPL**
T: Four rand eighty? Before you continue, why o malthiplaya twenty cents ka twenty-four hours *[why do you multiply twenty cent by twenty-four]*? **CSC/CAR/** *HL-E*/**TLI/PROBE**
Thamsanqa: Twenty-four ke dihours tsa letsatsi. Like mo letsatsing re na le dihour tse itwenty-four. *[Twenty-four is hours of the day. Like in one day, there are twenty-four hours] HL*/**TLI/EXPL**
T: Eya, ke batla go itse gore why o maltiplaya ka …, diura tsa letsatsi di … *[Yes, I want to know why do you multiply by …, hours of the day are….] HL*/**TLI/PROBE**
Thamsanqa: Twenty-four hours ke *[is]* one day. *E-HL*/**TLI/EXPL**
T: Yanong why o maltiplaya ka one day? Akere le e entse jaaka group? [Now why do you multiply by one day? you did it as a group, isn't it?] *HL*/**TLI/PROBE**
Thamsanqa: Akere re maltiplaile per month. *[We multiply per month] E-HL*/**TLI/EXPL**
T: Yanong ha o tsaya per month is how many days? *[If you take it per month, how many days is it?] HL-E*/**TLI/PROBE**
Thamsanqa and Calvin: Thirty days. *E*/**TLI/RESP**
T: You multiply this by thirty? *E*/**TLI/QUEST**
Thamsanqa and Calvin: Yes. *E*/**TLI/RESP**
T: You said times thirty? *E*/**TLI/QUEST**
Group: Yes.
T: Then e re fa bokae? *[Then how much do we get?] HL*/**TLI/PROBE**
Calvin: One hundred and forty-four.
T: One four four. Then is this the total? *E/***TLI/PROBE**
Calvin: No, plus forty rands. *E/***TLI/RESP**
Thamsanqa: Ya diservice *[For services]*. *HL*/**TLI/EXPL**
T: Plus forty, which is … *E/***TLI/PROBE**
Class: One eighty-four. **DAR/DSC/DPF/***E*/**TLI/RESP**
T: Selo se ke sa se tlhaloganyeng ke gore goreng le maltiplaya ka matsatsi. Ke kopa le ntlhalosetse gore goreng le maltiplaya ka matsatsi. *[What I do not understand is that you multiply by days. Please explain why do you multiply by days.]* **CAR/CSC/***HL*/**TLI/INST**
Group: *(Silent)*.
T: A le direng gore re tlhaloganye sentle gore goreng le tsaya twenty cents le e maltiplaya ka matsatsi a thirty *[Just make sure that we understand why you take twenty cent and multiply it by thirty days]*. Can you explain. *(Class makes noise)* Can we give them a chance please. A re bafeng chance. A re ba reetseng, a re utlwelleng *[Let us give them a chance. Let us listen to them]*. **CSC/RAR/***HL-E*/**TLI/INST**
Calvin: What we did, twenty cents is like kilowatts used in an hour, and we have twenty-four hours in a day. We multiply that twenty cents by twenty-four hours. **DSC/DAR/***E*/**TLI/EXPL**
T: *(Writes on the chalkboardboard)* Oh, do you say one kilowatt-hour for a day is twenty-four hours, okay, yanong one kilowatt for twenty four hours, so e tlo nna for letsatsi *(writes '1kw 24h')*. O raya gore e tlo nna le dikilowatt-hour, o raya gore there are twenty-four kilowatt-hours *[now one kilowatt for twenty-four hours, so it is going to be for a day (writes '1kw 24h'). Do you mean it is going to have kilowatt-hours, do you mean there are twenty-four kilowatt-hours]*? *E-HL*/**TLI/PROBE**
Calvin: No, times twenty cents, because 1 kilowatt is equals to twenty cents. *E*/**TLI/EXPL**
T: One kilowatt? No, is not equal to twenty cents. Bala sentle selo seo. Sa re one kilowatt oe duella twenty cents? One kilowatt ga e lekane le twenty cents, okay. Yaanong ha o re …, ha o kwetse so, e

le yana *[points at '1kw 24h' on the board]*, e le yana, go raya gore ka letsatsi o dirisa dikilowatt tse twenty-four. *[Read carefully. Is it saying one kilowatt costs twenty cent? One kilowatt is not equal to twenty cent, okay. Now when you say …, if you have written like that, it means you use twenty-four kilowatts per day] E-HL*/**TLI/INSTR-EXPL-PROBE**

Calvin: Yes, the whole night the whole day, twenty-four hours. *E*/**TLI/RESP**

(Laughter in class)

T: Bala one kilowatt-hour ke eng. O e bale ka sekgowa, o e bale ka SeTswana. Ba re ke eng one kilowatt-hour? *(Reads English version)* Right, go raya gore the power, matla a that electricity is constant. The power ha e tšhentšhe. Ha o ka dirisa motlakase o, wa dikilowatt tse kae, e le nngwe ka kgwedi, mara the power is constant. That does not mean gore is one kilowatt per hour. Is one kilowatt-hour, not per hour. Because ha o bua ka power, power diuniti tsa teng ke dikilowatts or watts. Now electricity yona ba e mejera ka dikilowatt-hours. Mara the power there, provided that the power is constant, ha e fetofetoge. Because ha e le gore matla a teng a tsamaya a ntse a tšhentšha, a motlakase, is not going to be easy for them to calculate the electricity consumption. So, wena o re ke one kilowatt-hour, go raya gore ka letsatsi o berekisa … you use … *(goes to the light switch)*, ha ke laeta mo, that does not mean that ha awara e fetile, ha o e mejara o setse o dirisitse only one kilowatt, depending also on the power of the appliance that you use, that constant power …, if power ya appliance is …, ha o lebella, ha e le radio le geyser ore heater, ke efeng e e dirisang motlakase o montsi? **RCU**/*HL-E*/**TLI/INSTR-READ-EXPL-QUEST**

Class: Heater. *E*/**TLI RESP**

T: Ke hithara ka gore e dirisa matla a mantsi. E ka se je motlakase go lekana le wa radio ka nako e le nngwe. O ka fitlhela e le gore hithara ka ura e setse e jele motlakase o o leng kana ka forty-five kilowatt-hours mara radio yona e dirisitse fela three kilowatt-hours. Wa e tlhaloganya? Go raya gore ha o dirisitse five-hundred and sixty ke motlakase oo dirisitsweng kgwedi e yotlhe, kgwedi e yotlhe e felletse, from di-first tsa January go fitlha di-thirty tsa January. Ba estimeitile. *[It is the heater because it used a lot of power. It will not consume the same power as a radio at the same time. You may find that in one hour, a heater has consumed forty-five kilowatt-hours of electricity, but the radio used only three kilowatt-hours. Do you understand? That means if you use five-hundred and sixty, it is the monthly electricity, the whole month, from January the 1st until the 30th, if estimated]*. **RCU**/*HL*/**TLI/CONFIRM-EXPL**

Calvin: So, go raya gore that answer is correct *[So does it mean that answer is correct]*? *E-HL*/**TLI/QUEST**

T: Which one? *E*/**TLI/QUEST**

Calvin: That one, Steve's. *E*/**TLI/RESP**

T: According to the explanation, wena o nagana eng *[what do you think]*? **EAR/CSC**/*HL-E*/**TLI/PROBE**

Calvin: I think is incorrect. *E*/**TLI/RESP**

T: Why do you say is incorrect? **RAR**/*E*/**TLI/PROBE**

Calvin: I think that twenty cents, you have to divide that five sixty by twenty cents. *E*/**TLI/EXPL**

T: Why divide? **RAR/CPF**/*E*/**TLI/PROBE**

Calvin: Because twenty cents is the power that we use. *E*/**TLI/EXPL**

T: Twenty cents is the power that we use? What is the twenty cents? E bale gore twenty cents ke eng. E bale ka SeTswana, a reye ko SeTswaneng, gongwe o tla e tlhaloganya *[Just read what is twenty cents for. Read it in Setswana, let us go to the Setswana version, maybe you will understand it]*. Can you read it. **CCU**/*HL-E*/**TLI/QUEST-INSTR**

Calvin: *(Reads the statement)*. *HL*/**TLI/READ**

T: Twenty cents per how many kilowatt-hours? One kilowatt-hour o e patalla bokae *[How much do you pay for one kilowatt-hour]*? *E-HL*/**TLI/QUEST**

Calvin: Twenty cents. *E*/**TLI/RESP**

T: If one kilowatt-hour ha o e patalla twenty cents, ha dile ten di-kilowatt-hour o di patalla bokae *[If one kilowatt-hour is twenty cent, if they are ten how much will you pay]*? **RPF/CPF**/*HL*/**TLI/PROBE**

Calvin: Two ranta *[Two rand]*. *HL*/**TLI/RESP**

T: O e kreile yang two ranta *[How did you get two rand]*? **CSC/EPF**/*HL*/**TLI/PROBE**

Calvin: Twenty cents times ten. **DPF**/*E*/**TLI/EXPL**

T: Twenty cents times ten. Ha di le five sixty o etsang *[If they are five sixty what do you do]*? **EPF**/*E-HL*/**TLI/PROBE**
Calvin: Twenty times five sixty. **DPF/DSC**/*E*/**TLI/EXPL**
T: O a e tlhaloganga yaanong *[Do you understand it now]*? *HL*/**TLI/QUEST**
Calvin: Yes. *E*/**TLI/RESP**
T: Right, aa gona le potso e nngwe gape? Gona le dipotso? *[Do we have questions?] HL*/**TLI/QUEST**
Class: No. *E*/**TLI/RESP**
T: Manje ke *[Now]*, lets do number two. *(Observer indicates time up]* Right, we shall continue, re tla tswella pele ka moso. Er … baeng ba rona ba na le ko ba yang ko teng *[We will continue tomorrow. Er… our visitors are going somewhere]*. *E-HL*/**TLI/INSTR**

LESSON 2

TEACHER-LEARNER INTERACTION (CLASS)
(The teacher made two learners one from each IsiZulu group to exchange groups).

T: Sisi *[Lady]*, please join that group *(points at the first IsiZulu group, Nhlanhla's group)*. Why are you five here *(Referring to the first TshiVenda group, Sipho's group)*? Right, now class we are going to continue from where we ended yesterday. But before we continue, let us look at what we found yesterday. We have found that karabo ya ntlha *[the first answer]* was er… re ne re khalkhuleita *[we were calculating]* the estimated monthly consumption, and the answer was … what was the answer? *E-HL*/**TLI/INSTR-QUEST**
Class: One fifty two. *E*/**TLI/RESP**
T: *(Writes 'R152-00/month' on the chalkboardboard)* One fifty two rands per month. *E*/**TLI/COMFIRM**
Class: Yes
T: Okay that was hundred and fifty two rands per month. Imali ebaibadalayo after using ugesi we-five hundred and sixty kilowatt-hours, okay *[That is the money paid after using five hundred and sixty kilowatt-hours of electricity]*. Now for number two what was the answer? ***E-HL*/TLI/EXPL-QUEST**
Ls: We haven't done it. *E*/**TLI/RESP**
T: Right, can we quickly do number two. But let us … let us remind ourselves on the question before we do number two, okay. Let me ask …, can you read number two in your language, the statement just once, the statement once in your language, ka SeTswana. E bale ka SeTswana *[in Setswana. Read it in Setswana]*, the statement itself, the statement. *E-HL*/**TLI/INSTR**
Gabriel: *(Reads the statement in Setswana)*. *HL*/**TLI/READ**
T: Right, then ke kopa *[then I am requesting]*… can you read the question itself for number two *(points at the learner in the second TshiVenda group 2)*. *E-HL*/**TLI/INSTR**
Carol: *(Reads the question in TshiVenda)*. *HL*/**TLI/READ**
T: So that is question number two. I've, I've seen ukuthi bakhona abanye abase bayiyenzile *[that some have done it]*, but very few, about two … one group ise iyiyenzile *[has done it]*. So in … we are going to do that one, sizoyiyenza nge-two minutes in our groups, question number two. *(Goes to the SeTswana group 1)* Re dira number two ne. ke le fa metsotso e mebedi fela *[we will do it in two minutes in our groups, question number two]*. *(Goes to the XiTsonga group)* Le e entse *[Have you done it]*? *E-HL*/**TLI/INST-QUEST**
Group: Yes.
T: Who wants to explain? **CCU/EAR**/*E*/**TLI/QUEST**
Nkateko: *(Inaudible)*.

LEARNER-LEARNER INTERACTION (GROUP)

(The TshiVenda group1 on their own)
Sipho: People, think, be matured. Eya, they say *(reads question 2 in TshiVenda)* 'Bathu bararo ba dzula … athiri, tshikiloto … one eighty ne, so ba shumisa kha ngwedzi' *['Three people live…, their monthly charge …one eighty, so they use it per month']*. **RCU**/*E-HL*/**LLI/MOTIVATE-READ-EXPL**

Given: Kha ngwedzi. Nga duvha athiri kha duvha ba shumisa er … lets say like kha duvha one hour baitshatsha twenty cents, so twenty cents times electricity ebaishumisaho kha … *[Per month. Per day they use er ... let us say like per day one hour is charged twenty cent, so twenty cent times electricity consumed per ...]* **DCU**/*HL-E*/**LLI/EXPL**
Sipho: Kha ngwedzi *[Per month]*. *HL*/**LLI/RESP**
Given: Eya, twenty times … two times thirty? *E*/**LLI/QUEST**
Verda: Thirty-one.
Given: Are you sure? **CCU**/*E*/**LLI/PROBE**
Patience: *(Uses calculator to work out the answer and shows it to Sipho)*.
Sipho: Sixty-two rands. Eya, ke yone *[Yes, it is correct]*. *E-HL*/**LLI/RESP**
Given: *(Writes the answer down)*.
Sipho: Lets try to do number three. *E*/**LLI/MOTIVATE**
Ls: Eya.
Sipho: Right, *(reads question 3 in TshiVenda)*. *HL*/**LLI/READ**
(The group discusses and works on the question but they are inaudible. The teacher comes to the group).

TEACHER-LEARNER INTERACTION (GROUP*)*

T: *(Checks the group's written response for question 2)* You don't pay twenty cents per day. Uma uyenza so, zwamba huri ubadala *[if you do it that way, it implies that you pay]* twenty cents … twenty cents per day, duvha na duvha u badala *[per day you pay]* twenty? No. **CSC**/*E-HL*/**TLI/EXPL**
Given: Per hour. *E*/**TLI/RESP**
T: No, ukho ngwala twenty times thirty-one days, zwamba huri twenty cents boibadala *[No, you have written twenty times thirty one, meaning that they pay twenty]* every … per day. Let's first start here. Let's look at this one. They pay, where's the answer for number one? Okay, it is one-fifty two per month. This is on-fifty two per month, total. But total er … utanganyisa forty na one one two *[you add forty and one one two]*. Ivhagai *[how did you get]* one one two? **CSC/EPF**/*E-HL*/**TLI/EXPL-QUEST**
Given: Kha *[From]* twenty cents times five-sixty. **DPF/DSC**/*E-HL*/**TLI/EXPL**
T: Kha twenty cents times dzi-kilowatt hedzi five-sixty *[From twenty cen times five-sixty kilowatts]*. So when we add that *(Referring to R40-00)*, rho bona one-fifty two, athiri *[we get one-fifty two, isn't it]*? Zwino *[Now]*, then when the account comes, bona vho badala *[they will pay]* one-fifty two, total, but the electricity department has already added forty rands plus the amount of hundred and twelve. Let's look at this one *(Referring to question 6)*, the total now is what? **CSC/RPF**/*E-HL*/**TLI/EXPL-QUEST**
Ls: One-eighty.
T: One-eighty? How much is the service fee in this one? *E*/**TLI/PROBE**
Ls: *(silent)*.
T: The service for every month is how much? *E*/**TLI/PROBE**
Patience: Forty rands. *E*/**TLI/RESP**
T: Forty rands, so the forty rands … so how much will you pay for the electricy consumption? Ukho badhala vhugai for mudagasi ukhoushumisa *[How much will you pay for electricity consumed]*? *E-HL*/**TLI/QUEST**
Verda: One-forty.
T: So one-forty ndishelede ya dzi-kilowatt-hours athiri *[So one-forty is cost for the kilowatt-hours, isn't]*? *HL*/**TLI/EXPL**
Ls: Yes.
T: Per month, the one that you use. *E*/**TLI/EXPL**
Ls: Yes.
T: But forty rand is always there. *E*/**TLI/EXPL**
Sipho: All the time. *E*/**TLI/RESP**
T: Nga ngwedzi na ngwedzi, athiri. *HL*/**TLI/EXPL**
Ls: Eya.

T: Then that hundred and forty hiya dzi-kilowatt-hours, so you find the kilowatt-hours. But you must show how you get that one-forty, okay. Let's do it. So you start by doing what first? **RPF/***E-HL***/TLI/EXPL-INSTR-QUEST**
Verda: *(Inaudible. Writing on paper)*.
T: So write it down then. **INST/***E***/TLI**
Verda: *(Inaudible)*.
T: You said what? *E***/TLI/QUEST**
Verda: *(Inaudible)*.
T: Okay, let's think. Let's do it this way, akere one-eighty hiya the whole month *[one-eighty is for the whole month]*? **CPF/RPF/***E-HL***/TLI/MOTIVATE/EXPL**
Ls: Yes.
T: So from the one-eighty, can you first from one-eighty find the amount you pay for the electricity consumption. Imali ozoyibadala *[It is money you pay]* for consumption. *E-HL***/TLI/ASSIST-EXPL**
Sipho: Forty rands. *E***/TLI/RESP**
T: No, I am saying look for the amount that you will pay for the electricity consumption. How much is it? Imalini? **CCU/***E-HL***/TLI/INSTR/PROBE**
Ls: One-forty.
T: One-forty. How do you get one-forty from one-eighty? **CSC/RAR/***E***/TLI/PROBE**
Ls: *(Silent)*.
T: For services, is how much? **CCU/***E***/TLI/PROBE**
Sipho: Forty.
T: The total? *E***/TLI/PROBE**
Ls: One-eighty.
T: How do you get one-forty? **EPF/CSC/RAR/***E***/TLI/QUEST**
Given: Akere sir is one-eighty minus forty. **DPF/DAR/DSC/***E-HL***/TLI/EXPL**
T: Write it down. *E***/TLI/INSTR**
Given: *(Writes '180 – 40 = 140' on paper)*.
T: Zwino one-forty heyi ndi shelede ya mini *[Now, this one-forty, what is it for]*? **ECU/***HL***/TLI/QUEST**
Ls: Ya dzi-service *[For services]*. **DCU/***HL***/TLI/RESP**
T: Ya dzi-service pfedzi, athiri *[For services only, isn't it]*? *HL***/TLI/CONFIRM**
Ls: Yes.
T: Now, you need to use that one-forty, no, one-forty is not for services, is for the electricity consumption, dzi-kilowatt-hours that you used for this month. This is what we are looking for. **RCU/***E***/TLI/EXPL**
Given: So forty rhanda hiya *[So forty rand is for]*…? *HL***/TLI/QUEST**
T: Forty rand is for services. *E***/TLI/RESP**
Given: Okay.
T: Now, from this one-forty, you need to look …., to find the kilowatt-hours that you used for the month. So you need to think how much will they pay per kilowatt-hour. How much do they pay per kilowatt-hour? **RCU/RSC/RPF/***E***/TLI/EXPL-MOTIVATE-QUEST**
Ls: Twenty cents. **DCU/***E***/TLI/RESP**
T: Twenty cents. How much are they paying total? *E***/TLI/QUEST**
Sipho: One-forty.
T: One-forty. So how many kilowatt-hours will they use per month? You see. How many kilowatt-hours will they use if they pay hundred and forty for the kilowatt-hours, if one kilowatt-hour is twenty cents? Can you write this in your answer sheet. **RPF/***E***/TLI/INSTR/QUEST**
Given: *(Writes '180 – 40 = 140')*.
T: Ndi tshelede ya … *[It is money for …]* **CCU/***HL***/TLI/PROBE**
Given: Ya *[For]* electricity. **DCU/***HL-E***/TLI/RESP**
T: Consumption. How much will you pay for consumption, one kilowatt-hour? **ECU/***E***/TLI/PROBE**
Ls: Twenty cents. **DCU/***E***/TLI/RESP**
T: Bhala one kilowatt-hour is twenty cents. If one kilowatt-hour is twenty cents, so, if we convert twenty cents heyi to rands, how much is it going to be? Athiri this is twenty cents, convert it to

rands. If you convert twenty cents to rands, ke bokae *[how much is it]*? **ACU**/E-HL/**TLI/INSTR-QUEST**

Verda: *(Inaudible)*.

T: If you convert, how did you convert this one? How did you make this one dirands? **RAR/CSC/***E***/TLI/PROBE**

Ls: *(Silent)*.

T: Where does this come from *(Referring to 0,20 on the group's answer sheet)*? Zero point two, what is that? **RAR/CSC/***E***/TLI/PROBE**

Given: *(Inaudible)*.

T: How many rands are there? *E***/TLI/PROBE**

Patience: One.

T: Where is the one? How many rands here? Vho ngwala vhugai hapfa *[What have you written here]*? *E-HL***/TLI/QUEST**

Verda: Zero.

T: This is zero. So, how many rands? *E***/TLI/PROBE**

Given: No rands. *E***/TLI/RESP**

T: There are no rands. How many cents? *E***/TLI PROBE**

Ls: Twenty.

T: Twenty. So, if rands is zero comma two then you have to convert this also. You always use that. So, one kilowatt-hour is twenty cents. Ei-one ke twenty cents, ke one kilowatt-hour. If it is hundred and forty, how many kilowatt-hours? You work it out. *(The group works on question 3 as teacher looks on. They are unsuccesful)*. Let's … let's look at it this way, this is ama-twenty cents awabadalayo *[this are the number of twenty cents you pay]*, this money here, monthly instalment. So, in the other words, you multiply this by that and this by that *(points at figure that the group has worked out in question 2)*. Lana *[Here]* is hundred and forty for the … **RPF**/*E-HL***/TLI/ASSIST-EXPL-QUEST**

Ls: Consumption. *E***/TLI/RESP**

T: Consumption. *E***/TLI**

Ls: Yes.

T: This is the money that you pay. *E***/TLI/EXPL**

Ls: Yes.

T: Now, from this one kilowatt-hour is twenty cents, now how many twenty cents are you paying, because e i-one kilowatt-hour ke twenty cents? Ama-twenty cents anngakhe la *[because one kilowatt-hour is twenty cents? How many twenty cents are here?]*? So, you have to find ukuthi how many. Then that …that …, the answer is consumption. How many twenty cents are there? Remember the twenty cent is in rands. **RPF/ECU/***E-HL***/TLI/QUEST-ASSIST**

Ls: Eya.

T: Twenty cent is in rands. So, in rands is what? **ECU/***E***/TLI/PROBE**

Verda: *(Inauduble)*.

T: He! Rands la *(points at statement on the task sheet]*? Remember, is this twenty *(refers to what the group has written)*? This is twenty *(writes '20' on paper)*, but this is what *(writes '20c' on paper)*? **RCU/***E***/TLI/PROBE**

Ls: Twenty cents. *E***/TLI/RESP**

T: Twenty cents? *E***/TLI**

Ls: Yes.

T: Right, this in rands. This is twenty, okay. *E***/TLI/EXPL**

Ls: Yes.

T: And this is … *E***/TLI**

Given: Two.

T: Two! Is this two? Lana, this? *E***/TLI/QUEST**

Ls: Zero comma two.

T: Zero comma two. So, rands, this is zero comma two rands, which is twenty cents. So you can't divide by twenty, you need to divide by what? **CPF/CSC/***E***/TLI/CONFIRM-EXPL-QUEST**

Ls: *(Inaudible)*.

T: Angithi is twenty cents, but in rands is zero comma two, because consumption is in rands, so you need to divide by the same units, which is rands. So hundred and forty rands, you convert this

twenty cents into rands is zero comma two rand, then you divide with what? **RPF/RCU/*E*/TLI/GUIDE-EXPL-PROBE**

Patience: Twenty cents. ***E*/TLI/RESP**

T: He!

Patience: Twenty cents. ***E*/TLI/RESP**

T: *(Shakes head and writes on group's sheet)* This is the consumption, so you need to find …, this is the money that you pay. How many twenty cents are there? I said how many what, twenty cents are there? But our twenty cents you have to convert. **CCU/*E*/TLI/EXPL**

Given: zero comma two. **DCU/*E*/TLI**

T: Then o tlo thola zero comma two, akere *[Then you will get zero comma two, isn't it]*? ***HL*/TLI/CONFIRM**

Ls: Yes.

T: Zero comma two. So, we are going to use that. Remember the first time you said we divide by twenty. You said you do this *(writes '140/20' on paper)* but this twenty cents must be converted into what? **CSC/CCU/RPF/*E*/TLI/EXPL-PROBE**

Ls: Rands. **DCU/*E*/TLI/RESP**

T: Into rands. When you convert into rands it is equal to what? ***E*/TLI/PROBE**

Patience: *(Inaudible)*.

T: E ba…? ***HL*/TLI/PROBE**

Ls: Zero comma two.

T: Zero comma two, so we divide with what then? **CPF/*E*/TLI/PROBE**

Ls: *(Silent)*.

T: Angithi uthe si-divider nge-twenty cents *[You said we divide by twenty cent]*? ***HL*/TLI/QUEST-REMIND**

Patience: Yes.

T: Fine, you are correct, but that twenty cents must be converted into …, rho i-khonvetha into … **CPF/*E-HL*/TLI/CONFIRM-PROBE**

Ls: Rands. ***E*/TLI/RESP**

T: Into rands. Uma u ikhonvetile *[When you convert it]*, remember I said you are correct to divide twenty cents, but the twenty cents must be converted into … **RCU/RPF/*E-HL*/TLI/PROBE**

Ls: Rands. ***E*/TLI/RESP**

T: Rands. You divide by that, so in rands is what? **CCU/*E*/TLI/PROBE**

Ls: Zero comma two. **DCU/*E*/TLI/RESP**

T: Zero comma two. So do you still divide by twenty cents? U ikhonvetile angithi *[You have converted it, isn't it]*? **CSC/*E-HL*/TLI/QUEST-PROBE**

Ls: Yes.

T: So u divaida ngani *[So what do you divide it with]*? ***HL*/TLI/PROBE**

Patience: *(Inaudible)*.

T: Ha?

Given: Akere ha o e khonvetile e tlo ba zero comma two *[If it is converted it becomes zero comma two]*. ***HL*/TLI/EXPL**

T: Yes, you are correct. Then you use what you have. Your conversion is right. Do it then, divide that, write the next step. You divide what by what? **RPF/*E*/TLI/MOTIVATE-INSTR-PROBE**

Given: Re divaeda ntho ena *[We divide this thing] (refers to '140' written on task sheet)* sir …, **DPF/*HL*/TLI/RESP**

Verda: One forty.

T: By …? ***E*/TLI/PROBE**

Verda: Zero comma two.

T: Eya, ngwala moo *[Write it here]*. ***HL*/TLI/INST**

(Teacher leaves the group as Given writes on task sheet).

LEARNER-LEARNER INTERACTION (GROUP)

(TshiVenda group 1 working on question 3 on its own)

Sipho: ba engedza nga twenty rhanda, one-sixty ore bare one-fifty *[They increase by twenty rand, one-sixty or one-fifty]*? ***HL*/LLI/QUEST**

Verda: Ba engedza nga *[They increase by]* twenty rands. *HL*/**LLI/RESP**
Given: Twenty percent ndi twenty rhanda *[Is twenty percent twenty rand]*? **RCU**/*HL*/**LLI/QUEST**
Patience: Eya *[Yes]*.
Given: *(Laughing)* Mmhh, twenty percent ndi twenty rhanda *[Twenty percent is twenty rand]*? **RCU**/*HL*/**LLI/PROBE**
Sipho: No, not like that. Listen, they use seven hundred kilowatt-hours. They use seven hundred kilowatt-hours ne, in winter, ne. In winter they use, ikhuphuka nga vhugai *[it increases by how much]*? Twenty percent ne. So *(reads TshiVenda version)* … shikoloto swa vhona *[their monthly bill]… (has two versions next to each other and switshes between the two versions)*. **RCU**/*HL-E*/**LLI/EXPL-READ**
Given: *(Inaudible)*.
Verda: Heater, geyser, eya. *E*/**LLI/RESP**
Sipho: Geyser e tshwana le heater *[Geyser is the same as heater]*. *HL*/**LLI/RESP**
Verda: Fan.
Sipho: Most … most … heater, le er … geyser, stove … *E*/**LLI/RESP**
(Noise and laughter from the XiTsonga group as they discuss with observer. Sipho continues talking but inaudible. The teacher comes to the group).

TEACHER-LEARNER INTERACTION (GROUP)

T: Twenty percent hiya mini *[What is twenty percent for]*? **RCU/ECU**/*HL*/**TLI/PROBE**

(Observer with XiTsonga group)
Shirley: Can I explain in English or Tsonga? *E*/**TLI/QUEST**
K: No no no, any language. *E*/**TLI/RESP**
Shirley: Okay, a ilavha, a ilavha … *[Okay, I am looking for…] HL*/**TLI/EXPL**
Nkateko: *(Interjects)* Unknown. *E*/**TLI**
Shirley: Unknown ne. This is our unknown. *E*/**TLI/EXPL**
Nkateko: Hi represete unknown ya la hi-x. So hilava mali ka le tabza, hi two point zero percent, swa Itava tala. Ni teke x, anwiri hi-unknown, hi teka hi tabza nere x times twenty plus *(inaudible)* plus forty, iba two-eighty. *[The unknown here is x. So I am looking for the cost, which is zero point zero two percent, it comes here. I take x, which is the unknown, then I take it and say x times twenty (inaudible) forty, eighty]*. **DAR/DPF**/*HL*/**TLI/EXPL**
Promise: One-eighty.
Nkateko: One-eighty, so hi teka … hi teka … hi transposer forty la, hi beka hilaya, iba two-eighty. *[One-eighty, so I take… I take… I transpose here, I place it there, it becomes two-eighty] HL*/**TLI/EXPL**
Ls: One-eighty.
Nkateko: Se iba ka two *[Then it becomes two]* … *HL*/**TLI/EXPL**
Ls: Zero point two.
Nkateko: Zero point two, then is equals to … *E*/**TLI/EXPL**
Ls: One-eighty minus forty. *E*/**TLI/RESP**
Nkateko: Se i-zero point two is equals to… *(inaudible)*. Hi teka zero point two, hi divider hinkwato, hi khansela *(inaudible)*. So hi teka … hi teka zero point two leya, hi divider yona ka…. *(inaudible)*, hi koma seven hundred as answer. *[Then zero point two is equal to … (inaudible). I take zero point two, I divide all, it cancels (inaudible). So I take… I take this zero point two, I divide it with …(inaudible), I get seven hundred as an answer]*. **DAR/DSC/DPF**/*HL-E*/**TLI/EXPL**
K: So, your answer is seven hundred? *E*/**TLI/PROBE**
Ls: Eya.
Nkateko: Seven hundred.
Ls: Seven hundred kilowatt-hours. **DCU**/*E*/**TLI/RESP**
K: Okay.
(Laughter from the group)
Shirley: *(Reads question 4 in XiTsonga)*. *HL*/**TLI/READ**

(Teacher and observer go to the SeTswana group 2, and teacher then goes to the IsiZulu group 2, and then to the TshiVenda group 1).

(Teacher with TshiVenda group 1)
T: Right, twenty percent, percentage … percentage … percentage. Let's say, angithi let's say u ne hundred … hundred marks, zwino ri nyaga *[now we are determining]* twenty percent of hundred marks. *(Writes on paper)* Twenty percent of hundred ndi vhugai *[is how much]*? Twenty percent? **CCU**/*HL-E*/**TLI/QUEST**
Verda: Is eighty. **E/TLI/RESP**
T: Twenty percent is eighty? Eighty percent will be what? **CCU**/*E*/**TLI/PROBE**
Ls: *(Silent)*.
T: What is twenty percent of hundred? *E*/**TLI/PROBE**
Patience: Two hundred.
T: Two hundred, mo handreteng? **CCU**/*HL*/**TLI/PROBE**
Verda: Seventy.
T: How did you get seventy? **EPF/CSC**/*E*/**TLI/PROBE**
Verda: *(Inaudible)*.
T: Okay, a re etse so, o na le fifty marks, hundred percent of fifty marks. Let's say its an exam, wena e be o bona hundred percent of those marks, how many marks did you get? **ECU/CCU**/*E-HL*/**TLI/PROBE-EXMP**
Sipho: Total. **DCU**/*E*/**TLI/RESP**
T: How much is total? **ECU**/*E*/**TLI/PROBE**
Ls: *(Silent)*.
T: O ngwetse test ya fifty marks, o ngwetse test, test ke fifty marks, total. O kraya hundred percent, ke how many marks *[You have written a test out of fifty marks, you wrote the test, the test is fifty marks, total. You obtain hundred percent, how many marks is it]*? *E-HL*/**TLI/PROBE**
Sipho: (*Inaudible)*.
T: Hundred percent ya fifty ke bokae? Hundred percent iphelele ore hayi phelelanga *[Hundred percent of fifty is how much? Is hundred percent complete or not]*? **CCU**/*HL*/**TLI/PROBE**
Sipho: iPhelele *[Is complete]*. *HL*/**TLI/RESP**
T: A re re test ke *[Let us say the test is]* fifty marks *(writes down on paper)*, now thitšhere are o bone hundred percent, o kreile bokae? Hundred percent ya fifty marks *(write on paper)* ke bokae *[now the teacher says you obtained hundred percent, how many marks have you obtained? Hundred percent of fifty marks]*? **CCU**/*HL*/**TLI/PROBE**
Verda: Ke fifty *[It is fifty]*. **DCU**/*HL*/**TLI/RESP**
T: Fifty ke hundred … ya hundred percent. So fifty percent e tla nna bokae mo fifty *[Fifty is hundred ... ya hundred percent. So fifty percent will be how much]*? **ECU**/*HL*/**TLI/PROBE**
Verda: Twenty-five. **DCU**/*E*/**TLI/RESP**
T: Twenty-five, okay, akere? *HL-E*/**TLI/CONFIRM**
Ls: yes.
T: So hundred percent ya hundred ke hundred. Fifty percent ..? *HL-E*/**TLI/PROBE**
Ls: Fifty.
T: Ke fifty marks akere? *HL-E*/**TLI/CONFIRM**
Ls: Yes.
T: Forty percent? Forty percent of hundred? **CCU/ECU**/*E*/**TLI/PROBE**
Ls: *(Silent)*.
T: Akere ra re hundred, fifty percent ke …. *[We are saying hundred, fifty percent is…]* *HL*/**TLI/PROBE**
Ls: Fifty.
T: Fifty marks akere, fifty marks. Now, sixty percent ya hundred ke sixty marks, because ke hundred total. Seventy-five percent ya hundred ke seventy-five marks. Did you get that? Because ke di-hundred di le i-two. And then ten percent of hundred in marks ke bokae *[Fifty marks, isn't it. Now, sixty percent of hundred is sixty marks, because is hundred total. Seventy-five percent ya hundred is seventy-five marks. Did you get that? Because they are both hundreds. And then ten percent of hundred in marks is how much]*? **ECU/CCU**/HL-E/**TLI/ASSIST-EXPL-PROBE**
Ls: Ten. **DCU**/*E*/**TLI/RESP**

T: Twenty percent of hundred? **ECU**/*E*/**TLI/PROBE**
Ls: Twenty. **DCU**/*E*/**TLI/RESP**
T: Ke *[It is]* twenty. Let's say hundred *(writes down on paper)*, let's say mmm … di-marks ke sixty, now ba re re batle ten percent *[the marks are sixty, now are looking for ten percent]*. What you do you say *(writes down on paper),* ten percent divide by hundred percent times sixty. Percentage must be the total of a hundred, so it is ten percent divide by hundred percent times sixty, you see. So here they say it is increased by …, to increase means what, to do what? **RPF/RSC/ECU**/*E-HL*/**TLI/EXPL-ASSIST-QUEST**
Ls: To be big. **DCU**/*E*/**TLI/RESP**
T: Do you subtract or add? **RCU**/*E*/**TLI/PROBE**
Ls: Add. **DCU**/*E*/**TLI/RESP**
T: You add. So you need to look for twenty percent. You must add twenty percent to what, to consumption. **RSC/RPF**/*E*/**TLI/EXPL-ASSIST**
Sipho: (*Inaudible)*.
(Class makes noise)
T: Okay, okay …, one one two is consumption, so twenty percent of that, and then what do you do? **EPF**/*E*/**TLI/EXPL-ASSIST-PROBE**
Given: You add. **DPF**/*E*/**TLI/RESP**
T: You add it to what? **EPF**/*E*/**TLI/PROBE**
Ls: To one one two. **DPF**/*E*/**TLI/RESP**
T: To one one two? *E*/**TLI/CONFIRM**
Ls: Yes.
T: And then, then remember the services are always how much? *E*/**TLI/QUEST-ASSIST**
Ls: Forty.
T: You always add the forty, you mustn't forget that. **RPF/RCU**/*E*/**TLI/ASSIST**
Ls: Yes.
T: Do it then. *E*/**TLI/INST**
(Teacher leaves the group. Noise in class due to groups' discussions)

T: *(To whole class)* Do we all do number three? Have you done number three *(to Tshivenda group 2)*? *E*/**TLI/QUEST**
Dakalo: Yes. *E*/**TLI/RESP**

(Teacher with IsiZulu group 2)
T: So, what do you do? They say it increases, it increses by how many percent, that … *(inaudible)*. **CCU**/*E*/**TLI/QUEST**
Mulalo: *(Inaudible)*.

(Teacher with TshiVenda group 1)
T: What did you get *(looks at what the group has written)*? This is what? ***E***/**TLI/QUEST**
Given: One one two.
T: One one two? *E*/**TLI/PROBE**
Sipho: One one two plus …*(inaudible)*. *E*/**TLI/RESP**
T: Percentage, twenty percent, here I've got … *(Inaudible. Noise in class. Writes on paper.)* … Three times what? *E*/**TLI/EXPL-QUEST-ASSIST**
Verda: *(Inaudible)*.
T: Ninety-five, then we get what? What's the answer? **CSC**/*E*/**TLI/PROBE-ASSIST**
Given: *(Uses calculator)*.
T: So, twenty percent of sixty by sixty, you see. So you need to look for what? Twenty percent of one one two. You have twenty percent of sixty rand. Wena ufanele ukuthi uthole twenty percent of one one two, wa e bona *[You are supposed to get twenty percent of one one two, do you understand]*? **CSC/RPF**/*E-HL*/**TLI/EXPL-ASSIST**
Given: Yes. *E*/**TLI/RESP**
T: Bo ivhona *[Do you understand]*? *HL*/**TLI/QUEST-VERIFY**
Ls: Yes. *E*/**TLI/RESP**
T: La e tlhaloganya *[Do you understand it]*? *HL*/**TLI/QUEST**

Ls: Yes. *E*/**TLI/RESP**
T: So, le tlo etsa yang? Mo ke twenty percent of sixty, so wena o batla twenty percent of one one two, o tlo etsa yang? Ngwala mo fatshe *[So how are you going to do it? Here is twenty percent of sixty, so you are looking for twenty percent of one one two, what do you do? Write it down]*. **ESC/EPF**/*HL*/**TLI/PROBE-INSTR**
Given: *(Writes on paper)*.
T: You always divide by the total percentage, the maximum percentage, which is hundred percent. You always divide by hundred percent, times what? **RPF/CPF**/*E*/**TLI/EXPL-ASSIST-PROBE**
Given: *(Writes down)*.
T: So use your calculator. *E*/**TLI/INST**
Patience: *(Uses calculator)* Twenty-two comma four. **DPF**/*E*/**TLI/RESP**
T: Twenty-two comma four … twenty-two comma four. Bo ngwala vhugai *[What have you written]*? **CCU**/*E-HL*/**TLI/PROBE**
Given: Twenty-two rands four cents. *E*/**TLI/RESP**
T: Twenty –two rand forty. *E*/**TLI/CORRECT**
Given: Hoooo .., forty.
T: Forty. Four cents is zero comma zero four *(writes '0,04' on paper)*. Forty is zero comma four *(writes 0,4 on paper)*. So twenty percent is what? **RCU/ECU**/*E*/**TLI/EXPL-ASSIST-PROBE**
Ls: Twenty-two rand forty. *E*/**TLI/RESP**
T: Twenty-two rand forty. So, if it is twenty-two rand forty, then what do you do with it, because they said it increases? E inkhrizitse ka *[It increased by]* twenty-two rand forty, so what do you do? **EPF/RPF**/*E-HL*/**TLI/QUEST**
Ls: *(Silent)*.
T: What's your next step? *E*/**TLI/QUEST**
Ls: *(Silent)*.
T: Increase means what? **ECU**/*E*/**TLI/PROBE**
Verda: More. **DCU**/*E*/**TLI/RESP**
T: So what do you do when it increases? Do you subtract …? **RCU/EPF**/*E*/**TLI/QUEST**
Ls: You add. **DCU**/*E*/**TLI/RESP**
T: You add. You add it to what? *E*/**TLI/PROBE**
Ls: *(Silent)*.
T: What was the total consumption, consumption? *E*/**TLI/QUEST**
Verda: One one two.
T: One one two. So you add it to …. *E*/**TLI/ASSIST**
Ls: One one two. **DPF**/*E*/**TLI/RESP**
T: One one two. So add it. **RPF**/*E*/**TLI/INSTR-GUIDE**
Given: *(Writes on task sheet)*.
Patience: *(Uses calculator)*.
T: How much? What did you get? *E*/**TLI/QUEST**
Patience: Hundred and … *(inaudible)*.
T: Bhala lapha *[Write it down] (to Given)*. Hundred and what? *HL-E*/**TLI/INSTR-PROBE**
Patience: Hundred and twenty-four comma four.
Given: *(Writes down)*.
T: How much is that now? **ECU**/*E*/**TLI/QUEST**
Given: Hundred and twenty-four rands forty. **DCU**/*E*/**TLI/RESP**
Verda: Forty cents. **DCU**/*E*/**TLI/RESP**
T: Forty cents. It is for consumption. Now, did you pay the service? Service vho ibadala *[Did you pay for service]*? **CPF**/*E-HL*/**TLI/EXPL-QUEST**
Given: Yes. *E*/**TLI/RESP**
T: How much do you pay for service? **ECU**/*E*/**TLI/PROBE**
Verda: Forty rand. *E*/**TLI/RESP**
T: Did you pay it here? *E*/**TLI/QUEST**
Ls: No. *E*/**TLI/RESP**
T: So what do you do? *E*/**TLI/PROBE**
Patience: *(Inaudible)*.
T: *(To Patience)* So what do you do? *E*/**TLI/PROBE**

Patience: You add. **DCU/DPF/***E***/TLI/RESP**
T: You add. *E***/TLI/CONFIRM**
Given: *(Write on tasksheet)*.
T: Yes, so you do the same thing here *(refers to that of townhouse)*. So you check first how much the consumption was. How much was it? Consumption only, how much was it, of the townhouse? **RPF/***E***/TLI/EXPL-ASSIST-QUEST**
Sipho: One eighty.
T: One eighty is the total. Consumption? *E***/TLI/EXPL-QUEST**
Verda: One forty.
T: One forty, so you look for the …, so you do the same thing as here. *E***/TLI/EXPL**
Given: Hoooo …
T: So you look for twenty percent of what? **CPF/CCU/***E***/TLI/PROBE**
Patience and Verda: One forty. **DCU/***E***/TLI/RESP**
T: Of one forty, then you add it. *E***/TLI/ASSIST**
Ls: *(Laughter)*.
(Teacher goes to the other group).

(Teacher with TshiVenda group 2)
T: *(Inaudible)*.
Dakalo: *(Inaudible)*.
T: Then write, write your reasons there. Then write your reasons. Kha vha ngwale *[Write it down]*. *E-HL***/TLI/INST**
Dakalo: Which language? *E***/TLI/QUEST**
T: In … in any language. Kha vha ngwale. Kha vha ngwale hapfa dzi-reasons dza vhone. Kha vha ngwale dzi- reasons dza vhone, kha vha ngwale. *[Write it down. Write your reason here] E-HL***/TLI/RESP-INST**
Ls: *(Discussing but inaudible)*.
T: Ndi mini reason *[What is the eason]*? **EAR/***HL***/TLI/QUEST**
Dakalo: *(Inaudible)*.
Ls: *(Discussing and seem not to agree)*.
T: Kha vha ngwale, write it down. *E-HL***/TLI/INST**
Colbert: *(Writes down)*.

(Teacher with the IsiZulu group 2)
Nhlanhla: Why this increase, do we write it in English only? *E***/TLI/QUEST**
T: Unga ibhala nge-SiZulu ore nge-Silungu *[You can write it i IsiZulu or in English]*. *HL***/TLI/RESP**
Nhlanhla: Hooo…ngaibhala nge-SiZulu *[Hooo ...I can write it in IsiZulu]*? *HL***/TLI/QUEST**
T: Eya, unga ibhala nge-English ore la nge-SiZulu *[Yes, you can write it in English or in IsiZulu]*. *HL***/TLI/RESP**
Nhlanhla: Okay.
T: Ungasabe uku ibhala nge-SiZulu *[Do not be afraid to write it in IsiZulu]*. *HL***/TLI/MOTIVATE**
Nhlanhla: *(Writes down in IsiZulu on the tasksheet)*. *HL***/WRITE**
(Teacher goes to the XiTsonga group).

(Teacher with XiTsonga group)
T: This is how much? *E***/TLI/QUEST**
Maluleke: *(Inaudible)*.
T: No, how much is this? *E***/TLI/QUEST**
Maluleke: Twenty-two rand forty. *E***/TLI/RESP**
T: Twenty-two rand forty cents. So its twenty percent. What do you do with this? Angithi is twenty percent, they said it increases by twenty percent. Increase means what? **ECU/EPF/***E***/TLI/PROBE**
Ls: *(Silent)*.
T: If something increases …, **RCU/***E***/TLI/PROBE**
Shirley: We add. **DCU/DPF/***E***/TLI/RESP**
T: You add it to what? **EPF/***E***/TLI/PROBE**
Shirley: We add to the consumption. **DPF/***E***/TLI/RESP**

T: To the consumption. *E*/**TLI/CONFIRM**
Ls: Yes.
T: Twenty-two rand forty cents is equal to twenty percent of one one two. So you are saying consumption is increasing by twenty percent, which is twenty-two rand forty cents, okay. **CAR**/*E*/**TLI/EXPL**
(Class makes noise, discussion in the group not audible. Teacher and Observer moving from one group o the other. Teacher then moves to the front of the class).

TEACHER-LEARNER INTERACTION (CLASS)

(Teacher to the whole class)
T: Okay, when we look at number three *(writes on chalkboard)*, we have where we are supposed to get twenty percent, akere? *E*/**TLI/EXPL**
Ls: Yes.
T: And then for the house, for the family home, re kreile bokae *[how much have you obtained]*? **EPF**/*E-HL*/**TLI/QUEST**
Ls: Hundred and seventy-four rands forty. *E*/**TLI/RESP**
T: Ke hundred and seventy-four rands, akere …? *HL-E*/**TLI/CONFIRM**
Ls: Yes.
T: … forty cents. And then ya townhouse? **Q**/*E-HL*/**TLI/QUEST**
Some Ls: Two o eight.
Some Ls: Two hundred and eight rand. *E*/**TLI/RESP**
T: Two hundred and … *E*/**TLI**
Ls: Eighty rand. *E*/**TLI/RESP**
T: Eight?
Ls: Yes.
T: It was … e ne e le ka winter. *E-HL*/**TLI/EXPL**
Ls: Yes.
T: Mo e inkhrizitse ka bokae *[It increased by how much]*? Twenty percent. So, re batlile twenty percent ya …, mo re batlile twenty percent ya bokae *[So, we calculated for twenty percent of..., here we calculated twenty of how much]*? *HL*/**TLI/QUEST**
Ls: Hundred and twelve.
T: Ya one one twelve, twenty percent ya teng *HL*/**TLI**
Ls: Yes.
T: Ra kraya e le gore ke bokae *[how much have we obtained]*? *HL*/**TLI/PROBE**
Nhlanhla: Twenty-two rand forty cents. *E*/**TLI/RESP**
T: Twenty-two rand forty cents. Ra e tlhakanya le … *[And added to...]*? **EPF**/*E-HL*/**TLI/PROBE**
Ls: One one two.
T: One one two. Ra e tlhakanya le bokae gape *[And add to what else]*? Plus …**EPF**/*HL*/**TLI/PROBE**
Ls: Forty.
T: Forty ranta ya … *[Forty rand for…]*? **RCU**/*HL*/**TLI/PROBE**
Ls: Ya *[For]* service. **DCU**/*HL*/**TLI/RESP**
T: Di-service, then e re fa … *[For services, then we get...]*? *HL*/**TLI/PROBE**
Observer: *(Interrupting)* Why one one two? **EAR**/*E*/**TLI/PROBE**
T: Eya , goreng re multiplaya ka … lets go back, ha re sheba … *[Yes, we multiply with… lets go back, when we check…]* **EAR/CSC**/*E-HL*/**TLI/PROBE**
Observer: *(Inaudible)*.
T: Yes Pontsho.
Pontsho: Er … one one two ke…ke…ko…ko…mo…mo…mo dimo *[is… at… up there]*. *HL*/**TLI/EXPL**
T: Question one. *E*/**TLI**
Pontsho: Question one. *E*/**TLI**
T: Eya.
Pontsho: And ha ne o sa etsa, like kilowatt-hour le twenty cents e etsa one one two *[And when you did not do, like kilowatt-hour and twenty cent is equal to one one two]*. **DAR**/*HL*/**TLI/EXPL**
T: Kilowatt-hour le…? *HL*/**TLI**

Pontsho: Le *[And]* one … five sixty. *HL*/**TLI/RESP**
T: Five hundred and sixty. So what is this five hundred and sixty? **ECU**/*E*/**TLI/PROBE**
Pontsho: Ke kilo … ke dikhilowatse *[Kilowatts]*. **DCU**/*HL*/**TLI/RESP**
T: Kilowatt-hours. *E*/**TLI/CORRECT**
Pontsho: Then e … then e fitlha ko one one two. *[Then it becomes one one two] HL*/**TLI/EXPL**
T: Mara ha o tšheka ha e feletse ke bokae, one fifty what *[But, if you check, all together how much is it, one fifty what]*? *HL-E*/**TLI/PROBE-ASSIST**
Ls: One fifty-two.
T: So, why o sa malthiplaye ka one fifty-two and one one two *[So, why don't you multiply by one fifty-two and one-one two]*? **CAR/CSC**/*HL-E*/**TLI/PROBE**
Pontsho: *(Silent)*.
T: Why o sa sebedisa one fifty-two *[Why don't you use one fofy two]*? **CAR**/*HL*/**TLI/PROBE**
Pontsho: *(Silent)*.
T: Why o sa sebedisa one fifty-two *[Why don't you use one fofy two]*? **CAR**/*HL*/**TLI/PROBE**
Pontsho: One fifty-two re e plasitse ka … gore re e thole re e entse ka forty rands *[We added one fifty-two to… to get it we added forty rand]*. **DAR**/*HL*/**TLI/EXPL**
T: Forty ranta ke ya eng *[What is the forty rand for]*? **RCU**/*HL*/**TLI/PROBE**
Ls: Ya di-monthly service *[For monthly services]*. **DCU**/*HL*/**TLI/RESP**
T: Di-service.
Pontsho: Yes.
T: Yanong goreng o sa di kenya mo di-service, o sa batla percentage ya teng *[Now, why don't you add the services, and calculate its percentage]*? **ECU/CAR/CSC**/*HL*/**TLI/PROBE**
Ls: *(Silent)*.
T: Goreng o sa batla percentage ya di-service *[Why don't you calculate the percentage for services]*? **ECU/CAR**/*HL*/**TLI/PROBE**
Pontsho: Because diservice … *(inaudible)*.
T: Because …
Sindiswa: Er … *(inaudible)* … electricity consumption. *E*/**TLI/RESP**
T: Di sa eng *[They do what]*? *HL*/**TLI**
Sindiswa: Electricity consumption. *E*/**TLI/RESP**
T: Di-service di…*[Services do what]*? *HL*/**TLI/PROBE**
Sindiswa: Ha di inkhrizi *[They do not increase]*. **DCU/DAR**/*HL*/**TLI/EXPL**
T: So, ha di sa inkhrizi *[So if they do not increase]*? **CAR**/*HL*/**TLI/PROBE**
Sindiswa/Thami: O ka se di tsenye mo *[You cannot add them]*. **DCU**/*HL*/**TLI/EXPL**
T: O ka se di tsenye mo *[You cannot add them]*? *HL*/**TLI/PROBE**
Sindiswa/Thami: Yes.
T: Di … service e dula e ntse e le forty ranta, i hlala kuyi forty rand *[Services remain as forty rand.]*. *HL*/**TLI/CONFIRM**
Ls: Yes.
T: Hayi chentshe, into e chentshayo, e inkhrizayo hi consumption *[It does not change, what changes is the consumption]*. *HL*/**TLI/EXPL**
Ls: Consumption. *E*/**TLI**
T: I inkhriza nge-twenty percent *[It increases by twenty percent]*. So that is why usebenzisa *[you don't use]* i-one one two, because one one two is equal to consumption, not the total out, okay. So the same thing here *(refers to the townhouse)*, you only use the total consumption, right. Now generally why do you think electricity increases? **ECU**/HL-E/**TLI/EXPL-ASSIST-QUEST**
Thami: Ka winter go a bata, so batho ka winter ba laeta dihithara ba gatsela, ba yuza electricity, so electricity e tlo jega *[In winter it is cold, so people in winter switch the heaters on, and use electricity, so electricity is consumed more]*. **DCU**/*HL*/**TLI/RESP**
T: Okay right, we were busy with … most of the groups were now busy with question number five, ya formula. Some have done it, but most of you haven't yet done done it. The general … the formula *(writes on chalkboard:*

<u>*House*</u> <u>*Townhouse*</u>

R112 x 20% R208-00
= 22,40
+ 112,00
+ 40,00
R174,40]

that will help the department so that they must use for each and every household, or if they use this consumption, this is the same, so they must only use the same formula for everybody. So that was the question that you were supposed to do. We shall continue tommorrow. Think about the formula. I hope now you are getting the idea. *E*/**TLI/EXPL-MOTIVATE**
Ls: Yes. *E*/**TLI/RESP**
T: So, before we close, can you ask questions. A gona le dipotso? Vha hone vha nyaga ho vhudzisa? Gab, o na le question *[Are there any questions]*? *E-HL*/**TLI/QUEST**
Gabriel: No. *E*/**TLI/RESP**
T: O siame *[Are you fne]*? *HL*/**TLI/QUEST**
Gabriel: Yes. *E*/**TLI/RESP**
T: Okay, sizoqubheka kusasa *[Okay, we shall continue tomorrow]*. So Gab, whatever you discuss write it down. *E-HL*/**TLI/ INST**

LESSON 3

T: Question number… number five okay, we are continuing from where we ended yesterday, question number five. Question number five. *(Noise in class)* Are we all looking at question number five? *E*/**TLI/INSTR**
Ls: Yes.
T: Are we all looking at question number five? Siphiwe, can you read question number five in Zulu. *(Noise in class, pulling of chairs and tables as learners settle down)* Can we all listen please *(A sound of a knock at the door)*. Before you read, just a second *(Teacher goes to the door, talks to someone at the door and returns)*. Right, Siphiwe can you read in Zulu, question number five? *E*/**TLI/INST**
Siphiwe: *(Reads question five in IsiZulu)*. *HL*/**TLI/READ**
T: Right, angithi sizwile ukuthi utheni *[Right, we have heard what he had said, isn't it]*? What does the question want? Ifunani i-question? **ECU**/*E-HL*/**TLI/QUEST**
L1: Formula. *E*/**TLI/RESP**
T: *(Writes on chalkboard)* Formula.Okay, kule formula, what … what should appear in that formula? Kufunekani futhi? **CCU**/*E-HL*/**TLI/PROBE**
L2: *(Inaudible)*.
T: Yini *[What]*? *HL*/**TLI**
L2: Ama *[The]*… *(Inaudible)*.
T: Ama …?
Ls: Ama-units [Units]. **DCU**/*HL*/**TLI/RESP**
T: Ama-units [Units], okay *(Writes on chalkboard, 'units')*. What else? **CCU**/*HL-E*/**TLI/PROBE**
Ls: Variables. **DCU**/*E*/**TLI/RESP**
T: Variables *(Writes on chalkboard: 'formula* ⟶ *units* → *variables')*. Okay, so when you think of a formula, these are what you need to use or think about. Ke dilo tse o naganang ka tsone o di dirise. Right, how …, formula e re buang ka yone, what is it for? Ke ya gore e etse eng go ya ka *khwetšene [Those are what you think you can use. Right, how..., the formula we are talking about, what is it for? According to the question, what is it for?]* **ECU**/*E-HL*/**TLI/EXPL-PROBE**
Ronald: To calculate the monthly electricity … *(Inaudible)*. *E*/**TLI/RESP**
T: He?
Ronald: To calculate the monthly electricity bill. *E/***TLI/RESP**
T: For what, for eng? **CCU**/*E-HL*/**TLI/PROBE**
Ronald: For, for any household. **DCU**/*E*/**TLI/RESP**
T: E raya goreng? O e tlhaloganya yang wena ka Setswana *[What does it mean? How do you understand it in Setswana]*? **CCU**/*HL*/**TLI/QUEST**
Ronald: Eer … e raya gore er …*[Eer ... it means er...] (looks at question 5 in the Setswana version of the tasksheet)*. *HL*/**TLI/EXPL**

T: E raya goreng ka Setswana [What does it mean in Setswana]? *HL*/**TLI/PROBE**
Ronald: E raya gore er ... *[It means er…] (Reads question 5 in Setswana version)*. Er …, e thusa go … "go balela dituelo tsa motlakase tsa ntlo enngwe le enngwe ka kgwedi" *[Er ..., it assist in… "calculating the cost of electricity used for any household per month"]*. *HL*/**TLI/READ**
T: Wena o e tlhaloganya yang? **CCU**/*HL*/**TLI/PROBE**
Ronald: *(Silent)*.
T: Akere oa e buisa, yanong wena oe tlhaloganya yang? Ke eng se se tshwanetseng o batlane le sone *[You ave read it, how do you understand it? What is supposed to be calculated]*? Any other one, Steve? **CCU**/*HL-E*/**TLI/PROBE**
Steve: I think you must come with a formula to be used for the electricity department to pay the monthly electricity bill. **DCU**/*E*/**TLI/EXPL**
T: Eya, re mo utlwile akere? Simuzwile, simuzwile *[Yes, have we haerd what he said? Have we heard]*? *HL*/**TLI/QUEST**
Ls: Yes. *E*/**TLI/RESP**
T: Motswana, akere *[have you]*? *HL*/**TLI/QUEST**
Thapelo: Ha ka mo utlwa *[No, I did not hear]*. *HL*/**TLI/RESP**
T: Ha wa mo utlwa? Ke kopa o mo reetse ne, o mo reetse sentle *[You did not hear? Please listen attentively]*. Steve. *HL*/**TLI/INST**
Steve: You must come up with the formula that will be used for the electricity department to calculate the monthly electricity bill for any household. *E*/**TLI/EXPL**
T: For any household. Akere o mo utlwile Motswana *[You have heard him Motswana, isn't it]*? *E-HL*/**TLI/QUEST**
Thapelo: Yes. *E*/**TLI/RESP**
T: Areng ka Setswana? O ka re bolella gore ka Setswana gore areng *[What is he saying in Setswana? Can you tell us what is he saying in Setswana]*? **ECU**/*HL*/**TLI/QUEST**
Thapelo: Wa khalkhuleita *[You calculate]*. *HL*/**TLI/RESP**
T: O khalkhuleita eng [What do you calculate]? **CCU**/*HL*/**TLI/PROBE**
Thapelo: Ha ke tsebe meneer [I don't know sir]. *HL*/**TLI/RESP**
(Laughter in class).
T: Wena ha oe bala oe tlhaloganya yang? Wena ha oe bala oe tlhaloganya yang [When you read it, how do you understand it]? **ECU**/*HL*/**TLI/PROBE**
Thapelo: E bolela gore di-variables tse o di dirisitseng di eme sentle [It means that the variables that you are using are substituted correctly]. *HL*/**TLI/EXPL**
T: Oe tlhaloganya yalo [Is that how you understand it]? *HL*/**TLI/QUEST**
Thapelo: Yes.
T: Okay, formula e, e re tshwanetseng re tle ka yona, ke ya go ira eng [Okay, the formula that we are supposed to come up with, what is it for]? **CCU**/*HL*/**TLI/PROBE**
Thapelo: Ke gore re khalkhuleite di-units [To calculate units]. *HL*/**TLI/RESP**
T: Ke ya go irang [For doing what]? *HL*/**TLI**
Thapelo: Khalkhuleite di-units [Calculate units]. *HL*/**TLI/RESP**
T: Khalkhuleita eng [Calculate what]? *HL*/**TLI**
Thapelo: Units. *E*/**TLI/RESP**
T: Units tsa eng [What units]? *HL*/**TLI/PROBE**
Thapelo: Tsa electricity bill [For the electricity bill]. **DCU**/*HL-E*/**TLI/RESP**
T: Electricity ya eng [Electricity for what]? *HL*/**TLI/PROBE**
Thapelo: E re e dirisang [That we use]. *HL*/**TLI/RESP**
T: Ya eng [For what]? *HL*/**TLI**
Thapelo: E re e dirisang [That we use]. *HL*/**TLI/RESP**
T: E e dirisang ke bomang [Used by who]? *HL*/**TLI/PROBE**
Thapelo: Ke rona [Us]. *HL*/**TLI/RESP**
T: Rona [Us]? *HL*/**TLI**
Thapelo: Yes.
T: Mo klaseng [In class]? *HL*/**TLI/PROBE**
(Laughter in class).
Thapelo: Yes.
T: Ke rona mo klaseng *[In our class]*? *HL*/**TLI/PROBE**

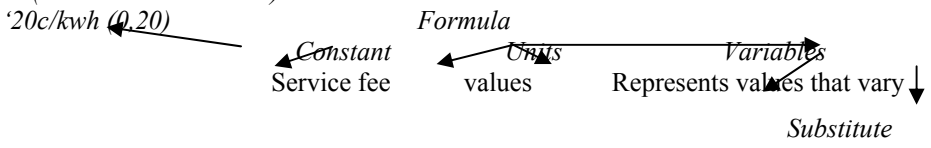
Thapelo: Yes.
T: Ke kopa… ke kopa oe bale sentle oe tlhaloganye. Okay, e bale sentle ka Setswana oe tlhaloganye. Ke tlo tla gape mo go wena. Akere yanong formula e ke e re tshwanetseng re tle ka yona e, e e tla irang gore the electricity department ukuthi kubelula for yona to calculate the electricity bill for any household. Akere yanong ha ba … when this people ba tla ko ntlong ya gago, or your home, ba tlo bala the meter, akere ba nka di-readings. Suppose last month ba nkile reading e e reng two zero four six three *(writes on chalkboard '20463')*, okay. This month ha ba nka reading ba kreya e le gore reading ere two zero seven five six *(writes '20756')*. Ke dinomoro tse pedi, ya last month le this month. Then gore ba kreye that reading ya motlakase oo dirisitseng, logesi loyo usebenzisile, how do they come up with that amount, bayenzani? Remember this is last month's reading *('20463')* and this is this month's reading *('20756')*. Ba ira yang gore ba kreye …ha ba re …, suppose akere mo ba re file gore the house used five sixty. Now if we have two readings, last month's, this month's, reading ya this month ba tla e dira yang ya gore o dirisitse electricity e kana kang? *[Please read it carefully and undertand it. Okay, read it in Setswana and understand it. I will come back to you. The formula that we should come up with, will enable the electricity department to calculate the electricity bill for any household. Isn't it when this people come to your home, they take the meter readings. Suppose last month they reading was two zero four six three, okay. This month they find that the reading is two zero seven five six. These are two numbers, Last month's and this month's. Then they find that the reading of the electricity used, how do they come up with that amount, what do they do. Rememember this is last month's reading and this is this month's reading. What do they do to get… when they sya…., suppose here they gave us that the house used five sixty. Now if we have two readings, last month's, this month's, how do they calculate the amount of electicity used?]* **ECU/ESC**/*HL-E* **/TLI/INSTR-EXPL-QUEST**
Sipho: You add. *E*/**TLI/RESP**
T: You add this two *(Referring to numbers '20463 and 20756' written on chalkboard)*? *E*/**TLI/QUEST**
Dakalo: No, I think you er … minus two zero four six three from two zero seven five six. **DSC/DCU**/*E*/**TLI/RESP**
T: Eya *[Yes]*, you subtract this *(Writes '20756 –20463')* then e tla go fa that reading ya this month, okay. Then ha o tla ka that reading, lets say is *[then it will give you this month's reading, okay. Then if you come with that reading, lets say is]… (Subtracts 20463 from 20756)* three … *E-HL*/**TLI/EXPL**
Steve: (Interjecting) One, zero….
T: Zero? Five minus six is zero? Fifteen minus six? **EPF**/*E*/**TLI/PROBE**
Steve: Nine.
T: Nine, and this *(Pointing at '6 – 4' on the chalkboard)*? **EPF**/*E*/**TLI/PROBE**
Steve: Two …
T: *(Writes on chalkboard he explains:*

6
20 7 '5 6
-20 4 6 3
9 3)

Two, so that will be the reading akere. Now ha … ha … otla ka this reading, now wena o tshwanetse gore o tle ka …, you need to come up with a formula a ba tla e dirisang because all different houses, ba tla be ba dirisitse … ba na le di-different readings akere. Ha ba tla ko wena ba nka di-reading tse different. So o tshwanetse o tle ka formula e e leng gore ha ba khalkhuleita, le ha ba nkile all this defferent readings in different houses, okay. Then you need to come up with that formula. Then mo formuleng ya gago o be le di-variables le di-units, athiri. So, zwambha huri zwino hapfa you need to come with a formula that will be used *[so that will be the reading. Now if …if… you come with this reading, now you are suppose to come with…, you eed to come up with a formula that will be used because all different houses shall have used… have different readings. When they come to you they take a different reading. So you are supposed to come up with a formula that will be used even if different reading were taken from different houses, okay. Then you need to come up with that formula. Then you formula must have variables and units. So, that means that now you eed to come with a formula that will be used]*. **RSC**/*E-HL*/**TLI/EXPL**
Dakalo: Sir, what are variables? *E*/**TLI/QUEST**
T: Variables? *E*/**TLI**
Dakalo: Yes.

T: What are variables? When we talk about variables, sikhuluma ngani masikhuluma ngama-variables *[what do we mean by variables]*? **ECU**/*E-HL*/**TLI/QUEST**
Thami: Are like symbols. *E*/**TLI/RESP**
T: Are like what? *E*/**TLI/QUEST**
Thami: Symbols. *E*/**TLI/RESP**
T: Are like symbols, for an example? **CCU**/*E*/**TLI/PROBE**
Thami: x, y.
T: In simpler terms those are variables, eya. E/**TLI/CONFIRM**
Observer: No, variables are symbols that represent numbers, and these symbols like x, they don't just represent one number and it's a very important thing to consider when you do a formula because those variables that will represent those values, they are not the same. There will be a value for this particular household, for instance how much electricity they spend, akere. So, if this one spend five-sixty kilowatt-hours right, er … they use five-sixty kilowatt-hours, the other household will use six hundred kilowatt-hours, the other house three hundred kilowatt-hours, other one thousand, the values vary, uyabona. So, not all houses consume the same amount of electricity. So, in your formula you have to find something that will represent those varying values, so that that variable …, you can always 'park-in' the number. When I say 'park-in', like o kenya fela *[you just substitute]* whatever number. *E-HL/***TLI/EXPL-ASSIST**
T: *(Interjects)* Substitute. *E*/**TLI**
Observer: Substitute ka whatever number e e leng gore *[Substitute with a number and]* that particular family consumed it in terms of electricity. You get the point? *E-HL*/**TLI/EXPL**
Ls: Yes. *E*/**TLI/RESP**
Observer: So, which numbers are varying here? The amount of electricity that people consume. What else will vary? **ECU**/*E*/**TLI/PROBE**
Mulalo: The amount, the cost. **DCU**/*E*/**TLI/RESP**
Observer: The amount, the cost, okay. Because the amount of electricity they consume affects how much they pay, right. So, that's a good one, right. So, those things will vary. Those things are the two things that will vary throughout. So your formula has to capture that and you use variables, like he says those symbols that will represent. So it won't be a number okay, it will be a variable, some symbol that says you can substitute it by whatever….kilowatt-hour they consume, and you will get whatever er … er … amounts when you calculate, okay. There are other values that won't vary. Can you think of what would they be in that formula? Because Mr Molefe has shown you that go tlo ba le di-variables, go tlo ba le di-units, whatever. There are other values in your variables … in that formula that would not vary. **RCU**/*E-HL*/**TLI/EXPL-ASSIST**
T: Eya, that are constant. *E*/**TLI/EXPL**
Observer: That would be constant. *E*/**TLI/EXPL**
T: Constant values. *E*/**TLI/EXPL**
Observer: What would it be? **ECU**/*E*/**TLI/PROBE**
Sindiswa: Service. *E*/**TLI/RESP**
Observer: He?
Sindiswa: Er…service. The forty rand for the service and the twenty cent. **DCU**/*E*/**TLI/RESP**

T: *(Writes on chalkboard)*



Observer: Right, why is the service fee not varying? Why is it the same? Why it is the same? Why er … e tlo tshwana forty rand ena ya service? Why athi izofana, ngeke ichintshe *[Why is the forty rand service fee constant? Why does he say it will not change]*? **CAR/CCU**/*E-HL*/**TLI/PROBE**
Nkateko: Imali lengabekiwa ya ti-service ntsena *[It is the amount for service only]*.
DCU/DAR/*HL*/**TLI/RESP**

Observer: Yes. Yes, because that's the amount of service. You pay for service. Each one pays the same amount for service, right. So, that's why in your formula that amount will appear as a constant, okay. As a constant which it would be forty, okay. Because it won't change, depending on the household or on the family. So, whether ke ko number twenty five, twenty one zone whatever, or twenty whatever zone six, ba patela forty rand for service. Is there any other value that will remain constant? **CCU**/*E-HL*/**TLI/EXPL/PROBE**
Gabriel: Twenty-cent remain constant. **DCU**/*E*/**TLI/RESP**
Observer: Twenty-cent e tlo ba constant. By the way, twenty cent eo ke ya eng *[what is twenty cent for]*? **CCU**/*HL-E*/**TLI/CONFIRM-PROBE**
Ls: For di-kilowatt-hour. **DCU**/*HL-E*/**TLI/RESP**
Observer: Ke e re e patelang *[Is what we pay]* for every kilowatt-hour, right. *HL-E*/**TLI/CONFIRM**
Ls: Yes.
Observer: So, everybody pays twent-cent per kilowatt-hour. It doesn't matter where they live, it doesn't matter how much they consume, they will pay twenty-cent per kilowatt-hour, right. So, you have two things that will remain the same, constant. They will remain the same in your formula. In your formula, we have this …it has …it has to show. They will appear in that formula, whatever happens they will be there, right. *E*/**TLI/EXPL**
Ls: Yes.
Observer: Then we have two things that will vary right, and those two things that would vary o lo sebedisa *[you will use]* variables to represent them, okay. So, you would choose what those variables are. *E-HL*/**TLI/EXPL-ASSIST**
T: Okay, any other … any question? *E*/**TLI/QUEST**
Nkateko: None. *E*/**TLI/RESP**
T: Now, you said the other constant is twenty cent per kilowatt-hour. Now, when you substitute that twent-cent in our formula, do you write it as a 20, do we pay our electricity in terms of rands or in terms of cents? **ECU/ESC**/*E*/**TLI/QUEST**
Ls: In terms of rands. **DCU**/*E*/**TLI/RESP**
T: Rands, isn't it? *E*/**TLI/CONFIRM**
Ls: Yes.
T: When you substitute it, are you going to substitute it as cents or it is going to be …, is it going to change or be converted? **ESC**/*E*/**TLI/PROBE**
Ls: Change. Converted. *E*/**TLI/RESP**
T: So, if you convert it, is going to be what? **ECU**/*E*/**TLI/PROBE**
Ls: Zero comma two.
T: Zero comma two in term of rands *(Writes '0,2' on chalkboard)*, is going to be zero comma two. Now when you come up with the formula, remember we calculated our electricity isn't it? In question one we calculated how much we pay for five hundred and sixty kilowatt-hours, and in question two we calculated the amount of kilowatt-hours used, okay, whereby we reversed the process in terms of question one to find the amount we would pay. Now when you come up with the formula, you need to think about what did you do when you calculated the amount in question one, okay. You need to think about what is that that you do first, what is that that you do next and what is that that you do next? Yini loyoiyenzayo *[What will you do]* first thing, second thing? As you calculate, what do you do, which number do you take and what do you do with that number? And in the first step, what do you with that number, what is that that you do with that number? Which value do you use, okay? Do you get my point? *E-HL*/**TLI/EXPL-MOTIVATE-ASSIST**
Ls: Yes. *E*/**TLI/RESP**
T: Re ya tlhaloganya *[Do we understand]*? *HL*/**TLI/QUEST**
Ls: Yes. *E*/**TLI/RESP**
T: So, ha o tla ka formula, nagana gore ke eng e o etsang ha o khalkhuleita the amount of consumption, the amount that would be paid by any household, ha o khalkhuleita in question one. Tsheka gore ke eng eo e dirileng, ke eng e oe khalkhuleitang pele, ke eng e oe khalkhuleitang, okay *[So, when you come up with a formula, just think how do you calculate the amount of consumption, the amount that would be paid bu any household, when you calculate in question 1. Check what is that which nyou have done first, what is that that you have calculated, okay]*. Think about that, because they say "come up with the formula to calculate consumption", okay. Can we do it in five minutes? So, if you did not understand ke kopa o emise letsogo *[please raise you hand]*. *HL-E*/**TLI/EXPL-MOTIVATE-**

ASSIST-INSTR
Nkateko: *(Raises hand)* I didn't understand. *E*/**TLI/ASSISTANCE**
(Observer attends to Xitsonga group. All groups begin to work on question 5. Any group that either finds the formula or needs assistance raises hand. The other observer attends to Isizulu group 1 as teacher attendS to Tshivenda group 2. Noise in class as groups discuss).

TEACHER-LEARNER INTERACTION (GROUP)

(Teacher with Tshivenda group 1)
T: Setse le feditse *[Have you finished]*? *Hl*/**TLI/QUEST**
Given: Mara ha re sure sir *[But we are not sure sir]*. *HL*/**TLI/RESP**

T: *(Looks at what group has written)*

0,20c x k + 40-00
0,20c x O variable + 40-00 = R40-00
40 units
0,20c x O variable + R40-00 service = R40-00
40 units

T: This is…? *E*/**TLI/QUEST**
Given: Ke variable sir. *HL-E*/**TLI/RESP**
T: Mo le ngwetse *[Here you have written]*…*(inaudible)*…monthly bill, remember …*(inaudible)*…this must be something else, monthly bill, akere. Is equal to 0,2 times… **RSC**/*E-HL*/**TLI/ASSIST**
Given: 'k'.
T: 'k' for … consumption? *E*/**TLI/PROBE**
Given: Yes.
T: Plus forty. So monthly bill is a constant or a variable? Monthly bill is a variable or what? **CCU**/*E*/**TLI/PROBE**
Ls: *(Silent)*.
T: Any house would pay a different amount. **RCU**/*E*/**TLI/MOTIVATE**
Ls: Yes.
T: So, it is what, a variable *(writes 'variable' on paper)*. So, which variable do you choose? **RCU/ECU**/*E*/**TLI/ASSIST-QUEST**
Ls: *(Silent)*.
T: Remember a variable can be any letter. **RCU**/*E*/**TLI/EXPL-ASSIST**
Sarah: 'k'
T: Mmh?
Sarah: 'k'.
T: 'k' is already there. You can use any variable. In a formula you cannot use ama-letter afanayo *[identical letters]* for different variables. **CCU**/*E-HL*/**TLI/ASSIST**
Given: Hooo …okay, a. **DCU**/*E*/**TLI/RESP**
T: *(Writes 'a' on paper)* Is equal to… is this value… does it change or is it constant? **ECU**/*E*/**TLI/PROBE**
Verda and Sipho: Constant. **DCU**/*E*/**TLI/RESP**
T: Constant. Then what you do you multiply with…you said what? **CSC**/*E*/**TLI/PROBE**
Ls: 'k'.
T: 'k' plus… *E*/**TLI/PROBE**
Ls: Forty.
T: Forty, you see, so this would be… *E*/**TLI/PROBE**
Given and Verda: Formula. **DSC**/*E*/**TLI/RESP**
T: Formula that you would use, okay. Now after that, what you do you need to tell us what these letters represent. What these represent. I-bill yakho imejarwa ngani? You pay your bill in what? In… **RPF/ECU**/*E-HL*/**ASSIST-PROBE**
Verda and Given: In rands. **DCU**/*E*/**TLI/RESP**

T: In rands. So you must tell us 'a' is what. Monthly bill in rands, then 'a' is equal to…, 'k' is …, for example in formula *(writes 'A = lb' on paper)*, 'A' is area in metres squared, 'l' is… you tell us is length in metres , 'b' breadth in metres. That's what you do here. Thina asiyazi angithi *[We do not know it]*? **RCU/RPF/***E-HL***/TLI/ASSIST**
Ls: Yes.
T: Hari dibhi huri *[We don't know what]* 'a'… HL/TLI
Given: *(Interjecting)* …i-ambhamini *[what it represents]*. *HL***/TLI**
T: I-ambhamini, 'b' i-ambhamini, 'k' i-ambhamini *[What it represent, 'b' what it represent, 'k' what it represents]*. *HL***/TLI**
Given: Yes.
T: Do you get that? *E***/TLI/QUEST**
Ls: Yes. *E***/TLI/RESP**
T: When, when they come with this two nine three kilowatt-hours, what they do they say *(points at formula written by the group)*, 'a' is equal to zero comma two times…, then 'k' is what? Two nine three kilowatt-hours. Another house would use seven hundred kilowatt-hours. You are just supposed to add that there, uyabhona? **RSC/***E***/TLI/EXL-MOTIVATE**
Ls: Yes. *E***/TLI/RESP**
T: Le ya utlwisisa *[Do you understand]*? *HL***/TLI/QUEST**
Ls: Yes. *E***/TLI/RESP**
T: So you write it there *(points to the tasksheet). E***/TLI/INSTR**
(The group writes formula in the task sheet. Teacher goes to other groups. Comes back to the Tshivenda group 1).
T: *(Looks at what group has written)* Fine, then here, fine. Is it area? Area mo? What is this 'a'? Ube ufuna I-formula yani? Ndi-formula yamini *[What formula were you looking for]*? Sipho, you've got this *(points at the task sheet)*. What does the question ask? The formula for…? Read ndi-formula yamini *[what is the formula for]*? **CSC/***E-HL***/TLI/QUEST**
Ls: *(Read the question silently)*.
T: Okay, in your formula can you use, lalelani *[listen]*, for 'a' and 'k', can you change the letters, use different from 'a' and 'k'? Use a different letter, don't use 'a' don't use 'k' because you seem to be confusing them with something else. Don't use 'k', don't use 'a'. Use any other letter except 'k' and 'a', and tell us what the letters represent. Read the question. **RSC/RCU/***E***/TLI/EXPL-MOTIVATE-GUIDE-INSTR**
Ls: *(Read the question silently)*.
T: So, what is that that you are supposed to do? What will the formula help us do? **ESC/CCU/***E***/TLI/QUEST**
Given and Sarah: To find consumption. **DCU/***E***/TLI/RESP**
T: The consumption, athiri, per month. So, if that is the monthly bill, the monthly bill that would be paid by any household, so your 'a' comes here *(points at the formula written by the group)*. So, the one that you calculate is this one. Sifuna le *[We are looking for this one]*, that is why I say change this letters *(refers to 'a' and 'k')*. Use different letters. Suppose you use… **RSC/***E-HL***/TLI/MOTIVATE-INSTR-GUIDE-EXPL**
Given: *(Interjecting)*…'m'.
T: Okay, you say this one *(refers to'a')* is going to be 'm'. This one *(refers to 'k')*? *E***/TLI/PROBE**
Verda: 'k'.
T: No, use another letter. *E***/TLI/INSTR-GUIDE**
Sarah: 'b'.
T: 'b', so your 'm' will be what? Yini esiikhalkhuleitayo? *(Sound of a knock at the door. Teacher goes to the door, speaks to someone outside and comes back)*. What were we calculating? This formula we use it to calculate what? **CCU/***E-HL***/TLI/PROBE**
Verda and Given: The monthly bill. **DCU/***E***/TLI/RESP**
T: The monthly bill. So, this *(refers to the letter 'm']* is going to be your monthly bill in what? Siyibadala ngani i-bill? Rho badhala ngamini? Ngadzi…*[What do we pay the bill with? We pay with what? With…]* **CCU/***E-HL***/TLI/PROBE**
Ls: *(Silent)*.
T: Ku badhela… *[To pay] HL***/TLI**
Sipho: Yes.

T: …ngani? Sibadala ngani? *[With what ? We pay with what ?] HL*/**TLI/PROBE**
Ls: Ngama-rands *[In rands]*. **DCU**/*HL*/**TLI/RESP**
T: Rands, and then this 'b', what does it represent? **CCU**/*E*/**TLI/PROBE**
Sipho: Units. **DCU**/*E*/**TLI/RESP**
T: Akere ke zero comma two multiply by 'b', so in question one this 'b' when we go back is what? **CCU**/*HL-E*/**TLI/PROBE**
Verda: One-twelve. **DCU**/*E*/**TLI/RESP**
T: Zero comma two multiply by…**CSC**/*E*/**TLI/PROBE**
Verda: Five-sixty.
T: Five-sixty. Zero comma two multiply by 'b', so what does that 'b' represent? **CCU**/*E*/**TLI/PROBE**
Sarah: Electricity. *E*/**TLI/RESP**
T: Electricity what? **CCU**/*E*/**TLI/PROBE**
Verda: Consumption. **DCU**/*E*/**TLI/RESP**
T: Consumption, that's electricity consumption. That's electricity consumption. So we have 'm', and this (refers to 'b') is consumption per month, you see. So you need to tell us…, this is not area, 'a, is not representing 'a'. I was just giving an example, okay. That was just an example. So it's a formula, you tell us what does the variable stand for. Monthly bill in rands, consumption in what? Is measured in what, consumption? **CCU**/*E*/**TLI/EXPL-PROBE**
Verda: Kilowatt-hours. **DCU**/*E*/**TLI/RESP**
T: In what? *E*/**TLI**
Verda: Kilowatt-hours. *E*/**TLI/RESP**
T: Kilowatt-hours…kilowatt-hours, okay. Consumption in kilowatt-hours. So can you write it *(goes to other groups)*. *E*/**TLI/CONFIRM-INSTR**

TEACHER-LEARNER INTERVENTION (CLASS)

(Teacher attends to the whole class) [R – Ronald; P – Pontsho; Gb - Gabriel]
T: Right, our formula… the formula that we found to calculate consumption, because all the groups have found that we…we…we looked for…, who can give us the formula? **ESC**/*E*/**TLI/QUEST**
Ronald: We usually say er…mmm…er, zero comma two x. **DSC**/*E*/**TLI/RESP**
T: *(Writes on chalkboard as learner responds)* Did you write that? *E*/**TLI/QUEST**
Ronald: Yes sir. *E*/**TLI/RESP**
T: Are you reading what you have written? *E*/**TLI/QUEST**
Group: Yes.
T: Eya, zero comma two x. *E*/**TLI**
Ronald: Kilowatt-hours. *E*/**TLI/RESP**
T: Is that what you have written? *E*/**TLI/PROBE**
Ronald: Yes.
T: I don't think so. I was in your group. *E*/**TLI**
Ls: Yes, ke yone *[that is the one]*. *E-HL*/**TLI/RESP**
T: Kilowatt-hours? *E*/**TLI**
Group: Yes.
T: I was there, I don't remember seeing that. **CSC**/*E*/**TLI**
Pontsho: keye sir *[Here it is sir]*. *HL*/**TLI**
T: And then. *E*/**TLI**
Ronald: Multi…plus. *E*/***TLI***
T: Plus…
Ronald: Plus forty. *E*/**TLI/RESP**
T: Plus forty… *E*/**TLI**
Ronald: Equals to ''b'. **DSC/DPF**/*E*/**TLI/RESP**
T: Equals to 'b', okay. Is equal to 'b' *(writes '0,2x kwh + 40 = b' on chalkboard)*. So tell us what zero comma two is for. **ECU**/*E*/**TLI/PROBE**
Ronald: Is for consumption. *E*/**TLI/RESP**
T: Zero comma two? *E*/**TLI**
Ls: Hayi, kanjani? *HL*/**TLI/QUEST**
Gabriel: Is the…the…the twenty cent. **DCU**/*E*/**TLI/RESP**

T: Okay, the 'x'? **CCU/*E*/TLI/QUEST**
Ronald: The 'x' er… represents electricity consumption in kilowatts. **DCU/*E*/TLI/RESP**
T: Consumption, so if its in kilowatts, so you need to remove…*(erases 'kwh' from the formula written on the chalkboard)*, consumption… **RCU/RPF/*E*/TLI/MOTIVATE**
Ronald: Consumption er…in kilowatts. ***E*/TLI/RESP**
T: In Kilowatts, kilowatts… **CCU/*E*/TLI/PROBE**
Pontsho: *(Interjects)* ... hour. **DCU/*E*/TLI/RESP**
Ronald: Kilowatt-hour. ***E*/TLI/RESP**
T: Kilowatt-hour, then 'b'? **CCU/*E*/TLI/QUEST**
Ronald: 'b' represents the monthly amount. **DCU/*E*/TLI/RESP**
T: Monthly amount… **CCU/*E*/TLI**
Ronald: In rands. **DCU/*E*/TLI/RESP**
T: In rands.That's the monthly amount in rands. Any different formula? So in your formula you should…, in your formula you should have zero comma two, the variable representing the consumption, the monthly consumption in kilowatt-hours, the forty rand that you add, and 'b' representing the monthly amount in rands. Any question? **RSC/*E*/TLI/QUEST-EXPL**
Steve: *(Raises hand)*.
T: Yes Steve?
Steve: I don't understand meneer. If they say zero comma two 'x' plus forty is equal to 'b', does that mean zero comma two kilowatt-hours plus forty is equal to 'b'? **CSC/*E*/TLI/QUEST**
T: Come again. ***E*/TLI**
Steve: If they say zero comma two 'x' is equals to forty rand is plus 'b', I mean… ***E*/TLI/QUEST**
T: *(Interjects)* That plus, this is 'plus forty rand is equal to b'. ***E*/TLI/RESP-CORRECT**
Steve: *(In disbelieve)* Zero comma two x?
T: Yes.
Observer: Maybe…maybe what you should do, he should tell you what… what they wrote. ***E*/TLI/INSTR**
T: Eya, what did you write? Let us write yours. **CSC/EAR/*E*/TLI/QUEST**
Observer: And then see…, because he seems to be confused by the zero comma two x. ***E*/TLI/EXPL**
T: x, eya.
Steve: We said er… in rands meneer, that twenty cent… ***E*/TLI/EXPL**
T: Heh?
Steve: Zero er…twenty cent, zero… ag…
T: *(Interjects)* Zero comma two?
Steve: Yes.
T: *(Writes on chalkboard)* Okay let me just write zero comma two. ***E*/TLI**
Steve: Times 's'. ***E*/TLI**
T: Times… ***E*/TLI**
Steve: 's'.
T: 's'?
Steve: Yes.
T: Okay.
Steve: Plus forty rand. ***E*/TLI**
T: Plus forty rand. ***E*/TLI**
Steve: Is Equal to 'c'. **DSC/DAR/*E*/TLI/EXPL**
T: Equal to… ? ***E*/TLI/QUEST**
Steve: 'c'.
T: 'c'?
Steve: Yes.
T: (*Written on chalkboard: ' 0,2s + 40 = c')* Okay, now, what does 's' stand for? **CCU/*E*/TLI/QUEST**
Steve: 's' is the … kilowatts used. ***E*/TLI/RESP**
T: Kilowatts used? ***E*/TLI/PROBE**
Steve: Yes.
T: Kilowatts? ***E*/TLI/PROBE**
Steve: Kilowatt-hours, meneer. **DCU/*E*/TLI/RESP**

T: So what does kilowatt-hour stand for? Is the unit for what? **ECU/*E*/TLI/PROBE**
Mulalo: Consumption. **DCU/*E*/TLI/RESP**
T: For consumption, okay *(writes 's = consumption in kwh' on chalkboard)*. For consumption, okay. And then the 'c'? **CCU/*E*/TLI/QUEST**
Steve: The cost. **DCU/*E*/TLI/RESP**
T: The cost, in what? **ECU/*E*/TLI/PROBE**
Ls: In rands. **DCU/*E*/TLI/RESP**
T: In rands *(writes 'c = cost in rands' on chalkboard)* and consumption in kilowatt-hours, right. Steve let's look at the two formulae *(referring to '0,2x + 40 = b and 0,2s + 40 = c)*, okay. *(Compares the two formulae)* We've got zero comma two, you got zero comma two. And then we've got 'x', you have 's' Plus, plus. Forty, forty. Is equal to 'b', you said 'c', okay. Do you see any difference between the two, except difference in variables? Are these two formulae different Steve? **CSC/*E*/TLI/QUEST**
Steve: That zero comma two 'x' meneer. Zero comma two 'x'? Hayi, meneer. ***E*/TLI/RESP**
Ls: *(Inaudible)*.
T: Ha di tshwane? ***HL*/TLI/PROBE**
Thami: Ha di tshwane. ***HL*/TLI/RESP**
T: Okay, a re ha di tshwane. The times, the multiplication sign here, so ha di tshwane yang yaanong *[how are they different now]*? What's the difference *(points between 0,2 and x and between 0,2 and s in the two formulae)*. So, a re mo *(points at '0,2x')* hagona multiplication mare mo *(points at '0,2 x s')* e teng *[So, he says here there is no multiplication, but here it is there]*. What are others saying? Ba bang bareng? Bathini abanye *[What are others saying]*? **CSC/*RAR*/*HL-E*/TLI/EXPL-QUEST**
Ls: *(Inaudible)*.
T: Heh?
Ls: *(Inaudible)*.
T: No… no, a re… uthiyena, lana kune i-multiplication sign, lana ayikho *[No….no, he says, here there is a multiplication sign, but here is not there]*. That is why they are different. Are they different? **CSC/*HL-E*/TLI/EXPL-QUEST**
Gloria: Mole go na le multiplication *(refers to '0,2 x s + 40 = c')* and mo le ha go na multiplication sign *[Here there is a multiplication, and here there is no multiplication] (refers to '0,2x + 40 = b')*. ***HL*/TLI/RESP**
T: Gloria a re mo ha go na multiplication sign mare mo e teng *[Gloria says here there is no multiplication but here it is there]*. ***HL*/TLI/EXPL-REP**
Observer: What difference does it make? **CCU/*E*/TLI/PROBE**
T: Eya *[Yes]*.
Observer: Ha enngwe e na le multiplication sign, enngwe e se na multiplication sign *[When the other one has a multiplication sign and the other one not having a multiplication sign]*? **CCU/*Hl*/TLI/PROBE**
L: *(Inaudible)*.
Obsever: Whats the difference between two x and two times x? **CCU/*E*/TLI/PROBE**
Ls: *(Silent)*.
Observer: Whats the difference? ***E*/TLI/PROBE**
T: Is there any difference? ***E*/TLI/PROBE**
Ls: No. ***E*/TLI/RESP**
T: Why? Gloria, you are changing again. You said they are different. **RAR/CAR/*E*/TLI/PROBE**
Steve: Because they all look the same. **DCU/DAR/*E*/TLI/RESP**
Ls: *(Laughter)*.
T: Di difarente Gloria, heh? **CCU/*HL*/TLI/PROBE**
Gloria: No, two times x is two x. **DCU/*E*/TLI/RESP**
T: Two times x is two x. Zero comma two times s, what will you get? **CCU/*E*/TLI/QUEST**
Steve: Two s. ***E*/TLI/RESP**
T: Two s, zero comma two times s? ***E*/TLI/PROBE**
Ls: Zero camma two s. **DCU/*E*/TLI/RESP**
T: You get zero comma two s. So Steve, then this will be zero comma two s *(writes '0,2s + 40 = c' on chalkboard)* plus forty is equal to c. You see that Steve? **RSC/RCU/*E*/TLI/EXPL**
Steve: Yes. ***E*/TLI/RESP**

T: But now, let me just write another. What if it was like this (writes 'c = 0,2s + 40' on the chalkboard), c is equal to zero comma two s plus forty. Is this different or the same? **ECU**/*E*/**TLI/PROBE**
Ls: Is the same. **DCU**/*E*/**TLI/RESP**
T: Is the same. *E*/**TLI/CONFIRM**
Ls: Yes.
T: Who thinks is different? *E*/**TLI/QUEST**
Ls: *(Silent)*.
T: Is the same because this *(points at '0,2 x s + 40 = c' on chalkboard)* can be read from left to right or from right to left, okay right. Now lets go to… lets look in the table. But think, the table is based on the statement whereby we have forty rand service fee, twenty-cent additional charge, and we are given the consumption there in the table. I don't think it would take you long. It won't take you long. Question six, remember, when you are doing the table, about forty rand service charge and twenty-cent additional charge, okay. Other groups have done it. *E/***TLI/EXPL-INSTR**
(Groups do question six. Teacher moves from one group to the other).

TEACHER-LEARNER INTERACTION (GROUP)

T: *(To the Tshivenda group 1)* Where is the table? This is the consumption (points at *table on worksheet)*. Use the formula *(points at the chalkboard)*. There is the formula. The formula is given. *(To the IsiZulu group 1)* Finished here? **RCU/RSC**/*E*/**TLI/PROBE -QUEST**
Ls: Yes.
T: Lets check. Consumption is zero… *(inaudible)*. *E*/**TLI**

(Teacher back with Tshivenda group 1)
T: Akere formula le na le yone? Kiye formula. 'b' e e representang *[You do have a formula? Here the formula. What does 'b' represents]*? **CCU**/*HL*/**TLI/QUEST**
Ls: Consumption. **DCU**/*E*/**TLI/RESP**
T: Consumption. Zero comma two multiply by consumption plus forty, kiye formula e le e berekisang *[here is the formula that you use]*. Use the formula. If its zero, then you say zero comma two multiply by zero, o bo eda forty rand *[then you add rands]*. Then you fill in this *(points at the table in the worksheet)*. **RPF/RCU**/*E-HL*/**TLI/EXPL-INSTR**
(Noise in class due to group discussions as learners work on question 6. Learners inaudible).

TEACHER-LEARNER INTERACTION (CLASS)

T: Right, I think we have all finished. We need to plot the graph after that. Lets plot the graph. *E*/**TLI/INSTR**
Ls: *(Inaudible. Making noise)*.
T: Did you plot the points? Plot the points, plot the points. Now, when you look at the this equation, you can look at this equation… *(Learners making noise)* Excuse me, sorry, when you look at this equation, okay. Steve… Steve… Thamsanqa, when you look at the equation, what graph is this? What kind of graph do you expect from this equation, similar to this one? **ECU**/*E*/**TLI/QUEST**
L: Parabola. **TLI/RESP**
T: Parabola? **TLI/PROBE**
Sipho: No, straight line. **DCU**/*E*/**TLI/RESP**
T: Why straight line? Whats the formula for straight line? **EAR/CCU**/*E*/**TLI/PROBE**
Sipho: Y is equal to … *(inaudible)*. *E*/**TLI/RESP**
T: Y is equal to…? *E*/**TLI**
Sipho: mx plus c. **DCU/DAR**/*E*/**TLI/RESP**
T: y is equal to mx plus c. So, if you look at the graph you need to expect… **CCU**/*E*/**TLI/PROBE**
Ls: Straight line. **DCU**/*E*/**TLI/RESP**
T: You see. *E*/**TLI**
Sipho: Hoo.
(Teacher goes to groups. He moves around groups).

LEARNER-LEARNER INTERACTION (GROUP)

(Tshivenda group 1)
Given: Hah… Sipho, athere mona, zero point two…, *HL*/**TLI**
Sipho: *(Uses calculator)* Zero point two…,
Given: Times…, *E*/**TLI**
Sipho: tmes…, *E*/**TLI**
Given: Zero…, *E*/**TLI**
Sipho: Zero…, *E*/**TLI**
Given: Plus forty…, *E*/**TLI**
Sipho: Plus forty…, *E*/**TLI**
Given: Na dovha. *HL*/**TLI**
Sipho: Wait, I have to understand *(writes in worksheet)*. *E*/**TLI**
T: You see, when you go out ubambezela i-group. *E-HL*/**TLI**
Sipho: Zero point two times hundred plus forty is equal to … *(writes answer in worksheet)*. *E*/**TLI/QUEST**
Given: Zero point two…
Sipho: Times two hundred ne? *E*/**TLI/QUEST**
Given: Eya, plus forty. *E*/**TLI/RESP**
Sipho: Plus forty equals to eighty, eighty *(writes in worksheet)*. **DPF/DSC**/*E*/**RESP**

(The group calculates other values and completes table. Other groups also work on question 6 and complete table. Teacher moves from one group to the other. Noise in class as groups discuss. Groups continue with the next question, Question 7and Question 8 drawing the graph).

Given: (Reads Question 8 in Tshivenda) So, zwiambha hore *[So, what does it mean]*…(inaudible). *HL*/**LLI/READ-EXPL**
(The group discusses and works on Question 8).

TEACHER-LEARNER INTERACTION (GROUP)

(Teacher with IsiZulu group 1)
T: In which graph will they pay more? **ECU**/*E*/**TLI/QUEST**
Steve: The second one. *E*/**TLI/RESP**
T: Which one is the second one? *E*/**TLI/PROBE**
Ls: *(Point at graph drawn on tasksheet)*.
T: Okay, lets call this one A and this one B (labels graphs 'A' and'B'). In which one will they pay more? **CCU**/*E*/**TLI/PROBE**
Ls: *(Silent)*.
T: *(Points at graph)* When consumption is zero cost is … **CCU**/*E*/**TLI/PROBE**
Ls: Forty. **DCU**/*E*/**TLI/RESP**
T: Which one do you recommend? *E*/**TLI/QUEST**
Steve: B. **TLI/RESP**
T: Why B? **EAR**/*E*/**TLI/PROBE**
Steve: *(Silent)*.
T: Look at the graph *(point at the graph on tasksheet)*, see what happens? *E*/**TLI/INSTR-QUEST**

TEACHER-LEARNER INTERACTION (CLASS)

(Noise in class)

T: Okay, lets stop now. Let us stop now. *(Sound of door opening. Someone at the door calls teacher)* Mem please I am busy. Tell the principal that I am busy. Right, we shall … we shall finish tommorrow, but most of the groups are just about to finish. They are done with the graphs, then we will get the report tommorrow. First we will look at the graphs then we will finish up the task. For tommorrow, we will finish it, over. *E*/**TLI/INSTR**

LESSON 4

TEACHER-LEARNER INTERACTION (CLASS)

T: Right, is there any group that has not yet drawn graphs? *E*/**TLI/QUEST**
Ls: No.
T: Right, now let's look at graph ya…, for the new…, for the old structure first. The graph ya old structure yethu *[The graph for the old structure]* was like…, is like this *(sticks on a graph drawn on a chart against the chalkboard)*. I hope you all see, okay, and we … sisesathi i-question yethu ya le graph le *[we said the question for this graph]*, when you came up with the equation, before you drew the graph, we came up with the equation similar to that *(points at the equation 'y=0.2x + 40' written on the chart)*. Even though our… ama-variables wethu ayadifara *[our variables differ]*, the equation is similar to that ye graph yethu ye old-structure *[of the graph for the old structure]*. E simolla mo forty,… mo forty ha the cost e le er… the consumption e le zero *(points at graph drawn on chart)*, because ne tshwentse re patale… re patale service fee ya forty ranta even re sa berekisa motlakase. So, that's our graph e leng straight line, yanong e be re tla ka the new-structure. Mo new-structure, go ile ga ntshiwa forty ranta ya service fee, then ra tla ra drowa graph ya teng. Now o… ha o, before ke baya grafo ya teng, ke… re e beya mo. Mo new-structure ya… ya… ya go khalkhuleita dicost tse di pataloang, what do you think is the equation ya the new-structure? Equation ya new-structure *[It starts at forty,... at forty when the cost is er... the consumption is zero, because we were supposed to pay the forty rand service fee even though electricity was not consumed. So, that's our graph which is a straight line, then the new structure. In the new structure, forty rand service fee was not included, then we drew the corresponding graph. Now you... if you, before placing the graph, I... we stick it here. With the new structure, to calculate the costs, what do you thinkis the equation of the new structure? The equation for the new structure]*? **ESC/ECU**/*E-HL*/**TLI/EXPL-QUEST**
L: y is…
T: Mmm, new-structure, equation ya teng *[its equation]*? *E-HL*/**TLI/QUEST**
Ls: y is equals to zero comma two. *E*/**TLI/RESP**
T: y is equal to zero comma…? *E*/**TLI/PROBE**
Ls: Two x.
T: Zero comma two? **CCU**/*E*/**TLI**
Ls: y is equal to zero comma … *E*/**TLI/RESP**
T: y is equal to…? *E*/**TLI/PROBE**
Some Ls: Zero comma two five.
T: Zero comma two…?
Ls: Five.
T: Two five.
Ls: x. **DCU/DSC**/*E*/**TLI**
T: x *(writes 'y=0,25x' on chalkboard)*.
Ronald: Two five x plus forty. *E*/**TLI/RESP**
Ls: Haaaa! E ntshitswe *[It was excluded]*. **DCU**/*HL*/**TLI/RESP**
T: You are saying 'haaa' when he says 'plus forty'. Why are you saying 'haaa', Nkateko? **ECU/EAR**/*E*/**TLI/QUEST**
Nkateko: Sir, haika hakelisiwa, haikafakiwa *[Sir, it is not being paid, it is not added]*. **DCU/DAR**/*HL*/**TLI/RESP**
T: Forty ranta haifakiwa *[Forty rand is not added]*. *HL*/**TLI/PROBE**
Ls: Eya *[Yes]*.
T: Forty ranta ha ya tsenyiwa *[Forty rand is not added]*. *HL*/**TLI/PROBE**
Ls: Ee *[Yes]*.

T: So then, this is the equation *(refers to 'y=0,2x)* for the new-structure, okay. Then grafo ya *[the graph of]* the new-structure *(sticks on a graph drawn on a chart against the chalkboard)*, there's the graph ya rona ya the new-structure, akere. E simolla mo point of origin *(points at zero on the graph)*, akere *[there's our graph for the new structure, isn't it. It starts at the point of origin, isn't it]*. *E-HL*/**TLI/EXPL**
Ls: Yes.
T: And there's the equation *(points at 'y=0,2x' written on the chart. Removes chart from chalkboard)*. But now mo karabong, mo worksheeting ya rona *[But now, in the response, in our worksheet]*, the question was we need to draw it on…, the instruction was 'on the same system of axes', okay. So we drew that on the same system of axes *(sticks on chart with drawn graphs against the chalkboard)*. Dzi-grafo dza hone *[The related graphs]* are going to be like that. So the black one, le emnyama *[the black one] (refers to the straight like drawn in black)*, is the… **CCU**/*E-HL*/**TLI/EXPL**
L: *(Interjects)* Old one. **DCU**/*E*/**TLI/RESP**
T: Old-structure indicating the cost. *E*/**TLI/EXPL**
Ls: Yes.
T: And the blue one *(refers to the straight line drawn in blue)* ke yona *[is the]*… **CCU**/*E-HL*/**TLI/PROBE**
Ls: New one. **DCU**/*E*/**TLI/RESP**
T: New-structure. *E*/**TLI/EXPL**
Ls: Yes.
T: Now the next question *(looks at tasksheet)*, number nine ere *(reads from tasksheet)* "Do both the family-home and the town-house benefit from this new-structure? Explain". Can we quikly do that one. "Do the family-home and the town-house benefit from the new structure?"
ESC/EPF/EAR/*E*/**TLI/READ-INSTR**

(Goes to Setswana group 2)
T: Aa family-home ya benefita from structure se sentsha *[Is the family home benefiting from the new structure]*? Question… question… *HL-E*/**TLI/QUEST**
Pontsho: *(Interjecting)* Question nine. *E*/**TLI/RESP**
T: Question nine. Ya benefita na? And you cannot just say… o ka sere 'ee ya benefita' kgotsa 'nnya ha e benefiti'. Angeke uthi 'yebo iyabenefitha' ore ca', you have to give… *[Does it benefit? You cannot just say 'yes it benefits' or 'no, it does not benefit'. You have to give…]* **RAR**/*E-HL*/**TLI/EXPL**
Ls and T: Reasons.
T: *(To Tshivenda group 1)* O fe gore why o re ya benefita ore why o re ha e benefite.
(Goes to Isizulu group1 and comes back to Tshivenda group 1). Zwino, if you say the money will decrease, tshelede ya hone ikhoya pfasi, you need to tell us by how much. If you say the money you pay with the new structure ikhoya pfasi, ngabhugai, okay. Ngabhugai *[You have to give reasons why do you say it does not benefit. Now, if you say money will decrease, you need to tell us by how much, okay]*? *(Goes to other groups)*. **RAR/RSC**/*E-HL*/**TLI/EXPL**

(Noise in class. Tshivenda group discussing but inaudible).
Given: *(Writes answer in English on tasksheet in the Tshivenda version)*.
Sipho: *(Silently reads what Given has written)*.

TEACHER-LEARNER INTETRACTION (GROUP)

(Teacher with Tshivenda group 1)
T: Right, *(Reads what the group has written)*. Now, if you say 'they pay less amount', less by how much? Less ngavhugai *[by how much]*? If you say 'they pay less', ngavhugai *[by how much]*? Mudi ukhobhadala this much *(points at tasksheet)*, athiri *[The household will pay this much, isn't it]*?
CSC/CAR/*E-HL*/**TLI/PROBE**
Ls: Yes.
T: Old structure, zwino mudi obhadala one forty new structure. Then hapfa ure wena vhobhadala less, less ngabhugai? Same thing with townhouse, vhobhadala this *[Old structure, now the household pays one forty for the new structure. Then here you say they pay less, less by how much? Same thing with*

the townhouse, they pay this], where's that *(turns to question 4 and points at group's solution in question 4)*. **CSC/CAR**/*E-HL*/**TLI/READ-PROBE**
Given: Two-eighty. Titshere mo *[Sir, here]….(points at solution in question 4)*,
T: *(Interrupts)* Ke winter *[Is winter]*.
Given: Ke…ke old structure ne *[Is the old structure]* …,
T: Eya, ke old structure *[Yes, it is the old structure]*.
Given: Ee ya, and ba patala one seventy-five *[Yes, and they pay one seventy five]*. *E-HL*/**TLI/EXPL**
T: This is… le is winter *(refers to question 4)*. So this one is summer *(refers to question 2)*. So if you compare the two you need to compare summer and summer and not summer and winter. So you compare this and that and tell us ubhadala less ngavhugai *[…how much less do they pay]*. **RPF/RCU**/*E-HL*/**TLI/EXPL-ASSIST**
Given: Hoooo *[Okay]*…
T: Same thing here *(points and group's response for question 6 in tasksheet)*, athiri *[isn't it]*?
Given: Eeya *[Yes]*.
T: With the same kilowatts ubhadela vhugai, one-eighty, same kilowatts ubhadela vhugai apfa *[How much do you pay with the same kilowatts, one eighty, same kilowatts here, how much do you pay]*? *E-HL*/**TLI/EXPL-PROBE**
Given and T: One-seventy five.
T: So, you need to tell us ubhadela less ngavhugai *[…how much less do you pay]*. So, I am not saying this is wrong *(referring to what the group has written)*, but I am saying you need to add more information in terms of values. **RPF/CPF**/*E-HL*/**TLI/EXPL-ASSIST**
Sipho: How much they pay? *E*/**TLI/QUEST**
T: How much less they are paying. They pay this old structure, new structure they paying so much less okay, boivhona *[do you see]*? **RPF**/*E-HL*/**TLI/RESP-EXPL**
Ls: Eya *[Yes]*.

(Teacher and observer moving from one group to the other. Teacher attends to whole class)

TEACHER-LEARNER INTERACTION (CLASS)

T: Er….class *(learners still discussing in their groups)*, can…can I get your attention. Ke ya utlwa *[I understand that]* most of you, in fact all of you are saying 'yes they benefit because they are now paying less', okay. That's not enough. If you say they are paying less, you need to compare the two values before, the old structure and the new structure. If you say is less, is less by how much? You cannot just say they pay less withou giving us values, go sena di-values. I also said you can also look at the graph. You can use the graph for your argument, not just 'yes they benefit', without the values, okay. Tshwentse o re bolelle gore ba patala bokae less *[You need to tell us how much less do you pay]*. **RPF/RSC**/*E-HL*/**TLI/INSTR-EXPL-ASSIST**

(Teacher goes to Isizulu group 2 and observer goes to Setswana group 2. Tshivenda group discussing on their own but inaudible. Teacher goes back to Tshivenda group 1)

Given: … Patience, rikhonyaga vhugai? Ndijiye one-seventy neh, forty, ndimayinase nga… *(inaudible)*. Ndikone huvhona huri… i-less ngavhugai. *[…Patience, how much do we want? I take one seventy , forty, and minus…] HL*/**TLI/QUEST-EXPL**
T: Eya *[Yes]*, the statement, where's the statement that you are reading from? *E*/**TLI/QUEST**
Patience: *(Gives teacher tasksheet)*.
T: *(Silently reads group's written response)* That's not enough. **CSC**/*E*/**TLI/READ**
Sipho: *(Inaudible)*.
Given: Eya, ee *[Yes]*.
T: That is… not only about that. Is also about… *(inaudible)*. Is not only about this. Remember ukuthi *[that]*, when… umaukhipha i- *[when you subtract]*…, when they subtract the forty rand, they increase this by five cents. **CSC**/*E-HL*/**TLI/EXPL-ASSIST**

Sipho: *(Silently reading Tshivenda version)* So the twenty-five cents, they put that on top, so… *E-HL*/**TLI/READ-EXPL**
(Noise in class. Teacher attends to other groups and come back to the Tshinenda group 1)
Given: *(Uses calculator)*.
T: What you calculate you need to write it down. Vhoingwala *[Write it]*, so lets…, how did you work it out? **EAR**/*E-HL*/**TLI/INSTR-QUEST**
Given: Akere sir, wa itse ke batla go etsa jwang, nna…nna, according to nna, nto e ke e naganang neh, ke itse, akere sir mona ke *(turns page to refer from tasksheet)… [You know what sir, do you know how I want to do it, according to me, what I think, I said, isn't it here] HL*/**TLI/EXPL**
T: Eya *[Yes]*.
Given: Ke *[It's]* one-seventy four. *E-HL*/**TLI/EXPL**
T: Ee, ke ya winter e *[Yes, this one is for winter]*. *HL*/**TLI/EXPL**
Given: Ee, mo ha ka *[Yes, here I did not]… HL*/**TLI/EXPL**
T: *(Interrupts)* Tse ke tsa summer *[This is for summer] (refers group to their previous solutions)*. Tse i-two tse *[These two]*. *HL*/**TLI/EXPL-ASSIST**
Given: Ee *[Yes]*.
T: So, tshwentse o khomphere di-summer. Tse ke summer, tse ke summer *(points at tasksheet)*, summer, summer. Ka summer mo ba patela one-forty two, ba ba patela one-twenty. So wa sheba, old structure le new structure. New structure summer ba patela bokae *[So, you should compare the summers. This is for summer, and these are for summer. In summer here they pay one forty, and they pay one twenty. So you check, old structure and new structure. New structure, how much do they pay in summer] (points at tasksheet)*, one-forty. **RPF/CAR**/*HL*/**TLI/EXPL-ASSIST**
Given: Hoooo *[Okay]…*
T: Ba ba patela bokae, one seventy-five. So o ka se khomphere *[How much do they pay, one seventy. So you must compare] …(inaudible)*. **CSC/RPF***HL*/**TLI/EXPL-ASSIST**
Given: Hoooo… re khomphera summer le winter *[Okay, we compare summer and winter]*? *HL*/**TLI/QUEST**
T: No, ke disummer tse i-two mara ka di-structure tse sa tshwaneng *[No, this are two summers but for different structures]*, *(points at two different solutions in tasksheet)* ke summer, ke summer. E ke ya mudi le townhouse. Townhouse uvhadela *[you pay]* one-eighty same amount of kilowatt-hours, one seventy-eight, same amount of kilowatt-hours. This one *(points at tasksheet)*,we'll pay one-forty for five-hundred and sixty kilowatt-hours old structure. New structure you pay one-fifty two, five hundred and sixty kilowatt-hours. So you compare this one and this one, and tell us is ..., like you compare e le e, then you tell us 'are they benefiting?' you campare this one and that one, 'are they benefiting?' wa utlwa *[do you understand]* Sipho? **RPF/RSC/RAR**/*HL-E*/**TLI/EXPL-ASSIST-QUEST**
Sipho: Ke ya utlwa meneer *[I understand sir]*. *HL*/**TLI/RESP**
(Teacher leaves the group)

LEARNER-LEARNER INTERACTION (GROUP)

Given: Di ya benefita.hapfa neh, kha summer, kha winter vha badhela seven hundred neh, kha townhouse. Then kha..kha mudi kha winter, kha botshibadhela one-fifty two, kha botshibadhela vhugai, one-forty. So vha benefitha ngavhugai *[In summer they benefit, in winter the townhouse pays seven hundred. Then the household in winter they pay one fifty two, and in winter again they pay one forty. So by how much do they benefit]*? The amount… *HL*/**LLI/EXPL-QUEST**
Patience: *(Interrupts)* Eya, mara I think vha budzisa huri vha kho inkhriza ngavhugai. Apfa vhobadhela one-fifty two and apfa summer vha kho vhadela one-forty *[Yes, but I think what is being asked is that 'by how much does it increase. Here they pay one fifty two and here in summer they pay one forty]*. E-**DCU**/*HL*/**LLI/RESP-EXPL**
Sipho: Eya *[Yes]*.
Patience: Vho budzisa huri vha kho inkhriza nga vhugai, because harishoma neh, one-fifty two minus one-forty ikhovha vhugai *[They are asking that 'by how much is it increasing', because when we calculate, one fifty minus one forty is how much]*? **DPF/DSC**/*HL-E*/**LLI/EXPL-QUEST**
Given: *(Uses calculator)*.
Sipho: Twelve cents. *E*/**LLI/RESP**
Given: Twelve cents? *E*/**LLI/PROBE**

Sipho: Twelve rand… twelve rand… twelve rand. **DPF**/*E*/**LLI/RESP**
Given: Ndikhongwala nga Tshivenda zwino *[I am now going to write in Tshivenda]*? *HL*/**LLI/QUEST**
Sipho: Eya, ngwala nga Tshivenda ngwananga *[Yes, write in Tshivenda baby]*. *HL*/**LLI/RESP**
Given: *(Writes in tasksheet)* Ndikhoneta nga English. Ritshi… kana ndimini u…u...u… *[I am tired of English. We say…, by the way what is to…to…to…] HL*/**LLI/QUEST**
Sipho: Khezo, ngwala nga English *[Aha, write in English]*. *HL*/**TLI/INSTR**
Given: Hae, kana ndimini u… *[No, by the way what is to…] HL*/**LLI/QUEST**
Patience: Kwitani *[To do what]*? *HL*/**LLI/QUEST**
Sipho: Dikhriza *[To decrease]*? *HL*/**LLI/QUEST**
Given: kutanga… kutanganisa, tshitangadzisa mudi kha…kha summer na mudi kha winter ritshi mini… mudi… Hu tanganisa ndimini nga Tshivenda *[To add… to add, we add the household in…in summer and in winter, what do we say? Household… What is to 'tanganisa' (add) in Tshivenda]*? *HL*/**LLI/RESP-QUEST**
Patience: Ndingutanganisa *[Is to 'tanganisa' (add)]*. *HL*/**LLI/RESP**
Given: Hooo *[Okay]*…
Sipho: *(Laughing)* Already answered. *E*/**LLI/RESP**
Given: Nditanganisa er… amount *[I add er…. amount]*? *HL-E*/**LLI/EXPL-QUEST**
Sipho and Verda: Tshelede ya kha old-structure na kha… *[The money for the old structure and for the…] HL*/**LLI/RESP**
Sipho: Tshelede ya kabhelo ya tshibadhelo *[The cost for consumption]*. *HL*/**LLI/RESP**
Given: Haa… *(writes on tasksheet)*, ene…
Verda: Kha mudi *[For the household]*. *HL*/**LLI/RESP**
Given: Vuriha, haa... *[Winter, oh...]*? *HL*/**TLI/QUEST**
Sipho: Veuriha, *(spells word)* v, e, u, h, a. Veuriha. *HL*/**LLI/RESP**
Given: Na nga..., summer ndimini *[And in…, what is summer]*? *HL*/**LLI/QUEST**
(Noise in class)

TEACHER-LEARNER INTERACTION (GROUP)

T: *(To whole class)* Right.

(Teacher attends to Setswana group 1 and two observers attend to other groups)
T: Le feditse *[Have you finished]*? *HL*/**TLI/QUEST**
Ls: No.
T: That is why ke re mo go lona, that is why ke re mo go lona ipueleng Setswana. Ke gore le seke la etsa dilo tse ditelle *[That is why I said to you communicate in Setswana. So that you should not write long sentences]*. **RSC**/*E-HL*/**TLI/INSTR**
Pontsho: Sir… sir… akere *(inaudible)*…, ke be ke ngwala *[Sir….sir…. isn't it…, then I wrote] (shows teacher what she has written)*. *HL*/**TLI/EXPL**
T: Le seke la etsa di-sentence tse ditelle. Ke fela gore ya ntlo e ne e patela bokana , e patela bokana, e difarente ka bokana. Townhouse e ne e patela bokana, e patela bokana, e difarente ka bokana. From there wa tsheka, aa structure sa rona se tswela ntlo le townhouse mosola *[Do not write long sentences. Just write what the household paid previously and how much is it paying now, and how much the difference is. The townhouse paid this much previouly and it now pays this much, and how much the differnce is. From there you check whether the new structure is beneficial for both the household and the townhouse]*? **RPF/RSC**/*HL*/**TLI/INSTR-EXPL-ASSIST**
Gabriel: *(Inaudible)*.
T: Kwala fa *[Write here] (points at tasksheet)*. That is why ke re le seke la berekisa sentence tse telle. Ntlo e ne e patela bokana, e patela bokana. Townhouse e ne e patela bokana, e patela bokana *[That is why I say do not use long sentences. The household paid this much, it pays this much. The townhouse paid this much, it pays this much]*. *(Goes to Setswana group 2)* Right, lets do number nine. *(Goes to Isizulu group 2 and checks their response in tasksheet)*. **RPF/RSC**/*HL-E*/**TLI/INSTR-EXPL**

TEACHER-LEARNER INTERACTION (CLASS)

(Teacher to the whole class)
T: Guys, let's look at the last question. *(Noise in class)* Can we look at the last question. Okay, groups… groups, I've checked your groups, that's correct. We…, when I checked your groups, you are all saying 'they benefit', angithi *[isn't it]*? *E*/**TLI/INSTR-MOTIV-QUEST**
Ls: Yes.
T: Because they've paid…, old structure ne ba patela *[they pay]* this, new structure they paid that, they save this much, akere *[isn't it]*. Is twelve rand, house saves twelve rand and the townhouse they save five rand. Then we say new structure they save, they benefit. Now the last question says, if they ask you ukuthi *[that]* which structure…, people come to you and say give us advise, go na le *[there is]* this structure ne, le this new structure. Forty rand service fee plus twenty cents per kilowatt-hour. Enngwe gape *[The other one]* is twenty-five cents per kilowatt-hour, which is the new structure. Then they ask you 'Which one can you recommend for us to choose?', okay. Then from those calculations and looking at the graph, from the calculations and the graph, which one do you think will…. Steve… *(inaudible)*. **ECU/EAR/RPD**/*E-HL*/**TLI/EXPL-QUEST**
Steve: The new one. *E*/**TLI/RESP**
T: The new one. Why the new one? **CCU/EAR**/*E*/**TLI/PROBE**
Steve: You don't pay the service fee. *E*/**TLI/RESP**
T: You don't pay the service fee. *E*/**TLI/PROBE**
Steve: And the money is… is less. **DCU/DAR**/*E*/**TLI/RESP**
T: So the new one is less? *E*/**TLI/PROBE**
Steve: Yes.
T: Okay.
Steve: But…
T: *(Interrupts)* But… but what? You said 'but'. *E*/**TLI/QUEST**
Steve: After the … what? Two hundred… *E*/**TLI/RESP-QUEST**
T: *(Interjects)* Two hundred kilowatt-hours. *E*/**TLI/RESP**
Steve: Two hundred kilowatt-hours. *E*/**TLI/RESP**
T: Yeh.
Steve: They are both *(puts first fingers together)* equal. **DCU/DAR/DSC**/*E*/**TLI/RESP**
T: Not after, at … *E*/**TLI/EXPL-CORRECT**
Steve: At two hundred… *E*/**TLI/RESP**
T: *(Interjects)* At two hundred kiliwatt-hours, they…they… whether they use the new structure or old structure, if their electricity is two hundred kilowatt-hours, then… (inaudible), eight hundred kilowatt-hours, okay, they will… they will all pay same amounts, whether new structure *(points at graphs on charts pasted on chalkboard)*. That's eight hundred. *E*/**TLI/EXPL-CORRECT**
Ls: Two.
T: *(Points at 'x=800' and moves ruler vertically up the graph)* There you are, there you are. They are equal there *(points at the point where the two graphs meet)*. *E*/**TLI/EXPL-CORRECT**
Steve: But then after eight hundred…,
T: Eya.
Steve: The new one becomes much er… **DSC/DCU/DAR**/*E*/**TLI/RESP-EXPL**
T and Steve: Less.
T: Okay, Setswana sa lona ke seo *[There is you Setswana]*? *HL*/**TLI/QUEST**
Ls: Yes.
T: La e tlhaloganya *[Do you understand]*? **CCU**/*HL*/**TLI/QUEST**
Ls: Yes.
T: So, mo *[here] (points at point of intersection of two graphs)* that's where the two graphs intersect…intersect, there, there *(points where the graphs meet)*. They are equal, this point of equality, whether new structure or old structure. But now, after there, if…if…the household, in fact, if this is more than eight hundred kilowatt-hours, then with the old structure they pay more… with the new struct… with the new structure they… *E*/**TLI/EXPL**
Ls: They pay more. **DCU**/*E*/**TLI/RESP**
T: They pay more, but with the old structure after that… *E*/**TLI/PROBE**
Ls and T: They pay less. **DCU**/*E*/**TLI/RESP**
T: With the old structure, if they use less than eight hundred kilowatt-hours, the old structure, if they use the old structure, then they start… they pay more. With the new structure, if they use less than

eight hundred kilowatt-hours, this is the old stryucture, the new structure they pay less. Yes Nkateko? *E*/**TLI/EXPL-QUEST**
Nkateko: Sir, minha *[I]*….*(inaudible)* …more than once…*(inaudible)*…tona timbiri ti-right…uka teka ingwani ingwani, lokuhatlisa amheteleleni ane, vahakela mali yokufana. Aswina difarente oku utirhise…*[both of them are right… you can take any one, when it reaches the end, they pay same amounts. There is no difference, as long as you use it]* **DAR/DCU**/*HL-E*/**TLI/RESP-EXPL**
L: Asikuzwa *[We don't understand you]*. *HL*/**TLI**
Shirley: Thina siyamuzwa *[We understand]*. *HL*/**TLI**
T: Do you understand? *E*/**TLI/QUEST**
Ls: No.
Siphiwe: Asizwanga *[We did not here a thing]*. *HL*/**TLI/RESP**
(Noise in class)
T: For her there's no difference. What she is saying, for her there's no difference. It depends on…, what she is saying, it depends on the amount of electricity that you use that will determine how much you pay. That's what she's saying. She says 'No, it doesn't matter which structure do you use, it depends on how much you use, the amount of electricity that you use, the household', that's what she is saying. What do you think? **CSC/CAR/***E*/**TLI/EXPL-PROBE**
Ls: *(Silent)*.
T: What do you think? Sipho group ya lona e naganang? A re ene, no no no, ga go tshwenye [*Sipho, what does your group think? She says no, it does not matter]*. It doesn't matter, old structure, new structure, no it doesn't matter, it depends on how much electricity you use. You…, what she says is,she'll just take anything, whether old structure or new structure. And Steve says…Steve says if you…you, if you use more than eight hundred kilowatt-hours *(points at graph)*, then you are going to pay more with the… **CAR/***E-HL*/**TLI/EXPL/PROBE**
Ls: *(Interject)* New structure. *E*/**TLI/RESP**
T: But you pay less with the old structure, but if you use less than eight hundred kilowatt-hours. So Steve, which one will you recommend, or how will you…how will you advise them? **EAR/ECU/RPD**/*E*/**TLI/EXPL/QUEST**
Steve: *(Silent)*.
(Noise in class)
T: How will you advise them? Yes Sindiswa. *E*/**TLI/PROBE**
Sindiswa: I will advise them to take the old structure. *E*/**TLI/RESP**
T: Why? **RAR/***E*/**TLI/PROBE**
Sindiswa: Because they use more…*(inaudible)*… *E*/**TLI/RESP**
T: You will advise them to use this one *(points at graph of y=0,2x+40)*? *E*/**TLI/QUEST**
Sindiswa: Yes.
T: Now, suppose now that the people that you advise they don't use much electricity. For instance they use electricity less that there *(points at consumption less than 800kwh on graph)*. They say 'ag, no no'. These are the people who don't have a lot of appliences. They just use electricity, like less electricity. Will you still say, no take the old structure, forty rand plus zero comma two x? **CAR/CCU/***E*/**TLI/PROBE**
Anza: Er…in fact nka ba advisor gore ba yuze new structure *[Er…in fact I can advise them to use the new structure]*, but a certain limit of atleast six hundred kilowatt. **DCU/DAR/***E-HL*/**TLI/RESP**
T: So you are saying wena you will advise them to use this one? *E*/**TLI/QUEST**
Anza: Yes.
T: Provided that they use atleast electricity ye six hundred kilowatt-hours and less than eight hundred? *E*/**TLI/PROBE**
Anza: Yes.
T: So you are saying to us it will depend on how much electricity they use? *E*/**TLI/PROBE**
Anza: Yes.
T: If they use less than this, you'll say no take the old structure…the new structure? *E*/**TLI/PROBE**
Anza: Yes.
T: Am I correct, *(Noise in class)* Yes Steve? **CAR/CCU/***E*/**TLI/PROBE**
Steve: Meneer, for instance, for the new structure, you don't have to pay the forty rand if you use electricity. **DCU/***E*/**TLI/RESP-EXPL**
T: Eya.

Steve: So, that old one meneer, if you use electricity, but you have to pay the forty rand. **DCU**/*E*/**TLI/RESP-EXPL**
T: Which one, this one? *E*/**TLI/QUEST**
Ls: Yes.
Steve: So, will take the new one meneer, because you have to pay the forty rand. *E*/**TLI/RESP-EXPL**
T: Forty rand? *E*/**TLI/PROBE**
Ls: Yes.
T: But even if you don't pay the forty rand, if it is more than eight hundred, even if you don't pay the forty rand. **CCU/CAR**/*E*/**TLI/EXPL-PROBE**
Steve: …*(Inaudible due to noise in class)*…
T: Gab, let's take the last two there, then we close. *E*/**TLI/INSTR**
Gabriel: Eya, according to my point of view,…
T: Eya.
Gabriel: I will advise both families to use the old… the new structure because they both save twelve rands, the family house will save twelve rand if they use the old…the new structure. *E*/**TLI/RESP-EXPL**
T: This one *(points at graph)*? *E*/**TLI/QUEST**
Gabriel: Because they used to pay one-fifty two, but if they use the new…the new…the new structure they will save twelve rand. When it comes to the townhouse, they will spend…they will save five rands because they use to pay one-eighty now they pay one-seventy five, so they save five rands. **DAR/DCU/DPF/DSC**/*E*/**TLI/RESP-EXPL**
T: Then townhouse will save twelve rands if they use electricity ya *[of]* seven hundred kilowatt-hours *(points at graph)*, if they use seven hundred kilowatt-hours. But if they are going to use more than, then they start to pay more than *(points at graph of 'y=0.25x' after 800kwh)* if they use the new structure. O ya e bona *[Do you see]* now? *E-HL*/**TLI/EXPL-QUEST**
Ls: Yes.
T: The moment ba dirisa motlakase wa *[…they use electricity of]* more than eight hundred kilowatt-hours, using the …the new structure, they start to pay more. *E-HL*/**TLI/EXPL**
Gabriel: But if… it will depend whether ha o…ha o sebedisa motlakase *[you did not use electricity]*. *E-HL*/**TLI/RESP**
L: Yes.
(Noise in class)
Sindiswa: *(Raises hand)*.
T: Okay, let's listen to the last one. So, o ka etsa eng *[what will you do]*? **CCU/CAR/RSC**/*E-HL*/**INSTR-QUEST**
Sindiswa: I will advise them depending on how much electricity they use. **DCU/DAR**/*E*/**TLI/RESP**
T: Per month? *E*/**TLI/PROBE**
Sindiswa: Yes.
T: So…? *E*/**TLI/PROBE**
Sindiswa: If they use less electricity, then I will… *E*/**TLI/EXPL**
T: *(Interrupts)* Less than which one? **ECU**/*E*/**TLI/PROBE**
Sindiswa: Less than eight hundred. **DCU**/*E*/**TLI/RESP**
T: Less than eight hundred? *E*/**TLI/PROBE**
Sindiswa: Yes. I will say…I will advise them to take the new structure. **DAR/DSC**/*E*/**TLI/RESP**
T: The new structure *(points at graph of 'y=0.25x')*, yes. *E*/**TLI/PROBE**
Sindiswa: Yes. If they use more than eight hundred kilowatt-hours, then I'll advise them to take the old structure. **DCU/DSC/DAR**/*E*/**TLI/RESP**
T: The old structure. *E*/**TLI**
Observer 2: If they consume eight hundred then what? **ECU**/*E*/**TLI/PROBE**
T: If they consume what? *E*/**TLI/QUEST**
Ls: Eight hundred.
T: Eight hundred, if they consume eight hundred what will you say? **ECU**/*E*/**TLI/PROBE**
Ls: They…they can take any. **DCU**/*E*/**TLI/RESP**
T: Any one. They can take any one. *(Noise in class)* Thank you, thank you, your answers are super. So, thank you er…boys and girls. *E*/**TLI**
Ls: Thank you.

T: Remember I said some of you are going to be interviewed today. The interview is based on the lessons. It is not about umsebenzi *[employement]*. *(Noise in class)* So before like, ngicela ukuthi when you collect amasheet, can you collect, lalela, you put the sheets tse tsa group ka one bunch *[please collect the sheets, listen, put the sheets of each group in one bunch]*. Each group must just put…don't combine them neh. Put them, the sheets tsa group, put yours here I'll come and collect them, okay. *E-HL*/**TLI/INSTR**

APPENDIX D

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
MATHEMATICS-HOME LANGUAGE PROJECT

Dear principal

My name is Terence Molefe, the mathematics teacher in your school. I am currently doing my M.Ed degree in Mathematics Education. As part of my studies, I am doing an action research investigating the use of multiple languages to support mathematical proficiency in a grade 11 multilingual classroom of second language learners. The hope is that the findings of this study will help us find ways of how we can use learners' home languages to support the development of proficiency in mathematics. In this project, I will be working with my supervisor Professor Mamokgethi Setati from the University of the Witwatersrand.

I am requesting permission to do the study in my grade 11 mathematics classroom, and to send letters to parents/guardians, inviting their children to participate in this research project. Once you have read the letter, you can decide whether you want the school to take part or not. With your permission, the lessons will be video recorded for five days during mathematics lessons in the month of October. Learner interviews will be tape recorded. The focus in these video-recordings and lesson observations will be on 'how languages are used to support the development of learners' proficiency in mathematics' during learning and teaching.

Learners whose parents/guardian do not agree that they should be video recorded, will not be video recorded; they will be kept away from the focus of the video recorder. This will not put them in a position where they are deprived from the lesson. For learners whose parents/guardian do not agree that they should participate, extra lessons will be arranged at an agreed upon time, where lessons taught during the study will be presented to those learners who did not participate in the study.

I intend to protect your school's and learners' anonymity and confidentiality. Their real names will not be used in the final report. I will remove any reference to personal information that might allow someone to guess the school's name and learners' 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, learners' faces will be hidden from public viewing. Permission from parents, learners and you will be requested before the video recording is used for conferences or for teaching purposes.

Remember that the school is not obliged to participate and may withdraw at any time during the study. Should you require any further information, do not hesitate to contact me.

Terence Molefe

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
MATHEMATICS-HOME LANGUAGE PROJECT

Dear parent or guardian

My name is Terence Molefe, your child's mathematics teacher. I am currently doing my M.Ed degree in Mathematics Education. As part of my studies, I am doing a research investigating the use of multiple languages to support mathematical proficiency in a grade 11 multilingual classroom of second language learners. The hope is that the findings of this study will help us find ways of how we can use learners' home languages to support the development of proficiency in mathematics. In this project, I will be working with my supervisor Professor Mamokgethi Setati from the University of the Witwatersrand.

Your child's principal has given me permission to send this letter to invite your child to participate in this research project. Children whose parents/guardians agree that they participate in this study will be video recorded for five days during mathematics lessons in the month of October. The focus in these video-recordings and lesson observations will be on 'how languages are used to support the development of learners' proficiency in mathematics' during learning and teaching.

Children whose parents/guardian do not agree that they should be video recorded, will not be video recorded; they will be kept away from the focus of the video recorder. This will not put them in a position where they are deprived from the lesson. For children whose parents/guardian do not agree that they should participate, extra lessons will be arranged at an agreed upon time, where lessons taught during the study will be presented to those learners who did not participate in the study.

I intend to protect your children'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. Permission from you will be requested before the video recording is used for conferences or for teaching purposes.

Remember that your child is not obliged to participate and may withdraw at any time during the study. Should you require any further information, do not hesitate to contact me – my telephone numbers are below.

If you agree that your child be part of the research project, please complete the consent form on the next page and sign in the space provided.

Terence Molefe (011) 936-3642

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

MATHEMATICS-HOME LANGUAGE PROJECT

Researcher: Mr Terence Molefe

Supervisor: Prof M. Setati

Consent form for learners in the study (To be completed by parent/guardian).

I give consent to the following:

- My child to be video-recorded during the lessons.

  Yes ☐ No ☐ (use a cross to indicate your selection)

- The possible future use of the videotext for teaching purposes

  Yes ☐ No ☐ (use a cross to indicate your selection)

…….. ……..
Signature of student Date

…….. ……..
Signature of parent/guardian Date

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
MATHEMATICS-HOME LANGUAGE PROJECT

Dear learner

My name is Terence Molefe, your mathematics teacher. I am currently doing my M.Ed degree in Mathematics Education. As part of my studies, I am doing a research investigating the use of multiple languages to support mathematical proficiency in a grade 11 multilingual classroom of second language learners. The hope is that the findings of this study will help us find ways of how we can use learners' home languages to support the development of proficiency in mathematics. In this project, I will be working with my supervisor Professor Mamokgethi Setati from the University of the Witwatersrand.

Your principal has given me permission to send this letter to invite you to participate in this research project. Once you have read this letter, you can decide whether you want to participate or not, since participation is voluntary. You are encouraged to talk to your parents/guardian about it.

If you agree to participate in this study, you and the other learners in your class will be video recorded for five days during mathematics lessons in the month of October. The focus in these video-recordings and lesson observations will be on 'how multiple languages are used to support the development of learners' proficiency in mathematics' during the mathematics lessons.

I intend to protect your anonymity and confidentiality. Your real names will not be used in the final report. I will remove any reference to personal information that might allow someone to guess your identity. In case I need to use the information in the video recording for conferences or for teaching purposes, your faces will be hidden from public viewing. Permission from you and your parents/guardians will be asked before it is used for conferences or for teaching purposes.

Remember that you are not obliged to participate and may withdraw at any stage during the study. Your participation, non participation or withdrawal, will not in any way affect your relationship with me and your mathematics marks. I will also avail a third marker to mark your work so as to ensure consistency of my marking of your work done following the completion of the study. If you wish not to be video recorded, you will be kept away from the focus of the video recorder. You will not be put in a position where you will be deprived from the lesson. If you do not agree to participate, extra lessons will be arranged at an agreed upon time, where lessons taught during the study will be presented to you. Should you require any further information, do not hesitate to contact me – my telephone numbers are below.

If you agree to take part in this research project, please complete the assent forms on the next page and sign in the space provided.
Terence Molefe (011) 936-3642

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

MATHEMATICS-HOME LANGUAGE PROJECT

Researcher: Mr Terence Molefe

Supervisor: Professor Mamokgethi Setati

Learner assent form: Videotaping.

I ……. (please print your name in full) a mathematics learner at ……., am aware of all the data collection processes in the Mathematics Research Project as listed in the information sheet attached.

I fully agree to the following:

- Being videotaped during the mathematics lessons.

  Yes □ No □ (use a cross to indicate your selection)

- The possible future use of the videotext for conference purposes.

  Yes □ No □ (use a cross to indicate your selection)

Signed: …… Date: ……
Learner

Signed: …… Date: ……..
Student

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

MATHEMATICS-HOME LANGUAGE PROJECT

Researcher: Mr Terence Molefe

Supervisor: Professor Mamokgethi Setati

Learner assent form: Tape recording.

I …… (please print your name in full) a mathematics learner at …….., am aware of all the data collection processes in the Mathematics Research Project as listed in the information sheet attached.

I fully agree to the following:

- Being interviewed at some point during the study.

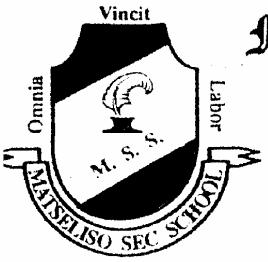
  Yes □ No □ (use a cross to indicate your selection)

- The tape recording of my interview with the researcher.

  Yes □ No □ (use a cross to indicate your selection)

Signed: …… Date: ……
Learner

Signed: …… Date: ……..
Student



Matseliso Secondary School

P.O. Box 206
Meadowlands
1852

Tel: (011) 936-3642

The University of Wits
Human Research Ethics Committee
1st Jan Smuts Avenue
Johannesburg
2000

Dear Sir/ Madam

RE: Permission to conduct research involving learners.

The above matter has reference.

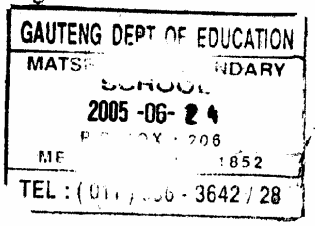
The school is aware of the study program that Mr. T. B. Molefe is persuing . To that extent, hopes to support him in ensuring that he becomes successful. From the Office of the principal, we will communicate what needs he may have in linking up with the parents and or guardians of the learners concerned.

We therefore wish to summarily give permission to Mr. Molefe to do or conduct Action Research among the learners generally and in particular the Grade 11, in pursuit of whatever aim that might serve to enrich his studies.

We hope that this note serves the aim it was meant to convey.

Sincerely
Ntsamai M. R. (principal)

Signature.



UMnyango WezeMfundo
Department of Education

Lefapha la Thuto
Departement van Onderwys

Date:	03 October 2005
Name of Researcher:	Molefe Terence
Address of Researcher:	6 Granite Street
	Reefhaven
	Roodepoort 1724
Telephone Number:	0845101078
Fax Number:	(011) 9366956
Research Topic:	Using multiple languages to support mathematical proficiency in a grade 11 multilingual classroom of second language learner: An action research
Number and type of schools:	1 Secondary School
District/s/HO	Johannesburg West

Re: Approval in Respect of Request to Conduct Research

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

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

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

Office of the Senior Manager – Strategic Policy Research & Development
Room 525, 111 Commissioner Street, Johannesburg, 2001 P.O.Box 7710, Johannesburg, 2000
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, chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.
6. Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Senior Manager (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.
7. Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year.
8. Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.
9. It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.
10. The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.
11. The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.
12. On completion of the study the researcher must supply the Senior Manager: Strategic Policy Development, Management & Research Coordination with one Hard Cover bound and one Ring bound copy of the final, approved research report. The researcher would also provide the said manager with an electronic copy of the research abstract/summary and/or annotation.
13. The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.
14. Should the researcher have been involved with research at a school and/or a district/head office level, the Senior Manager concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.

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

Kind regards

ALBERT CHANEE
ACTING DIVISIONAL MANAGER: OFSTED

The contents of this letter has been read and understood by the researcher.	
Signature of Researcher:	
Date:	04/10/2005

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Molefe

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER 50911**
PROJECT Proficiency in a	Using Multiple Languages to Support Mathematical
INVESTIGATORS	Mr TB Molefe
DEPARTMENT	School of Education/Mathematics
DATE CONSIDERED	05.09.07
DECISION OF THE COMMITTEE*	Approved unconditionally

This ethical clearance is valid for 2 years and may be renewed upon application

DATE 05.10.31 **CHAIRPERSON** .....
(Professor C Penn)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Prof M Setati
School o fEducation

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

This ethical clearance will expire on 1 February 2005

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES