OBSTACLES THAT HAMPER LEARNERS FROM SUCCESSFULLY TRANSLATING MATHEMATICAL WORD PROBLEMS INTO NUMBER SENTENCES

AMARIA REYNDERS

Thesis submitted in fulfilment of the requirements for the degree

MASTER'S IN EDUCATION

in the

SCHOOL OF MATHEMATICS, NATURAL SCIENCES, AND TECHNOLOGY EDUCATION

FACULTY OF EDUCATION

UNIVERSITY OF THE FREE STATE

BLOEMFONTEIN

FEBRUARY 2014

Promoter:

Dr K.E. Junqueira

Co-promoter:

Dr D.S. du Toit

DECLARATION

I hereby declare that the work which is submitted here is the result of my own independent investigation and that all sources I have used or quoted have been indicated and acknowledged by means of complete references. I further declare that the work was submitted for the first time at this university/faculty towards the Master's in Education degree and that it has never been submitted to any other university/faculty for the purpose of obtaining a degree.

…… ……

A. REYNDERS **DATE**

I hereby cede copyright of this product to the University of the Free State.

…… ……

A. REYNDERS **DATE**

The teacher who is indeed wise does not bid you to enter the house of his wisdom but rather leads you to the threshold of your mind.

Khalil Gibran

ACKNOWLEDGEMENTS

I wish to acknowledge the following persons who assisted me in the submission of this research project.

First, thank you to my two promoters, Dr K. Junqueira and Dr D.S. du Toit. This submission would not have been possible without you. Thank you, Dr. Junqueira, for starting me off on this road and for the value that you have added to this study. Thank you for being willing to take up the challenge and seeing me through to the end. I am most grateful for your unwavering support, commitment and patience which have been truly inspiring. Dr. Du Toit, thank you for your insights, prompt feedback, as well as positive and encouraging comments.

Thank you also to Professor Du Toit for your kindness, approachability and willingness to accommodate me in your Department. I would like to especially thank Mr E.H. Jacquire and his team from Practical Teaching at the Faculty of Education, for supporting me with the audio-recording of the data for this study. I really appreciate your patience and kindness.

My appreciation also goes to Mrs M. Murray for doing, what I consider a fine work, in proofreading this document.

Next, I wish to record my deepest appreciation to my precious family, to whom I am greatly indebted, especially my two sons Luan and Billy. Thank you all for being patient with me during the past few years and for accommodating my constant need for time to complete my (seemingly never-ending) dissertation. A special thank you also goes to my brother and sister-in-law for their support and inspiration.

Thank you to all my friends, acquaintances and others who have encouraged me to keep going. To all my colleagues at Kruitberg Primary School who constantly encouraged me, I really appreciate your moral support and prayers.

Last, but certainly not least, I wish to thank my heavenly Father. He has been my Rock and my Strength!

DECLARATION: LANGUAGE EDITING

144 Sewe Damme Retirement Village
General Beyers Street
Dan Pienaar
Bloemfontein
15 January 2013

TO WHOM IT MAY CONCERN

This is to confirm that I have edited the study by A. Reynders entitled **Obstacles hampering learners from successfully translating mathematical word problems into number sentences,** for language use and technical aspects.

Mrs Marie-Therese Murray
Cellular phone: 082 8180114

SUMMARY

Various research studies show that the language ability and Mathematics performance of primary school learners are closely related. In South Africa, as is elsewhere, the language issue at schools has always been shifted from the academic battlefield into the political battlefield. The Minister of Education has always been a politician and therefore the current curriculum in SA is politically inspired and do not always address the needs of learners, according to Sedibe (2003). Many primary school learners with an African background are taught in a second language and not in their mother tongue due to the policy of the National Education Department. It is mostly these learners who find it difficult to relate to the language of instruction and the meaning-making of that language in a Mathematical context.

The Annual National Assessment (ANA), an initiative of the National Education Department, shows that most of the primary school learners in South Africa are still not on track concerning Numeracy and Literacy skills. Language barriers for learners who are not taught in their mother tongue lead to misunderstanding regarding Mathematical word problems. The interpretation of word problems has throughout the years been a concern of Mathematics teachers, even if the learners were taught in their mother tongue.

The purpose of this study was to investigate, by means of a case study, the barriers primary school learners experience with the translation of mathematical word sums into number sentences. Qualitative research was conducted. The study was grounded in the interpretivist paradigm, hence the reasons for the learners' problems in converting word problems into number sentences and perations were investigated in real-life situations.

Data was collected through observations. Audio-visual material was used. Activities of Grade four learners, from a primary school in the Motheo teaching district of the Free State Province, was recorded audio visually, while being busy with group work. The group work was done in the form of a worksheet, which contained two word problems. The learners had to discuss the word problems in order to compile number sentences.

The learners could use any language during their discussions. A Sotho translator translated the discussions into English for analysis purposes.

The research findings support the research problem, as it was clear that although learners were presented with word problems in a language other than their mother tongue, they preferred to discuss the content of the word problems in their mother tongue.

The main recommendations emerging from this study is that teachers should become more aware of the linguistic issues in learning and teaching Mathematics and must develop tools for talking about language in ways that enable them to engage productively with learners in constructing mathematical knowledge. Teachers in culturally diverse school settings need to develop "tools" to enable learners to understand the mathematical vocabulary better via the language of instruction. The following recommendations regarding these tools can be made. Teachers who teach Mathematics in the foundation phase should compile a Mathematics dictionary as part of their literature studies. These teachers must consult language interpreters in order to find mother tongue words for words that explain mathematical concepts. These words should be repeated regularly throughout their contact time with the learners, even if it is not the Mathematics period.

The Mathematical concepts and content must be carried over to non-mother tongue learners in such a way that they can identify the context of their everyday lives in it. Only then will the learners make meaning of word problems and will they be able to compile numbers sentences from the word problem in order to carry out the correct Mathematical operations.

OPSOMMING

Verskeie navorsingstudies toon dat die taalvaardigheid en Wiskunde prestasie van primêreskoolleerders baie nou verwant is. In Suid-Afrika, soos ook in sommige ander lande, is die taalkwessie op skolevlak nie altyd akademies verwant nie, maar meestal polities geïnspireer. Die Minister van Onderwys was nog altyd 'n politikus en daarom is die huidige kurrikulum in Suid-Afrika polities gefundeerd en spreek dit nie altyd die spesifieke behoeftes van die diverse leerder gemeenskap aan nie (Sedibe 2003). Baie primêreskoolleerders met 'n Afrika-agtergrond word onderrig in 'n taal wat nie hulle moedertaal is nie. Dit is meestal hierdie leerders wat sukkel om sin te maak van die onderrigtaal, in die meeste gevalle Engels, en om betekenis daaraan te gee in 'n Wiskunde konteks.

Die "Annual National Assessment" (ANA), 'n inisiatief van die Nasionale Departement van Onderwys, toon dat die meeste primêreskoolleerders in Suid-Afrika baie swak presteer in Wiskunde. Taalvaardigheidstekorte weerhou nie-moedertaal sprekers daarvan om Wiskundige begrippe hul eie te maak, veral in die hantering van woordprobleme. Die hantering en begrip van woordprobleme was nog altyd vir Wiskunde-onderwysers 'n kwessie en nog te meer in gevalle waar leerders nie in hul moedertaal onderrig word nie.

Die doel van hierdie studie was om deur middel van 'n gevallestudie die moontlike struikelblokke te ondersoek wat primêreskoolleerders verhoed om woordprobleme om te skakel in oop getalsinne. 'n Kwalitatiewe studie is onderneem. Die studie is gegrond in die interpretivistiese paradigma waarbinne redes vir leerders se problematiek om woordprobleme om te skakel in oop getalsinne, ondersoek is.

Data is verkry deur middel van waarnemings. Audio visuele materiaal is gebruik. Graad vier-leerders van 'n plaaslike primêre skool in die Motheo-onderwysdistrik het deelgeneem aan die audio visuele opnames. Die leerders se deelname was in die vorm van groepwerk. Hulle is in twee groepe verdeel en elke groep moes 'n werksvel voltooi met twee woordprobleme daarop. Die leerders moes die probleme in groepsverband

bespreek in die taal van hulle keuse. ‘n Vertaler het die groepbesprekings vanuit Sesotho na Afrikaans vertaal vir analise doeleindes.

Die kwalitatiewe bevindings het die navorsingsprobleem versterk in die sin dat leerders wat met Wiskunde-woorprobleme omgaan in ‘n ander taal as hulle moedertaal, verkies om die inhoud van die probleme om te skakel na hul moedertaal alvorens hulle sin daarvan probeer maak.

Belangrike aanbevelings wat uit die studie voortspruit, is dat onderwysers daarvan bewus moet raak dat taalkwessies tydens die onderrig en leer van Wiskunde op so ‘n manier hanteer moet word dat leerders wat nie in hul moedertaal onderrig word nie, op so ‘n wyse ondersteun word, dat hulle Wiskundekennis sal toeneem. Die taal van onderrig moet nie leer belemmer nie. Onderwysers in ‘n diverse skool opset moet vaardighede ontwikkel wat leerders in staat sal stel om die Wiskunde terme te verstaan en te begryp, ongeag die taal van onderrig. Onderwysers in die Grondslagfase moet ‘n twee- of meertalige Wiskundewoordeboek saamstel met nodige en relevante terme. Die onderwysers sal met moedertaal konsultante moet beraadslag ten einde die korrekte moedertaalwoorde te kry wat die terme in die taal van onderrig beskryf. Die spesifieke vakterme moet gereeld herhaal word gedurende Wiskundelesse.

Die Wiskundekonsepte en –inhoud moet op so ‘n manier aan die nie-moedertaal-leerders oorgedra word dat hulle dit in alledaagse konteks kan sien en verstaan. Dit is slegs dan dat leerders betekenis kan gee aan woorprobleme, oop getalsinne kan neerskryf en die korrekte bewerkings kan uitvoer.

TABLE OF CONTENTS

CHAPTER 1

ORIENTATION

CHAPTER 2

LITERATURE REVIEW

CHAPTER 3

RESEARCH METHODOLOGY

CHAPTER 4

DATA ANALYSIS AND DISCUSSION

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

APPENDICES

TABLES

FIGURES

ACRONYMS

OBE	Outcomes-based Education
NCS	National Curriculum Statement
RNCS	Revised National Curriculum Statement
ANA	Annual National Assessment

CHAPTER 1
ORIENTATION

1.1 INTRODUCTION

In the context of lifelong learning, the process of teaching and learning Mathematics is an indispensable life skill (Maree, 2005:80). Currently, learners are constantly exposed to mathematical thought processes and mathematical language. As far as learners' mathematical achievement, in particular, is concerned, researchers question the current curriculum, of which Outcomes-based Education (OBE) forms an integral part.

Yeld (quoted in Crafford & Maree, 2005) believes that South African learners are becoming increasingly 'dumb' and that both learners and teachers are experiencing an intellectual decline as the cognitive challenges they face are gradually decreasing in difficulty. Maree (2005:84) declares that, in 2001, the National Department of Education's systemic evaluation on Grades 3 and 6 levels indicated that Grade 3 learners performed badly, especially in numeracy skills, with the average mark of the tests throughout the country being at 30%.

This research focuses on the significance of language in a diverse primary school Mathematics classroom. Due to the cultural diversity of the learners, there is a vast deficit in correlating the language of instruction with the mathematical language ability of the individuals.

"When children are performing mathematics for example calculating, solving, constructing, they are required to read mathematics" (Adams, 2007:117). The degree to which learners can master mathematical language, as a result of their mastery of the grammatical language of teaching, will determine their success at interpreting and solving word problems. Light and DeFries (quoted in Vilenius-Tuohimaa, Aunola & Nurmi, 2008) point out that Mathematics performance and

reading skills are closely related and that difficulties in arithmetic are associated with the development of reading ability. In the same article, Velenius-Tuohimaa *et al*. (2008:409) note that Jordan *et al*. (2002), in a two-year longitudinal study, found that reading disabilities predict children's progress in Mathematics, but that Mathematics disabilities do not affect children's progress in reading. Pape (2004:188) states that the semantic content of seemingly identical items often differs significantly in different languages, and that identical meanings in different languages are expressed in different ways. Therefore, this study endeavours to investigate those obstacles that prevent primary school learners from translating word problems into number sentences.

1.2 PROBLEM STATEMENT AND RESEARCH FOCUS

The validity of mathematical language lies in its structure and use in Mathematics (Adams, 2007:117). Mathematics involves the written expression of symbols such as numbers and signs that convey meaning. The symbols can be manipulated to have different meanings in different contexts. Mathematics contains a specialised vocabulary that can convey definite ideas in written or spoken form. The identified problem is that learners are not sufficiently equipped to convert language expressed in English into mathematical language (Orton, 1996:120). This observation gave rise to the following research questions.

1.2.1 Main research question

What obstacles prevent learners from successfully translating mathematical word problems into number sentences?

1.2.2 Sub-research questions

The following sub-questions attempt to answer the main research question.

What problems do learners experience with developing mathematical understanding from the language of instruction?

How do learners assign meaning to the various parts of a word problem?

1.3 RATIONALE OF THE STUDY

Mathematical processes involve calculations, problem-solving and construction. In order to execute these processes, learners are expected to be able to read Mathematics. The reading of Mathematics involves the primary goal of building and mastering skills. Adams (2007:118) emphasises the definite correlation between Mathematics and reading. Teachers in a diverse classroom experience the daily challenge of finding a way to improve language skills which, in turn, can lead to improved mathematical language ability.

The Revised National Curriculum Statement (RNCS) for Grades R to 9 (Schools) for the Mathematics learning area emphasises the importance of problem-solving. Problem-solving is, among others, a way of thinking and analysing situations. Problem-solving focuses on using skills to deduce that which cannot be learned by memorising facts (Ellis, Maree & Van der Walt, 2006:178). The language skills of the learners are, therefore, crucial in dealing with the problem-solving processes.

This study investigates the influence of the language medium of instruction on the understanding of mathematical language, by focusing on the use of language to interpret word problems and to translate these into number sentences in the intermediate phase. Identification of barriers to this process could lead to ways of addressing these issues.

1.4 RESEARCH DESIGN AND DATA-COLLECTION METHODS

The planned qualitative research addresses the phenomenon as encountered in its natural state (Leedy & Ormrod, 2005:133). In an attempt to answer the research

questions, a case study was planned, including an in-depth data-collection process. The study was grounded in an interpretivist paradigm, where learners were observed in their natural surroundings, in order to seek reasons as to why they experience problems in converting word problems into number sentences. An inductive approach was taken by implementing a case study. The participants consisted of 12 learners from a Grade 4 Mathematics class at a primary school in the Free State Motheo teaching district.

Data was collected by means of observations and audiovisual instruments. The observation took place during a Mathematics class of the Grade 4 learners. The video recording was done in one of the experimental classrooms at the Education Faculty of the University of the Free State. A worksheet with two different word problems, on the mathematical level expected from Grade 4 learners, was handed out to the participants. I made use of an observation sheet to observe the learners while they were working in groups. The observation sheet included the following aspects: the reading ability of the learners; the language they use during the group work; the choice of mathematical methods; the use of known mathematical methods, and how they compiled the number sentence. The learners were divided into two groups of six learners each; the groups were video-recorded during their group work. They were encouraged to talk in their mother tongue in order to try to make meaning of the word problems given to them. I made use of an interpreter and a translator to recall the learners' exact words and their meaning.

Once the data was collected, I analysed and organised them logically by coding and setting research themes, as stipulated by the qualitative research approach applicable for a case study. During the analysis of the data, the facts pertaining to the study were organised logically. The data was categorised to give meaning to the content of the observations. Patterns appearing during the observations were identified.

1.5 LIMITATIONS OF THE STUDY AND ETHICS

Researchers such as Durkin and Shire (1991) have already proven that the process of solving word problems in Mathematics is related to the language of instruction (O'Donoghue, 2008:48). The intended study might have some limitations, due to the fact that it is a case study. Problems that might be encountered during this study may differ from those encountered in a subsequent study, because the composition of the Grade 4 Mathematics class, whose learners were used as participants, will differ between the various year groups. Data was obtained from observations by means of video recording the participants and from the worksheets done by them. Every piece of information must contribute to the same conclusion (Leedy & Ormrod, 2005:136). As an observer, I played an active role in the observation process. The learners received detailed explanations regarding their contributions and their roles as sources of data.

The medium of instruction at the school in question is English, but the home language of the learners varies between Sesotho, isiXhosa and Setswana. The learners' language diversity may have added another limitation to the study. Since the home language of the learners differs from the language of instruction, this may have influenced the learners' ability to convert English into mathematical language. No distinction was made between learners in the same class with regard to intellectual capabilities. The fact that I cannot speak any indigenous language can also contribute to the limitations of the study, because I cannot code-switch while observing the participants. The study has limited value with regard to making generalisations based on the findings, since it involves only learners from one Grade at one school. Standardised measuring instruments such as the Department of Education's recently formulated Annual National Assessment (ANA) were not used, as the learners are not familiar with the measuring instruments used in the ANA. Only measuring methods and instruments familiar to the learners at the school in question were used. Due to the language diversity, the word sums given to the learners contained grammatical language which they were used to and mathematical language which they already knew.

The school's principal and the parents of the learners involved were asked to grant written permission for the learners' participation. The school's learning area facilitators for Mathematics as well as all stakeholders at the teaching district office were also informed of the study.

Further ethical questions that were addressed include the protection of the learners' privacy and the protection of learners from any emotional and physical harm. Prejudice and generalisations were guarded against.

1.6 CREDIBILITY AND TRUSTWORTHINESS

According to Silverman (2011:366), credibility in qualitative research concerns the truthfulness of the inquiry's findings. The credibility of the study is supported by the choice of participants. They are Grade 4 Mathematics learners from a culturally diverse class where the language of instruction is English and not their mother tongue. The case study methodology further contributes to the credibility, as it represents the reality of the participants and ensures that the obligations or the research questions are met.

Trustworthiness in qualitative research views consistency as the extent to which variation can be tracked or explained (Silverman, 2011:366). The trustworthiness lies in the logic and stepwise replication as well as the setting of themes from the data. I assume that, if the same research methods are used for a culturally diverse class at the school where the study is to take place, the outcomes will be approximately similar. The language of instruction is English and it is not the mother tongue of the learners. The methods used to carry out the case study are appropriate for other Mathematics classes at the same school, as the learning environment is similar. The findings are documented in such a way that they are applicable to other Mathematics classes at the same school.

1.7 FRAMEWORK OF THE THESIS

Chapter 1: General orientation to the study: the research questions are formulated and a qualitative case study, in which data are collected by means of an observation, is planned.

Chapter 2: Overview of the literature: the literature concerning language problems experienced by learners when the language of instruction is not the same as their mother tongue is discussed.

Chapter 3: Methodology: the research design, the data-collection methods as well as the selection of the participants are discussed.

Chapter 4: Results: the findings of the data collected as well as their influence on answering the research questions are recorded.

Chapter 5: Conclusion and recommendations: the main research findings are highlighted and recommendations for further studies made.

1.8 CONCEPTS AND EXPLANATIONS

OBE	Outcomes-based Education
NCS	National Curriculum Statement
RNCS	Revised National Curriculum Statement
ANA	Annual National Assessment

Word Problem

It refers to any mathematical exercise where a narrative of some sort is involved and the problem is presented as text rather than in mathematical notion.

Mathematics Register

Include words from ordinary English with specialised mathematical meaning for example "similar", "difference".

Mother Tongue

The language which a person has grown up speaking from early childhood.

Multilingualism

It is the act of using multiple languages either by an individual speaker or by a community of speakers.

Reading Comprehension

It is an intentional, active, interactive, process that occurs before, during and after a person reads a particular piece of writing.

Language of Instruction

The specific language used during the teaching and learning process at a certain time as implemented by the educational institute.

1.9 SUMMARY

The aim of this chapter was to briefly inform the reader as to what to expect from this study. The outline of the study and a short description of each chapter were given.

Chapter 2 focuses on the literature concerning the research topic as well as the literature involved in attempting to answer the research questions.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

Language is an essential element of learning, thinking, understanding and communicating, and it is crucial for Mathematics learning. The content of Mathematics is not taught without language and there is a complex relationship between language and the teaching of Mathematics in multilingual settings (O'Donoghue, 2008:43).

Vygotsky (quoted in Mercer & Sams, 2006:508) argues for the importance of language as both a psychological and a cultural tool. He also claims that social involvement in problem-solving activities is a crucial factor for individual development. O'Donoghue (2008:44) further indicates that the language, which learners initially use to learn Mathematics, will provide the foundations to be built upon and developed within that language.

Setati (2005:448) realises that South Africa's language-in-education policy, which recognises 11 official languages, is intended to address the overvaluing of English and the undervaluing of African languages. However, in practice, English still dominates. Although English is the home language of a minority, it is a dominant symbolic resource in the linguistic market in South Africa (Setati, 2005:448).

Contextualised problems, also called word problems or story problems, play a vital role in the development of mathematical thinking in learners of all ages (Murray, 2003:39). Language relates to problems such as poor reading and comprehension skills. Understanding grammatical constructs, which learners have and use in word problems, can reveal other factors that can contribute to poor problem-solving when dealing with word problems (Murray, 2003:39). This study attempts to identify

factors that could influence learners' abilities to construct number sentences from word problems.

2.2 LITERACY LEARNING FOR MATHEMATICS

In an article on adapting a model for literacy learning to the learning of Mathematics, Hopkins (2007:123) refers to a set of conditions learners experience through teaching and learning processes. The latter confirm that, when children learn to talk, the following conditions are always present: immersion, demonstration, engagement, expectations, responsibility, approximations, and use. Hopkins (2007:123-136) highlights how these conditions might be applied to the teaching of Mathematics.

Immersion is a critical component of Mathematics learning in both aural and visual forms (Hopkins, 2007:123). Immersion is the interaction of a variety of visual and aural content. Hopkins (2007:124) is of the opinion that, in order to broaden mathematical vocabulary, teachers must use daily classroom activities such as telling time, taking attendance, interpreting the calendar, reading a thermometer, organising and sequencing daily routines, sorting materials as they put them away, and describing patterns they see in songs, shapes and words.

Hopkins (2007:124) adds that we tend to learn best when a concept is demonstrated by someone we trust. Demonstrations can either take the form of actions, looking and listening to someone talking, or be artefacts such as noting the symbolic form of the word. Demonstration in the Mathematics class takes place when the teacher and students talk out loud. The learners will become meaningfully engaged with a task when they can apply demonstrations and begin to perceive patterns and structures in the language and meaning of Mathematics. In early Mathematics, learners must be engaged in actions to describe numbers and they must be able to ask questions about a number such as, for example: Is ten bigger than nine?, or between which two numbers does ten lie? Demonstration leads to critical thinking.

Learning does not take place without engagement (Hopkins, 2007:126). Engagement requires that the learners feel capable of learning what is presented to them, that the material presented will affect their future life in some meaningful manner, and that the benefits of learning the concept will outweigh the risk of trying to learn it. According to Manouchehri (quoted in Hopkins, 2007:127), "shared problem-posing" is an excellent way to involve learners through engagement. The teacher and the learners interact to pose and subsequently solve problems. For example, the teacher could ask the learners to identify some questions people might ask about their class. Children will typically begin by asking simple 'how many' questions such as, for instance: How many girls are there? How many boys are there? How many girls have long hair? Ultimately, more complex questions emerge such as, for instance: How many more boys than girls are there? How many learners are there altogether in the class?

Children can be encouraged to solve each problem by describing how they found the solution and why they chose to do it that way. Shared problem-posing can become more interesting if the teacher provides a numerical answer and the learners try to determine what question could have generated that answer. For instance, if there are 13 boys and 15 girls in the class, an answer might be 2. As the learners generate a list of possible questions such as, for instance: How many more girls are there than boys?, learners will not only develop an understanding of the comparison meaning of subtraction, but also begin to note how questions and answers are related. If we create boy-girl pairs, how many children would be left without partners? In my opinion, engagement is one of the best ways to demonstrate the importance of incorporating literacy language into mathematical language.

Teachers and parents expect children to learn to talk and, ultimately, to read. An environment that displays confidence in the learner demonstrates that teachers and parents value the learners and celebrate all their attempts to talk. Talking when presented with a learning opportunity is also highly valued. Hopkins (2007:129) affirms that the learners turn to the people they trust most for guidance in deciding

whether they want to invest the time, energy and risk necessary to learn a new concept.

I agree with Hopkins (2007:129) that, if a learner is valued according to his/her own ability, the teacher's expectations of what the learner can master will comply with the learner's expectations of him-/herself to master a problem. The teacher must show appreciation for the learners' attempts to reach an answer, by gently leading them towards the correct possibility.

In growing up and simply living, a child is constantly exposed to language. Without realising it, the small child chooses what language to heed and what parts to ignore. This is a process of taking responsibility for learning.

Grant (1978:59) expands on the notion that we understand each other through words. However, when a child uses a word, s/he does not always show that s/he understands what it means. By practising the use of the word, in concrete situations, with the help and correction from the teacher, the child gradually realises and knows the true meaning of the word. Grant also mentions that many mathematical words are used in other lessons and beyond the school. These should be introduced and used at suitable times.

It is important that each learner in the Mathematics class be engaged in learning on his/her own level. Using appropriate language, the teacher must provide content, which the learners can understand, and work out different strategies to involve learners in finding solutions to problems. Learners will be urged to take responsibility for their learning process, if they can master content (Hopkins, 2007:132).

Charles (2005:137) gives the following example. A Mathematics lesson for Grade 2 learners guides them through the process of adding multiples of ten to two-digit numbers using mental Mathematics and/or cubes. The first page of the lesson provides an example, complete with a written thinking strategy for solving the problem, followed by two more examples that are to be discussed or completed as a

class exercise. At the bottom of the page is a rather powerful question – What number plus forty equals eighty three? – that leads learners to consider what they are doing, and the remainder of the lesson consists of 10 practice problems, followed by a single word problem. According to Charles (2005), there is no doubt that the Mathematics in this lesson is important. However, is the lesson likely to be engaging to a wide variety of learners? Based on this example, one could ask whether one word problem is adequate. How can learners, whose mother tongue is not the same as the language of instruction, take responsibility for learning, if they are not sufficiently exposed to word problems?

As far as word problems are concerned, approximation is a vital skill to gain. Hopkins (2007:132) mentions that a child's first attempt at using language is merely an approximation of the word(s) s/he is trying to say. When a child utters anything remotely similar to a word we know, we typically celebrate enthusiastically. As we celebrate, we usually also include the correct word, thus helping the child feel confident that his/her attempt was worth the risk and gently providing him/her with the correct word. For example, when a child says "Da da" while looking at his/her father, a common response is: "Yes, I'm Daddy". Without both the confirmation and the celebration, the child will likely think twice before trying to talk again.

Learners do not always get positive responses to approximation at school. The issue of approximation is a delicate one in Mathematics instruction in which there are definite right and wrong answers. Learners expect teachers to respect and celebrate their approximation.

Learning to talk requires a great deal of repetition. Games, songs and read-aloud contain repetitive phrases and rhymes. The child repeats sounds that are interesting to him/her and those that produce the responses s/he seeks. The child begins to talk when s/he sees a purpose for it. Transferring the user principal to the Mathematics classroom, learners must feel an urgent need to do Mathematics for purposes other than to learn Mathematics (Hopkins, 2007:133). With respect to usage, I believe that word problems and compiling number sentences clearly demonstrate the use of

Mathematics in daily life situations. Teachers must realise the importance of blending literacy with Mathematics instruction.

2.3 THE RELATIONSHIP BETWEEN MATHEMATICAL WORD PROBLEMS AND READING COMPREHENSION

Research has shown that Mathematics performance and reading skills are closely related. In a two-year longitudinal study, Vilenius-Tuohimaa *et al*. (2008:409-410) found that reading disabilities predict children's progress in Mathematics, but that Mathematics disabilities do not affect children's progress in reading. They also found that, when demographic factors are held constant, the group with only Mathematics difficulties progresses at a faster rate in Mathematics than the group with reading difficulties. The groups progress at the same rate in reading.

2.3.1 The association between mathematical word problems and reading comprehension

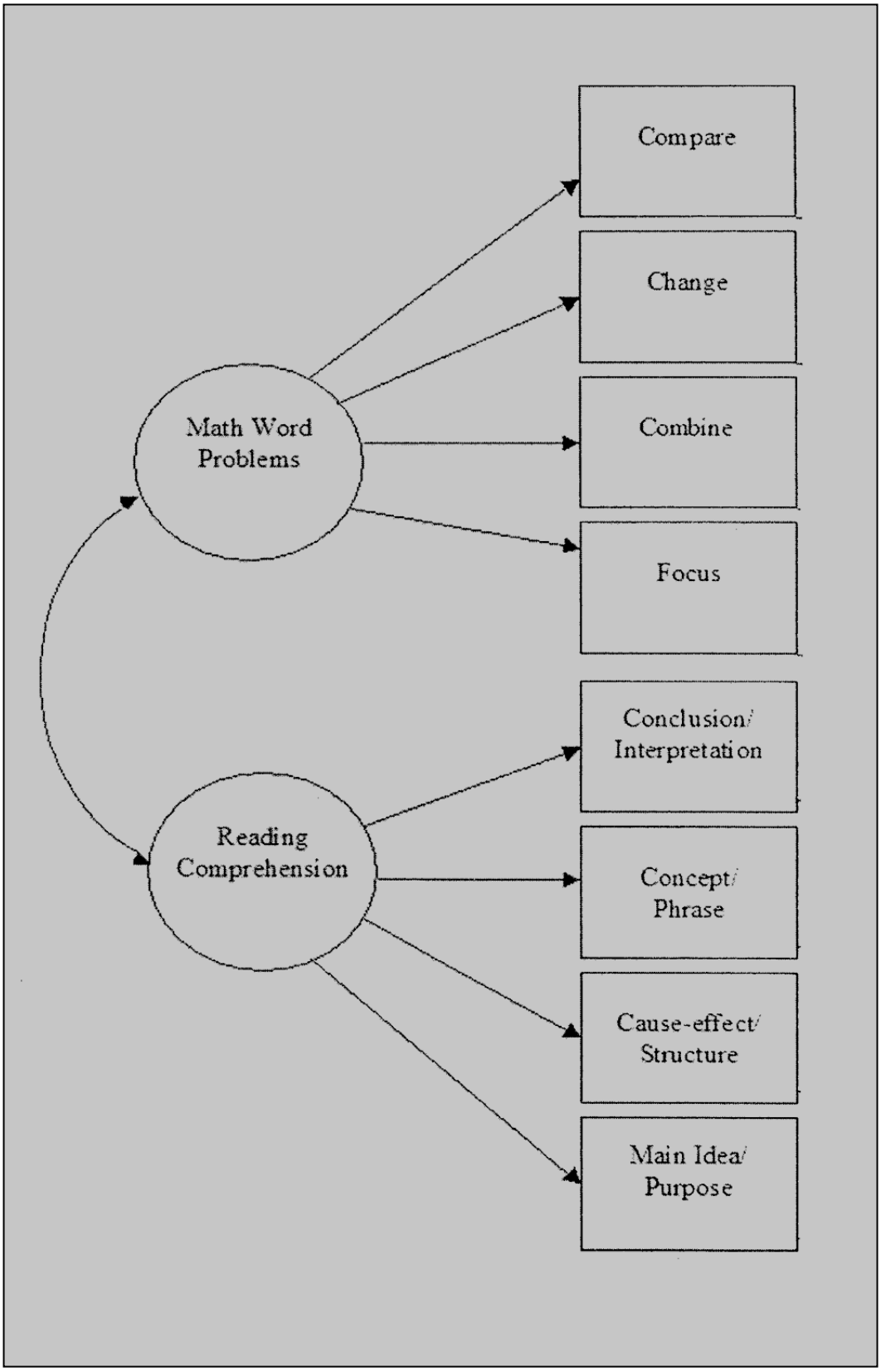
Vilenius-Tuohimaa *et al.* (2008:410) indicate that mathematical word problem-solving performance and reading comprehension skills are both related to overall reasoning skills. They found that the reasoning strategies behind these skills must be discussed in the light of methods used for classifying mathematical word problem structures and reading comprehension question types. Children are usually asked to read, or listen to the mathematical story or the problem presented, write down the mathematical operations necessary for completing the task, solve the problem and reach an answer.

Jordan, Kaplan and Hanrich (2002:588) categorise mathematical word problems into four item types, each defined by the problem-solving strategy required: compare, change, combine and equalise. Vilenius-Tuohimaa *et al*. (2008:410) consider a combination of these strategies with some adjustments. They state that, in general, reading aims at understanding and operates on two main levels. First, the reader extracts the meaning of the sentence and, secondly, the reader applies prior general

and specific knowledge to the material at hand. In an extensive quantitative study, Vilenius-Tuchimaa *et al*. (2008:416) categorise four question types for reading comprehension, namely conclusion/interpretation, concept/phrase, cause-effect/structure, and main idea/purpose.

They also set up a schematic model for mathematical word problem items such as compare, change, combine and focus, in an attempt to answer one of their research questions, namely whether text comprehension skills and performance on mathematical word problems are interrelated. Pearson correlations were calculated between reading comprehension variables and Mathematics word problem variables. Figure 1 presents a schematic model for Mathematics word problems and reading comprehension.

Figure 1: A schematic model for Mathematics word problems and reading (Vilenius-Tuohimaa *et al*, 2008:417)



The results of the Vilenius-Tuohimaa study show that the structure of mathematical word problems was not as clear as the structure of the reading comprehension factor proved to be. Their study provides evidence that some Mathematics word problem types have more components of reading comprehension than of Mathematics. For example, the items in the focus category contain multi-step directions of a linguistic nature, but they do not require complex mathematical skills. In other words, mathematical word problems that require multi-step calculations are more relevant to mathematical word problem-solving factors than those items that require detailed linguistic information processing, such as focus. The results of the Vilenius-Tuohimaa study also showed that both the compare and the combine item types proved to be more mathematical in nature, although items in the combine category may well be contrasted with reading comprehension question types such as cause-effect/structure, conclusion/interpretation, and main idea/purpose, in terms of required reasoning strategies. The items included in the cause-effect/structure question type measure the extent to which the readers understand connections between items and how they arrange the information obtained from the text. The ability to combine prior and current text-based information is crucial in the conclusion/interpretation question type. By contrast, the main idea/purpose question type involves extracting the key ideas of the text.

Vygotsky (quoted in Sedibe, 2003:4) mentions that it may be appropriate to view word meaning not only as a unity of thinking and speech, but also as a unity of generalisation and social interaction, a unity of thinking and communication. This point of view is extremely significant for all issues related to the genesis of thinking and speech, and reveals the true potential for a causal generic analysis of thinking and speech. Only when we learn to perceive the unity of generalisation and social interaction, do we begin to understand the actual connection that exists between the child's cognitive and social development. Vygotsky refers to the link between language and thought in pre-school children.

Sedibe (2005:5) refers to the above quote by Vygotsky, in order to emphasise the interrelationship between language, on the one hand, and learner mental output, on

the other. He testifies that the Third International Mathematics and Science survey (TIMMS) commissioned an analyses that revealed that the South African group fared poorly in the test compared to learners from other countries. One possible explanation for the poor performance of the South African learners in the TIMMS survey is poor literacy in the language in which the test instruments were administered, namely English. Seventy-two per cent of the South African group that participated in the TIMMS survey were not native speakers of English.

Vilenius-Tuohimaa *et al.*'s (2008) as well as Sedibe's (2003:4) research give further insight in order to address my sub-questions, namely: What problems do learners experience with developing mathematical understanding from the language of instruction? and How do learners assign meaning to the various parts of a mathematical word problem?

2.3.2 Mathematical word problems and story grammar

Xin, Wiles and Lin (2008:163) explain that, in the early 1900s, anthropologists found that people follow a pattern when retelling stories they have read or heard, regardless of age or culture. They define the word 'grammar' in story grammar as "elements". Therefore, story grammar addresses the elements of a story. The internal structure of a story involves a set of expectations or knowledge about the story, in order to make comprehension and recall of the story more efficient.

Story grammar is a text structure common to a set of narrative stories (Gardill & Jitendra, 1999:2). Similarly, a word problem story structure that is common across a set of word problem situations can be defined as word problem story grammar for a particular type of problem (Xin, Wiles & Lin, 2008:164). Story grammar aims to improve students' reading comprehension by giving them a framework they can use when reading stories, for example by asking a series of story grammar questions such as who, what, where, when and why. Consistent use of the same questions about stories equips students with a framework they can apply on their own.

Xin *et al*. (2008:165) designed a framework through a set of word problem story grammar self-questioning prompts that emphasise the algebraic expression of mathematical relations in word problem conceptual models to assist meaningful representation and problem-solving. Generally speaking, part-plus-part-equals-whole is a generalisable conceptual model in addition and subtraction word problems in which 'part', 'part' and 'whole' are the three basic elements. By contrast, factor-multiply-by-factor-equals-product is a generalisable conceptual model in multiplication and division arithmetic word problems in which 'factor', 'factor' and 'product' are the three basic elements.

In the part-plus-part-equals-whole problem types, typical basic word problem story grammar questions are: "Which sentence tells us about the whole?" or "combined quantity?" and "Which sentence tells us about one of the small parts that makes up the whole?". The following example illustrates this concept. Emily has 4 pencils and Pat has 8 pencils. How many do they have all together? The number of pencils Emily has and the number of pencils Pat has are the two parts. These two parts make up the combined amount or the whole. By contrast, a change problem type is, for example, the following: Susan had 12 candies, she gave 4 to Tom. How many candies does Susan have now? The number of candies Susan had in the beginning is the whole amount, whereas the number of candies Susan gave away and the number of candies she has now, are the two parts that make up the whole or the initial amount.

Word problems of a specific problem type, for example the part-plus-part equals the whole concept, share a common underlying structure involving the same key elements such as 'part', 'part' and 'whole'. A set of word problem story grammar questions can be generated to serve as prompts in guiding students when they organise information and express mathematical relations in word problem conceptual models. For instance, in the part-part-whole problem types, basic word problem story grammar questions can assist in the comprehension and representation of the underlying structure of a word problem, in order to facilitate solution planning. For example: "Which sentence tells about the whole" or "combined quantity?" and

"Which sentence tells about one of the small parts that makes up the whole?" (Xin *et al.*, 2008:165).

Emphasis on the meaningful representation of mathematical relations in problem-solving is consistent with contemporary approaches to story problem-solving that emphasise conceptual understanding of the story problems before deciding on the choice of operation (Xin *et al.*, 2008:165). They also add that an emphasis on representing mathematical relations in conceptual models facilitates algebraic reasoning and thinking that involves symbolic expressions of mathematical relations in equations.

Xin *et al.*'s (2008) theoretical framework will serve as model for my research. I will investigate the part that language plays in identifying a mathematical equation or the ability to construct an open number sentence from the word problem.

Setati (2005:448) mentions that part of learning Mathematics is acquiring fluency in the language of Mathematics; this includes words, phrases, symbols, abbreviations and ways of speaking, writing and arguing that are specific to Mathematics. In multilingual classrooms, Mathematics teachers must find a balance between making language choices by way of both instruction and written work to suit their learners' needs.

In her article "Teaching Mathematics in a primary multilingual classroom", Setati (2005:447-466) focuses on language as an educational tool in the Southern African education set-up. She attempts to find answers to the following questions: What language practice do teachers in multilingual primary Mathematics classrooms use? Which language do teachers use for what purpose? These observations were made in a Grade 4 Mathematics class in a township north of Johannesburg. Her article links with my study in the sense that I also investigate learners from a diverse language background who are educated in a language that is not their mother tongue. It also links with the mathematical aspects, whereas language proficiency affects the learners' ability to deal with word problems.

My research focuses more on what obstacles prevent learners from translating Mathematics word sums into number sentences. The research is carried out in a multilingual Grade 4 Mathematics class in a primary school in a northern suburb of Bloemfontein. The language of instruction in this particular school is English, but the mother tongue of 80% of the learners is Sesotho. This kind of research has not yet been done in Bloemfontein. I also determine the reasons as to why Grade 4 learners with the described background find it difficult to compile number sentences from mathematical word sums. The findings of the research will be published, in order to contribute to the understanding of problems learners may experience when being taught Mathematics in a language other than their mother tongue, especially when they have to deal with word problems.

2.4 TRANSLATION AND UNDERSTANDING OF WORD PROBLEMS: GENERAL ISSUES

Word problems form an integral part of the Mathematics curricula. However, learners find it difficult to solve mathematical word problems as, most of the time, they do not comprehend the wording of the problem.

2.4.1 Word problems in English-language learning contexts

According to Bernardo (2002:283), learners are often overwhelmed by word problems not because they cannot solve these, but because they do not comprehend the problem statement due to a language barrier. Consequently, they often wait for the teacher to solve the question in numerical form; otherwise, learners tend to rely on key words or misinterpret the problem statement and reach the wrong answer themselves. Many studies (among others, Abedi & Lord, 2001; Bernardo, 2002; Cuevas, 1983) have shown that learners' failure on word problems is due to a lack of linguistic knowledge. This situation becomes even more problematic when the word problem is expressed in the learners' second or third language. Vilenius-Tuohimaa, Aunola and Numri (2007:409) indicate that research carried out in New Zealand (Bartin, Chan, King, Neville-Barton & Sneddon, 2005) with students for whom English was a second language concluded that learners

experience a disadvantage of between 10% and 15% in Mathematics due to language issues.

The role of language comprehension is essential in the teaching and learning of Mathematics, because understanding mathematical concepts and solving problems primarily depend on the language used in the process of teaching and learning (Salma & Rodrigues, 2012:06). Salma and Rodrigues also argue that performance on mathematical word problems is related to language proficiency. It has been generally observed that learners spend a considerable amount of time trying to understand the problem, because they find it difficult to make sense of the language problem. Pape (2004:187) notes that word problems in Mathematics often pose a challenge, because they require that learners read and comprehend the text of the problem, identify the question that needs to be answered, and finally create and solve a numerical equation.

Hence, it is challenging to construct meaning by reading a problem statement superficially. According to Orton and Frobischer (1996:133), it is possible to read a story or novel in English fairly superficially, yet still derive meaning, message and morale. It is also even possible to use rapid reading techniques, perhaps skipping sentences or descriptive paragraphs which are clearly not crucial. Non-fiction cannot generally be read in a superficial manner without losing details that might be essential; mathematical text resorts under this category.

Consequently, the role of comprehending the text of the word problem is crucial, because it is not only a means of conveying information, but it is also used to interpret the events and phenomena in a way that provokes learners' thinking (MacGregor, 1990:101). In addition, the role of word problems in the teaching and learning of Mathematics is interesting, because word problems require the integration of several competencies, language understanding being one of them. Therefore, without understanding the language of the word problem, it is difficult to initiate the process of solving it. Cuevas (1983:148) endorses this notion and mentions that solving mathematical word problems is often hampered by the

learners' failure to comprehend the problem. In addition, comprehension becomes even more problematic for English second language learners due to a lack of proficiency in the English language. MacGregor (1990:104) as well as Salma and Rodrigues (2012:12) assert that learning Mathematics, in general, and solving word problems, in particular, pose difficulties, given that large-scale assessments show that many students are not proficient in the language. Likewise, research (for example, Bernardo, 2002:284) has shown similar findings in that students' difficulties in comprehending word problems are due to a lack of understanding the language of the problem. Students tend to solve problems easily if presented with a numerical version rather than with words; however, they may fail to solve word problems, although they can solve corresponding problems given in purely numerical format. Similarly, Cuevas (1983:152) argues that a major source of difficulty experienced by learners in the problem-solving process is to transform the written word into mathematical operations and symbols. Therefore, he argues that understanding what is to be solved requires understanding the problem statement given in an oral or written form. Word problems are mathematical problems with words. However, for a student who is learning a second (or third) language, words in that new language can create a barrier to understanding (MacGregor, 1990:104).

Some researchers have proposed that a major component of problem-solving is the acquisition of information concerning the interpretation and use of language in word problems. Moreover, interpretations occur at two levels in understanding the problem statement. First, making sense of the language, grammar and usage of words, in which the Mathematics problem is coded and, secondly, making sense of the Mathematics involved (Cuevas, 1983:150). Personal experience indicates that, while working on a word problem, learners mainly engage in calculations, regardless of understanding the problem statement. Likewise, Vilenius-Tuohimaa *et al*. (2008:410) state that children are usually asked to read or listen to the mathematic story or the problem presented, write down the mathematical operation necessary for completing the task, solve the problem and then arrive at an answer.

One of the data-collection methods of my study requested the participants to complete a worksheet: they had to read the word problem at hand and then rewrite the "story" of the word problem in their own words. After completing this task, the learners had to compile a number sentence for the word problem, in order to carry out the necessary mathematical operation to be able to arrive at an answer.

2.4.2 Comprehension of mathematical text

It appears that language proficiency and Mathematics performance are linked, such that lower language proficiency tends to translate into poorer Mathematics performance (MacGregor, 1990:106).

Readability includes all factors related to reading and comprehending written text. As Adams (2007:119) points out, it is unlikely that standard readability formulas will ever be able to offer real help in understanding what it is about Mathematics embedded in text that makes it difficult to read. A far more important task is identifying areas of difficulty. One is context and the other is linguistic difficulty. One result of being schooled in word problems may be to pay only superficial attention to verbal text. Students may call upon learned strategies deemed to be appropriate to Mathematics, such as finding key words, "in all" or "how much more", for example, to signal which operation to apply to the numbers in a problem (Davis-Dorsy, Ross & Morrison, 1991:61). According to De Corte, Verschaffel and De Win (1985), experienced problem-solvers can fill in gaps and comprehend ambiguities that less experienced problem-solvers have not yet learned to do. They accept certain "between-the-lines" information as "given" in school-form word problems. De Corte *et al.* (1985) mention that competent problem-solvers have well-developed semantic schemata for these types of problems, and solve them conceptually ("top down"). Less able problem-solvers depend more on the text, or a "bottom-up" approach. This may be the reason why, in Silver and Marshall's (1990:265) research, younger students were more concerned about mathematical formalism, such as the form of their answers, in solving and answering word problems than were older students, who paid more attention to interpreting their answers.

Word problems are laced with language that differs from everyday usage; this is potentially difficult for problem-solvers (Pimm, 1987:83). Mathematics-specific language, such as numerator, table, product, rational and odd, must be acquired. Of course, symbolic language is another area of comprehension to master in Mathematics. Students must learn symbols for the operations, relational symbols, for example, > and <, the meaning of parentheses and brackets, and so forth. Prepositions typically are conceptually challenging and carry important and often confusing functions in Mathematics. Cuevas (1983:151) notes that, in general, prepositions and the relationships they indicate are critical lexical items in the Mathematics register that can cause a great deal of confusion. Word order, such as subtract x from y, and different ways of saying the same expression, such as 24 divided by 8 and 8 divided into 24, can also be perplexing. Logical reasoning carries its own Mathematics language, for example, therefore, if, then, to which learners must become accustomed.

Given these Mathematics-related language challenges for the mother-tongue speaker of English, one can only imagine what this means for English-as-a-second-language learner. Norton (1991:67) indicates other personal factors that impact on learners' school Mathematics experiences; cultural background, for example, determines a person's mental structures and frames the way s/he views the world, including the discipline of Mathematics. This can affect the way in which individuals group and categorise things, their manner of logical thinking and their meaning-making of the language in a mathematical word problem.

Evaluation of word-problem readability should include multiple factors such as vocabulary, wording, and story concepts presented, as suggested by Mestre (1988:215); language proficiency mediates cognitive functioning. Mestre categorises the types of language proficiencies that can influence problem-solving as follows: proficiency with language in general, in the technical language of the domain, with the syntax and usage of language in the domain, and with the symbolic language of the domain.

The inability of some learners to translate and understand word problems is driven by problems with language. These learners may also experience difficulty with reading, writing, and speaking. In Mathematics, however, their language problem is confounded by the inherently difficult terminology, some of which they only hear in the Mathematics classroom. These learners find it difficult to understand written or verbal directions or explanations, and to translate word problems.

2.5 LANGUAGE ABILITIES OF GRADE 4 SECOND-LANGUAGE SPEAKERS

Many children who are second-language speakers are placed into English-speaking classrooms where they understand nothing of what they are hearing. Many flounder in this "sink or swim" situation. According to Thomas and Collier (1998:23), this notion of "the more English, the better" is fallacious and can, in fact, considerably slow down children's learning. They also mention that children may manifest a common second-language acquisition phenomenon called the *silent period*. When children are initially exposed to a second language, they focus frequently on listening and comprehension. These children are often very quiet and hardly speak as they focus on understanding the new language. The younger the child, the longer the silent period tends to last. Older children may remain in the silent period for a few weeks or months, whereas pre-schoolers may be relatively silent for a year or more.

Grant (1979:137) considers four aspects when talking about language: speaking, listening, reading and writing, for which vocabulary is a necessity. In school we try to increase the number of words the learner uses. Grade 4 second-language learners are expected to have a fair amount of nouns and verbs in their vocabulary. According to the language policy document of the CAPS curriculum in South African schools, they must be able to listen, talk, read and write the language of instruction, English, in such a way that they can obtain an average of 50% at the end of the year in order to be promoted to Grade 5.

Language and thought are *socially constructed* (Vygotsky, 1987:10). Language learning proceeds best when children use language for meaningful purposes (Au, 1998:297). An individual's prior experience, culture, motivation, and goals determine meaningful language use (Fitzgerald, 1995:117). Language learning proceeds best when children are encouraged to take risks, experiment, and make mistakes (Grant, 1979:120). Grade 4 learners whose language of instruction is not the same as their mother tongue are challenged to take the risk of making meaning out of the word problems in the Mathematics class by depending on prior learning. Their language abilities are an obstacle to overcome when they deal with word problems.

2.6 DIFFICULTIES: LEARNING IN A LANGUAGE DIFFERENT FROM THE MOTHER TONGUE

All the praise that is heaped on the classical languages as an educational tool is due in double measure to the mother tongue, which should more justly be called the 'Mother of Languages'; every new language can only be established by comparison with it ... (unknown).

Using the mother tongue, we have learned to think and communicate, and acquired an intuitive understanding of grammar (Gurney, Gersten, Dimino and Carnine, 2001:340). Gurney *et al* also mentions that the mother tongue opens the door, not only to its own grammar, but to all grammars, in as much as it awakens the potential for universal grammar within all of us. This foreknowledge is the result of interactions between a first language and our fundamental linguistic endowment, and is the foundation on which we build ourselves. It is the greatest asset people bring to the task of foreign-language learning. For this reason, the mother tongue is the master key to foreign languages, the tool that gives us the fastest, surest, most precise, and most complete means of accessing a foreign language.

2.6.1 Mother tongue

First language or mother tongue is the language whereby the child makes acquaintance with everything about it to communicate (Radhika & Kala, 2012:99) and this happens most of the time in their mother tongue. Radhika and Kala (2012)

also state that learning a mother tongue takes place naturally and through imitation and exposition. All the language skills such as listening and speaking are learnt at home. A child is then sent to school to learn other skills such as reading and writing the language. However, the process of second language, known as foreign-tongue learning, is considerably different (Radhika & Kala, 2012:99). Language skills such as listening and speaking precede reading and writing at school only. Radhika and Kala (2012) mention that the learning of a foreign tongue is an artificial process and there is no proper model to imitate it. Herbert (2002:455) explains that the question of mother-tongue education in South Africa remains a vexed one because, on the one hand, it seems reasonable and desirable that learners should be able to receive education in their mother tongue, if they so wish. On the other hand, there are some real difficulties involved in the implementation of this ideal. The participants in this study received second-language instruction, with English as the language of instruction at their specific school. Chapter 3 expands on the demographic composition of the participants.

2.6.2 The interference of mother tongue while learning a second language

The interference of mother tongue in learning English as a second language is generally a lifelong experience in speaking, reading and writing (Radhida & Kala, 2013:99). Radhika and Kala point out that learners never manage to shake off the lexical stress pattern of their mother tongue in their English oral production. When a child learns the mother tongue, his mind is a clean state. He thus learns the mother tongue easily by imitating, but when he learns a foreign language such as English, he finds it difficult to accept the rules that are against the rule of the mother tongue. The mother tongue interferes with children's learning and communication.

Herbert (2002:466) reports on the South African situation, pointing out that the standard of the written forms of the indigenous languages, as they currently exist, have not yet been developed to the point where they are able to carry academic discourse effectively. They, therefore, function as full-fledged languages of learning and teaching, even at the Foundation Phase. Most of them are based on specific

rural dialects within conservative contexts, having been standardised in the nineteenth century by missionaries for such specific purposes as proselytisation, and later by the apartheid era's Language Boards at least partly as a mechanism of social control. As such, these standard written forms remain archaic, limited, context bound, and out of touch with the modern scientific world.

2.6.3 Difficulties learners ecperience

According to Rhahida and Kann (2013:100), difficulties for learners who learn English are that in their mother tongue, alphabets are used to produce sounds upon which their spoken and writing systems are based. However, while learning English, they realise that there is no one-to-one correlation between spelling and pronunciation. With reference to Herbert (2002:459), South Africa's indigenous languages use many words borrowed from English and, therefore, certain principles used in Mathematics cannot be translated directly. Learners whose mother tongue is not English, but another of South Africa's eleven official languages, cannot relate certain mathematical concepts to concepts in their mother-tongue language, for example, *more than* or *less than* has different meanings in Sesotho, where they only refer to something that is small or big.

Prepositions are conceptually challenging and they carry important and often confusing functions in Mathematics (MacGregor, 1990:101); the same preposition can signify different actions, as in the expressions: 3 multiplied by 10 versus 3 increased by 10. MacGregor (1990:102) notes that, in general, prepositions and the relationships they indicate are critical lexical items in the Mathematics register that can cause a great deal of confusion. Khisty (1995:227) indicates that word order such as, for example, subtract x from y can also be confusing. There are also different ways of saying the same expression, such as 24 divided by 8 and 8 divided into 24. Logical reasoning carries its own Mathematics language (for example, therefore, if-then) to which students must become accustomed (Khisty, 1995:239). Even if a second-language learner speaks English reasonably proficiently, another language issue is that mathematical expressions do not always translate directly into other languages, such as use of the phrase concludes (MacGregor, 1993:107).

Khisty (1995:239) goes a step further and argues that Mathematics teachers are realising that every Mathematics lesson should also be a language lesson, providing opportunities for all students to develop their English language skills.

2.7 Meaning of Mathematics concepts in different languages

The use of English in teaching and learning Mathematics involves ordinary English as in everyday use and mathematical English, where words and phrases have specific meanings in Mathematics (Pimm, 1987). The latter has been referred to as the Mathematics register (Halliday, 1974). The Mathematics register includes words from ordinary English with a specialised Mathematics meaning, for example, 'set', 'power', 'similar' and 'difference', as well as words such as 'polygon', 'isosceles' and 'quadrilateral' which are borrowed from other languages (Orton, 1992; Pimm, 1987).

Studies investigating learners' understanding of a variety of Mathematics words have shown that some learners do not understand many of the words that are commonly used in Mathematics classes (Berenson & Vidakovic, 1996). The word 'similar', for instance, means 'proportional' in Mathematics; yet in ordinary English it means 'alike'. This causes confusion, because what is similar in ordinary English is not necessarily similar in Mathematics, and vice versa (Orton, 1992:126). Pimm (1987:83) and Orton (1992:126) provide some interesting anecdotes about learners experiencing difficulties in Mathematics, because they do not understand the mathematical meanings of the words involved. For example, in response to the question "What is the difference between 47 and 23?", one learner responded: "One of the numbers is bigger than the other". When this was not accepted, he tried "One number contains a 4 and a 7 but the other number doesn't" (Orton, 1992:128). Another example is that of a 13-year-old learner who counted the number of diagonals in a given figure as the number of sloping sides the figure had relative to the orientation of the page (Pimm, 1987:84). The learner's response to the question "If you knew the number of sides of a polygon, could you work out the number of diagonals?" was "It depends on what the shape is and which way you place it". The

two examples show clearly that the learners did not understand the mathematical meanings of the words 'difference' and 'diagonal' and were employing the ordinary English meanings, thus leading to their errors. This illustrates the problems learners experience when they make errors of interpretation based on common everyday use of the words.

Comprehension of mathematical word problems is another area that highlights the role of language in learning Mathematics. Researchers such as Fasi (1999:31) and Woo-Hyung Whang (1996:289) explore how learners understand word problems in Mathematics. A common finding is that the more competent the learners are in English, the better they are at comprehending word problems. In addition, many learners with low competence in English perform better on non-verbal Mathematics tasks than on mathematically equivalent word problems (Fasi, 1999:31); this suggests that language difficulties interfere with learners' ability to solve Mathematics word problems. As Fasi (1999:31) concludes, the English in the word problems confuses and misleads many learners, even when the Mathematics involved is simple.

2.8 Summary

Setati (2005:451) strongly opines that a Mathematics teacher must learn to talk like a Mathematics teacher; their ways of talking, seeing and valuing themselves are inseparably intertwined in the process of successful mathematical learning in their classes.

According to Hopkins (2007:133), mathematics learning is closely related to a set of conditions that are always present when learners learn to talk, namely immersion, demonstration, engagement, expectations, responsibility, approximations and response. Hopkins (2007:136) states that children will learn when they are fully immersed in Mathematics; when they observe Mathematics by way of constant demonstrations that help them learn the structure of Mathematics; when they are fully engaged with the immersion and demonstrations (through need, desire, interest

and participation); when they internalise the expectation from those they trust, that they will and can use Mathematics; when they assume responsibility to choose when and how they will engage with Mathematics; when they are encouraged to use Mathematics before it is fully mature and know that the resulting approximations will be acknowledged and accepted.

Vilenius-Tuohimaa *et al*. (2008:409-425) conducted an in-depth qualitative study among primary school learners on a model for reading comprehension and mathematical word problems. Their findings showed that the covariance between performance on mathematical word problems and reading comprehension is strong: the better the children's reading comprehension skills, the better their performance on mathematical word problems. In a pedagogical sense, they emphasise the importance of fluency in reading skills before shifting the main focus of teaching to more comprehensive reading strategies for both reading comprehension and mathematical word problems (Vilenius-Tuohimaa *et al.*, 2008:423).

As a concept that is part of reading comprehension, story grammar led to an article by Xin *et al*. (2008:163-178). The correct understanding and interpretation of the story grammar of a word problem will assist the learner in setting a number sentence and to carry out the correct mathematical operation.

The abovementioned concepts form the basis on which this study was constructed and executed. Chapter 3 will now present the methodology of this research.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

> *To behold is to look beyond the fact; to observe, to go beyond the observation. Look at the world of people, and you will be overwhelmed by what you see. But select from that mass of humanity a well-chosen few, and observe them with insight, and they will tell you more than all the multitudes together (Anonymous).*

This chapter focuses on the methodology that was employed to answer the following research question: What obstacles prevent learners from successfully translating mathematical word problems into number sentences?. The chapter begins with a discussion of the research design, namely qualitative research, and the particular approach that was used, namely a case study approach. Next, the selection of participants is considered, followed by the specific strategies and techniques that were used to collect the data. The data-collection methods and instruments are then discussed. Finally, the methods used to analyse the data are presented.

Murray (2003:39) indicates that contextualised problems, also called word problems or story sums, play a vital role in the development of mathematical thinking in learners of all ages. This research will focus on the significance of the language medium used in the culturally and linguistically diverse primary school Mathematics class and how the learners' use of a second language influences their mathematical thinking.

3.2 RESEARCH PROBLEM AND MOTIVATION FOR THE STUDY

The research focuses on the significance of the language of instruction in the linguistically diverse primary Mathematics class. Having taught learners through the medium of English, which is not their home language, for sixteen years, I realise that word problems in Mathematics remain a problem to most learners. They are capable of successfully carrying out direct operations in the Mathematics class;

however, as soon as they are confronted with word problems, they seem to lose their ability to carry out direct operations. This observation gave rise to the research problem: *Obstacles that prevent learners from successfully translating mathematical word sums into number sentences.*

Grant (1978:59) is of the opinion that mathematical words must be used frequently in class in order for the learners to realise the true meaning of a word. Words expressing mathematical notions include, among others, many, more, small, smaller than, big, bigger than, how long, how short, how near, how far, a long time, a short time, light, heavy, cheap, expensive, the whole, a part of, a fraction, a half of, far, near, above, below, first, second, and so on, in the middle, before, and after. Grant suggests that these words must be used in conversation with the learners. As Southern Sotho is the mother tongue of 80% of those learners who took part in this case study, I realise that this kind of descriptive mathematical vocabulary was not sufficiently emphasised by the teachers who taught them in the Foundation Phase. It is likely that the teachers who taught the learners in their early years did not know or realise that the mentioned words are not only new words to expand their daily usage of English, but also words that will expand the learners' mathematical vocabulary.

The teachers and the learners at the school where the observation took place do not speak the same mother tongue. The lack of knowledge concerning the real meaning of the English words used in Mathematics word problems can be a reason as to why learners find it difficult to translate word sums into number sentences. For learners to translate English words into their mother tongue while trying to solve word problems, could be one of the main obstacles that prevents them from constructing number sentences. Sesotho words that relate to the English words given in the word sums might not exist. These uncertainties necessitated a study of this nature.

3.3 RESEARCH QUESTIONS

Communication in the Mathematics classroom amounts to talking, listening, reading and writing (Chappell & Thompson 2007:181). In addition to the questions mentioned in the purpose and objectives of the study, the main research question can be formulated as: *What obstacles prevent learners from successfully translating mathematical word problems into number sentences?*

As mentioned in Chapter 2, Setati (2005:448) argues that South-Africa's language policy addresses the overvaluing of English and the undervaluing of African languages. This language practice implies that learners must become familiar with mathematical language by using a language that is not their mother tongue. Bearing this in mind and considering the theory of Vilenius-Tuohimaa *et al*. (2007), which refers to the association between mathematical word problems and reading comprehension, leads to the first sub-question*: What problems do learners experience with developing mathematical understanding from the language of instruction?*

The language diversity of Grade 4 learners participating in the study gave meaning to the second sub-question: *How do learners assign meaning to the various parts of a mathematical word problem?*

3.4 RESEARCH DESIGN

A qualitative, case study design was employed for this study and will be described in detail in the following paragraphs.

3.4.1 Qualitative research

In qualitative research, the characteristics, qualities or properties of a particular phenomenon are examined in order to achieve enhanced understanding and explanation of the phenomenon (Henning 2004c:3, 5). In order to achieve this, Merriam (1998:6) states that qualitative research is based on the view that

individuals interacting with their social world construct reality. The researcher is the primary instrument for data collection and analysis by physically going to the participants.

Since this dissertation is concerned with answering questions regarding perspectives, experiences and practices, none of which is easy to quantify or standardise, they are best described in words. The qualitative method is thus more appropriate for evaluating such outcomes since "knowledge is constructed not only by observable phenomena, but also by descriptions of people's intentions, beliefs, values and reasons, meaning making and self-understanding" (Van Rensburg 2004:20).

Making meaning is an important goal of this research project. The Russian educationist, Vygotsky, considered making meaning essential to true learning (Van der Veer & Valsiner 1991:17). Important components of this research, therefore, include participants' understanding of their realities and their attempts to make sense of those realities concerning word problems in the primary Mathematics classroom. As the researcher, I endeavour to interpret or reconstruct my interaction with the participants according to the meanings they attach to their realities. The key concern is understanding the phenomenon of interest from the participant's, not the researcher's, perspective (Merriam 1998:7).

Furthermore, Henning (2004c:3) states that in qualitative research, the aim is not only to scrutinise people's actions such as their speech and writing, but also to find out *how* they represent their feelings and thoughts in these actions. A qualitative research design enables the researcher to capture "rich data regarding people's conceptual frameworks, [or] their *lived experience"* (Henning 2004c:9)

Merriam (1998:6) assumes that meaning is embedded in people's experiences and that this meaning is mediated through the investigator's own perceptions. This research project, therefore, aims to meet people in their unique socio-cultural contexts. I seek to discover their realities as they attempt to make meaning of their

practices and perspectives and how they express their understanding of the phenomena under investigation.

Leedy and Ormrod (2005:133) mention that qualitative researchers believe that the researcher's ability to interpret and make sense of what s/he perceives, is critical for understanding any social phenomenon. In this sense, *the researcher is an instrument* in much the same way that a sociogram, rating scale, or intelligence test is an instrument. This research project, therefore, aims to meet learners in their unique teaching and learning environment. A Grade 4 Mathematics classroom is the specific learning environment which the researcher wishes to interpret and make sense of. The learning and teaching situation in the Mathematics classroom is the experience where learners gave meaning to various parts of word problems. The researcher plays the role of acting as the teacher during the Mathematics lesson where the learners make sense and meaning of word problems.

3.4.2 Case study approach

Although it is difficult to explain the research category 'case studies' by means of a simple definition, McBurney (2001:223) states that a case study can be regarded as the study of a single example of something for its own sake or as an exemplar or paradigm of a general phenomenon. Leedy and Ormrod (2005:135) mention that, in a case study, a particular individual, programme, or event is studied in depth for a defined period of time.

According to Algozzine and Hancock (2006:15), it is mainly assumed in a case study that a phenomenon is studied as a system bound by space and time. Such a system may be a group of people, or a set of documents, or a television series. Merriam (1996:27) concludes that the single most defining characteristic of case study research lies in delimiting the object of study, the case. She defines this as a thing, a single entity, a unit around which there are boundaries. She writes that the researcher can "fence in" what s/he will study. The case could be a person such as a

student, a teacher, a principal, a group such as a classroom of children or a mobilisation of professionals studying a childhood condition.

A case study may be a practical problem that needs to be solved as soon as possible, or it may even be an event or a phenomenon that intrigues the researcher (McBurney 2001:214). Case studies are anchored in real-life situations and can help researchers gain insights and understanding which can serve to expand their experiences and help structure future research (Hodgskiss 2007:33).

Case studies are very common in education, and involve the in-depth exploration of a particular case (Taber 2007:73). The process that is followed in a case study is an essential part of the study's outcome. This implies that a careful description of *how, where, when* and *why* things happen in the case are taken note of and are an essential part thereof. The process itself becomes part of the outcome and the context of the study; therefore, it is not merely part of the case but it *is* the case (Henning 2004d:41).

Merriam (1998:31) mentions that the uniqueness of a case study lies not so much in the methods employed (although these are important) as in the questions asked and their relationship to the end product. The case or "bounded system" under investigation is studied in its natural context. Grade 4 learners from a primary school in the Motheo district of the Free State were observed and video recorded while interacting with word problems and with each other during a Mathematics lesson.

3.5 SELECTION OF PARTICIPANTS

In qualitative case study research, two levels of sampling are usually necessary (Merriam 1998:65). First, one must select the case to be studied and then, unless one plans to interview, observe, or analyse all the people, activities, or documents within the case, one needs to do some sampling within the case.

The two basic types of sampling are probability and nonprobability sampling (Merriam 1998:60). Probability sampling, of which simple random sampling is the most familiar example, allows the investigator to generalise the results of the study from the sample to the population from which the sample is drawn and since generalisation, in a statistical sense, is not a goal of qualitative research, probabilistic sampling is not necessary or even justifiable in qualitative research (Merriam 1998:61).

A more appropriate way of selecting participants is by means of *purposeful selection,* or *purposeful sampling*, or *criterion-based selection* (Maxwell 2005:88). Purposeful sampling is based on the assumption that the investigator wants to discover, understand, and gain insight and, therefore, must select a sample from which the most can be learned (Merriam 1998:61). Maxwell (2005:88) defines purposeful selection as a strategy in which particular settings, persons, or activities are selected intentionally so that information is provided that cannot be obtained as accurately from other choices.

These persons and settings can be referred to as "information-rich cases" which one would study in depth, and from which one can learn much about the key issues involved in the research. These information-rich cases provide for the power and logic behind purposeful sampling (Patton, quoted in Hodgskiss, 2007:34).

Bear in mind that, with certain types of purposeful sampling methods such as convenience sampling, along with snowball, theoretical sampling and network sampling, the sample chosen cannot be assumed to be representative of a population, and the findings should not, therefore, be generalised to the rest of the population. Generalisation is not the aim of qualitative research; however, if the report is credible and lucid, specific elements of the findings would be transferable and can, therefore, be extended to other settings (Henning 2004a:71).

Before a researcher begins such purposive sampling, s/he should first determine what selection criteria will be used in selecting the subjects to be studied (Hodgskiss

2007:34). Merriam (1998:61) refers to this selection criteria as choosing the people or sites to be studied. The following selection criteria were used for this study:

- A primary school in the Motheo teaching district of the Free State Province.
- One of five Grade 4 Mathematics classes at the particular school.
- Twelve learners out of that specific class.

In order to find the desired participants, I did the following:

I chose a specific primary school where the language of instruction is not the same as the mother tongue of the learners. I chose this specific school because I teach at that school, and it would simplify any organisation and arrangements with the learners. I had to select a specific Grade 4 Mathematics class out of a possible five classes. After I used the purposive sampling method described earlier to find research participants, I also made use of typical sampling, which basically reflects the average person, situation, or instance of the phenomenon of interest to select the class. I chose the Grade 4 class that I am teaching for no other reason than to simplify arrangements. Merriam (1998:62) states that the site is specifically selected, because it is not in any major way atypical, extreme, deviant, or intensely unusual. According to typical sampling, any of the Grade 4 Mathematics classes could have been chosen for the study. In order not to disrupt the normal academic activities of the school, I decided to take the Grade 4 class, which I taught, to be observed by means of video recording.

To do the observation for the case study, I took the learners to the Faculty of Education at the University of the Free State. The video recording took place in the experimental classrooms of the practical teaching division. To obtain the best results when video recording learners, the technical staff of the practical teaching division advised me to use a group of six learners which would make it possible to have an ultimate view of each learner when video recording while doing group work. I decided to have two groups of six learners each in order to be able to compare the activities of the groups when I analyse the data. Therefore, I had to

appoint a group of twelve learners out of the class of thirty two learners for the observation. To choose the twelve learners, I used the way in which the learners were seated in the Mathematics class. For no specific reason I chose the two middle rows of the class as it was exactly twelve learners.

I wrote an informative letter to the principal of the involved school. She confirmed that it was not necessary to inform the Department of Education on the participation of the learners in this study. I also wrote a letter of consent to the participant's parents. They could grant their permission or their refusal of their child's participation in the study. The learners were very excited to be participants. I chose an unfamiliar environment to do the observation so that the learners could not experience a risk of coercion.

3.6 RESEARCH STRATEGY AND TECHNIQUES

Merriam (1998:6) explains that qualitative researchers are interested in understanding the meaning people have constructed, that is, how they make sense of their world and their experiences in the world. She also states that the key concern is understanding the phenomenon of interest from the participants' and not the researcher's perspectives. The phenomenon of the study was to research the correlation, if any, between second-language learners' language abilities and the way they apply it to mathematical language. The study focused on how the learners gave meaning to different parts of word sums. The data collected reflects how Grade 4 learners experience language in the Mathematics classroom.

3.7 DATA-COLLECTON METHODS AND INSTRUMENTS

Merriam (1998:69) describes qualitative data as data conveyed by means of words, and it can consist of direct quotations from people about their experiences, opinions, feelings and knowledge obtained through interviews or observations. The data-collection techniques used, as well as the specific information considered to be "data" in a study, are determined by the researcher's theoretical orientation, by the

problem and purpose of the study, and by the sample selected (Best & Kahn 2003:255).

The selection of the sample was thoroughly discussed in paragraph 3.5. Algozzine and Hancock (2006:46) state that, unlike interviews that rely on a person's often biased perceptions and recollections of events, observations of the setting by a case study researcher may provide more objective information related to the research topic. Observations in a qualitative study are intentionally unstructured and free-flowing, because the researcher can shift focus from one aspect to another as new and potentially significant objects and events present themselves (Leedy & Ormrod 2005:145).

In this particular study, two groups of Grade 4 learners were observed during group work in a mathematical teaching and learning environment. The researcher wanted to observe the interaction between Grade 4 learners while they were discussing word problems as well as the usage of language. The language used would indicate if the learners preferred their mother tongue while discussing mathematical issues of would they do it in the language of instruction. The observation took place by means of video recording. The learners were divided into their groups upon their arrival at the University of the Free State. Group 1 was taken into the observation room first. The learners each received a number from 1 to 6. This number identified the learner for further reference. I explained to the learners the procedures that would be followed and how to participate in the group work.

The learners had to complete a worksheet (Appendix 2) containing two word problems. The examples of the word problems aligned with the theory mentioned in Chapter 2 where Xin *et al*. (2008:165) designed a framework within which story grammar can be used to structure Mathematics word problems. Story grammar is a text structure common to a set of narrative stories (Gardill & Jitendra, 1999:2). Similarly, a word problem story structure that is common across a set of word problem situations can be defined as word problem story grammar for a particular type of problem (Xin, Wiles & Lin, 2008:164). Story grammar aims to improve

students' reading comprehension by giving them a framework they can use when reading stories, for example by asking a series of story grammar questions such as who, what, where, when and why. Consistent use of the same questions about stories equips students with a framework they can apply on their own. Xin *et al*. (2008:165) designed a framework through a set of word problem story grammar self-questioning prompts that emphasise the algebraic expression of mathematical relations in word problem conceptual models to assist meaningful representation and problem-solving. Generally speaking, part-plus-part-equals-whole is a generalisable conceptual model in addition and subtraction word problems in which 'part', 'part' and 'whole' are the three basic elements. The choice of the content of the two Word Problems used, was based on this mentioned concept as the operation required to carried it out were addition and subtraction.

Each learner was closely observed and his/her actions were recorded. After Group 1 completed their group work, Group 2 underwent the same procedure. The recorded video and the learners' written worksheets served as data which was analysed in an attempt to answer the relevant research questions. Merriam (1998:111) points out that when observation is combined with document analysis it allows for a holistic interpretation of the phenomenon under investigation.

3.8 CREDIBILITY AND TRUSTWORTHINESS

According to Silverman (2011:366), credibility in qualitative research concerns the truthfulness of the inquiry's findings. The credibility of the study was supported by the choice of participants. They were Grade 4 Mathematics learners from a culturally diverse class where the language of instruction is English and not their mother tongue. The case study methodology further contributes to the credibility, as it represented the reality of the participants and ensured that the obligations or the research questions were met.

Trustworthiness in qualitative research views consistency as the extent to which variation can be tracked or explained (Silverman, 2011:366). The trustworthiness

lies in the logic and stepwise replication as well as the setting of themes from the data. I assumed that, if the same research methods were used for a culturally diverse class at the school where the study took place, the outcomes would be approximately similar. The language of instruction was English and it was not the mother tongue of the learners. The methods used to carry out the case study would be appropriate for other Mathematics classes at the same school, as the learning environment would be similar. The findings were documented in such a way that it would be applicable to other Mathematics classes at the same school.

3.9 DATA ANALYSES

Maree (2007:99) explains that qualitative data analysis attempts to establish how participants make meaning of a specific phenomenon by analysing their perceptions, attitudes, understanding, knowledge, values, feelings and experiences in an attempt to approximate their construction of the phenomenon. The collected data was organised in such a way that the researcher could try to understand the behaviour of the learners, confronting issues specially related to language, and to make meaning of the data throughout the entire process. The conversations of each group were transcribed and summarised by means of written script. A language interpreter assisted the researcher in cases where the learners used their home language during the discussions.

The data was presented by means of a written report. Merriam (1998:221) suggests that the researcher must ask him-/herself who will be reading the report and the answer to that question can provide guidance with respect to structuring the content the of report. To analyse and interpret the data, I identified themes into which certain aspects of the data could be grouped. These themes are discussed in Chapter 4.

3.10 SUMMARY

Setati (2005:448) explains that the majority of research on Mathematics education in multilingual classrooms has argued for the use of the learners' home language as resource for learning and teaching Mathematics. To confirm this view, my research focuses on the significance of the language of instruction in a linguistically diverse primary mathematical classroom. The main research question, namely *Obstacles that prevent learners from successfully translating mathematical word sums into number sentences,* arose from the language barriers which primary school learners could experience in the multilingual Mathematics classroom.

A case study of a primary school in the Motheo teaching district of the Free State was conducted. Learners from a Grade 4 Mathematics class were observed and video recorded while they were doing group work. They received a worksheet on which they had to compile number sentences for the given word problems and also try to reach an answer to the specific word problem.

The motivation for the study is the concern about the difficulties some primary school Mathematics learners, whose home language is not the same as the language of instruction, experience when they have to compile number sentences from word sums. The video material and worksheets done by the learners served as the data for the study. The researcher analysed the data and made use of an interpreter to assist her in translating the home language of the learners into English if they used it during the group work discussions.

Chapter 4 will focus on the results obtained after analysis and interpretation of the data. A synthesis in terms of the research questions will also be provided.

CHAPTER 4
DATA ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

Chapter 3 presented a discussion of the research methodology. This chapter aims to answer both the main research question and the two sub-questions. The objectives of this study (refer to Section 3.3) gave rise to the following research questions:

Main research question:
What obstacles prevent learners from successfully translating mathematical word problems into number sentences?

Sub-questions:
What problems do learners experience with developing mathematical understanding from the language of instruction?

How do learners assign meaning to the various parts of a mathematical word problem?

This chapter begins with a description of the research participants, and proceeds with the presentation of the data obtained by means of an observation. It includes a discussion of the results obtained from the fieldwork.

4.2 BIOGRAPHICAL INFORMATION OF THE PARTICIPANTS

The selection of the participants was fully discussed in Section 3.5. To expand further on the biographical information of the participants, I shall explain the gender and language compositions of the two groups by means of a visual presentation.

The groups are labelled as Group 1 and Group 2. Tables 4.1 and 4.2 show the gender composition of each group, whereas Tables 4.3 and 4.4 display the language diversity of the two groups.

Table 4.1: Gender composition of Group 1

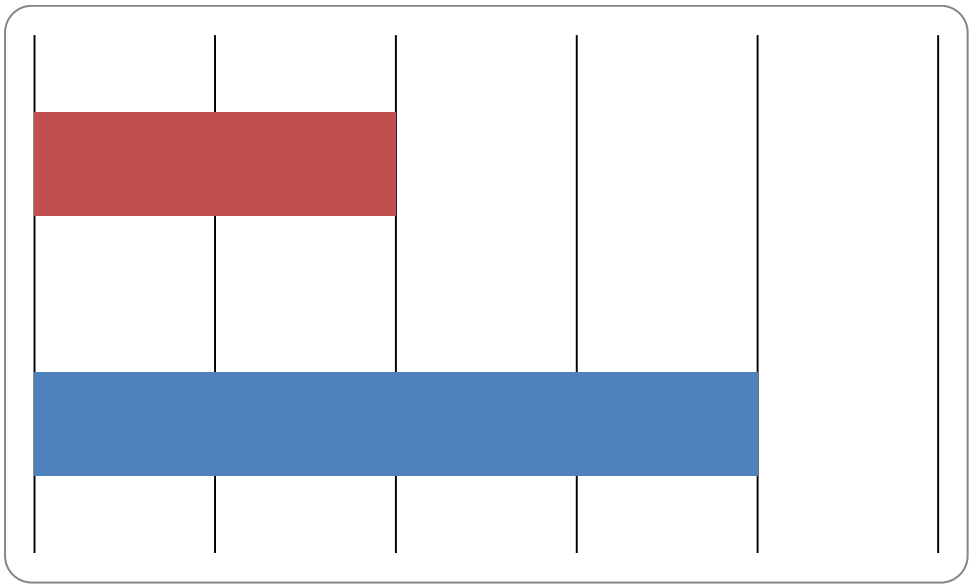
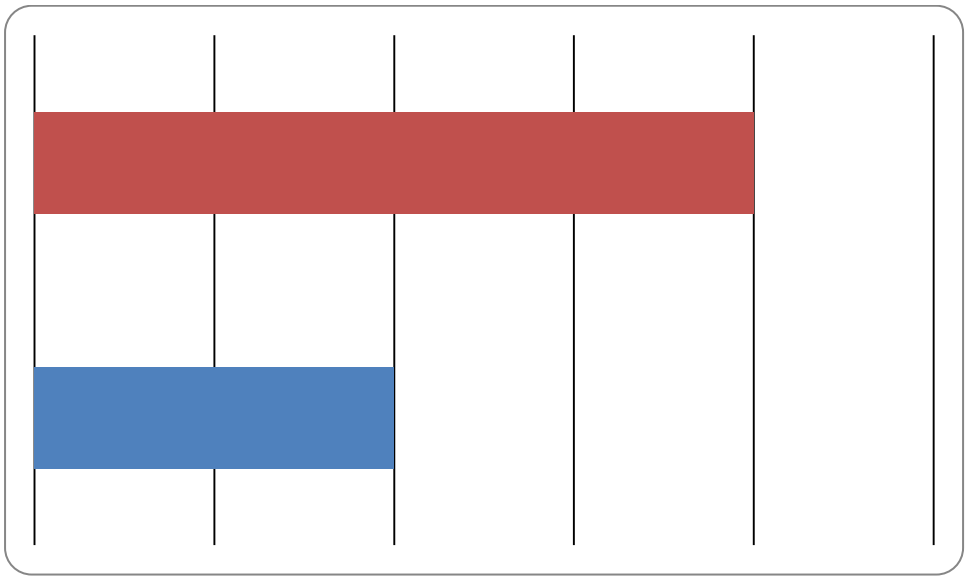


Table 4.2: Gender composition of Group 2



As can be seen Group1 had two boys and four girls, while Group2 had four boys and two girls.

Table 4.3: Language diversity of Group 1

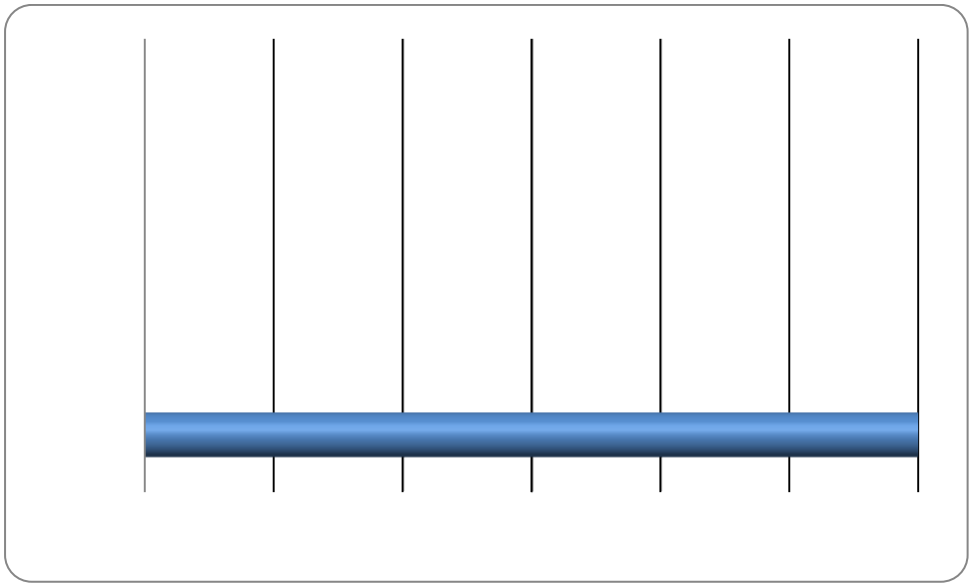
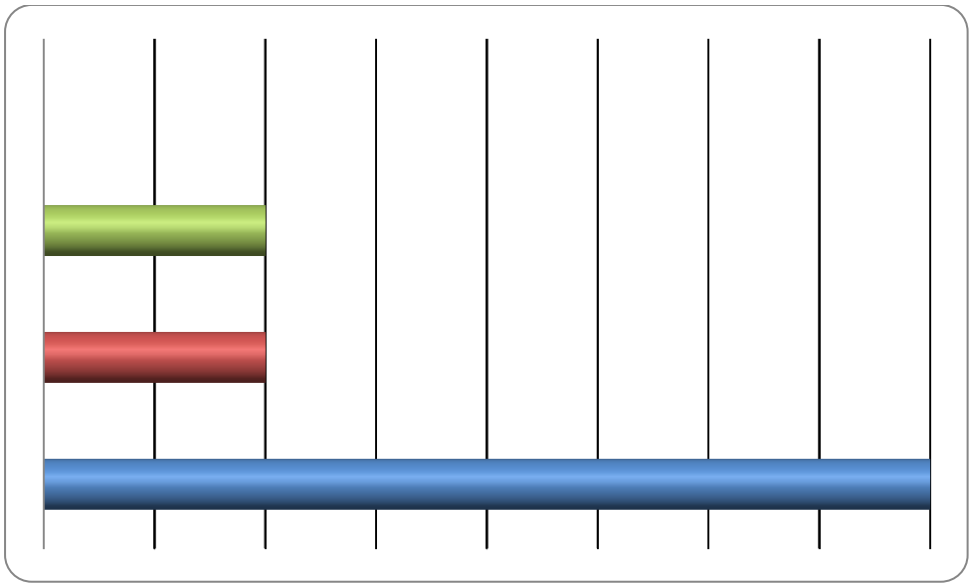


Table 4.4: Language diversity of Group 2



While Group 1 had only Sotho-speaking learners, Group 2 accommodated three languages, namely IsiXhosa, Setswana and Sesotho.

4.3 RESULTS OBTAINED AND PRESENTATION OF THE DATA

The findings are reported on and discussed in the following sections. In some cases, references to the literature serve to contextualise the findings.

The approach used in this section combines reporting with a discussion of the research findings. The researcher is aware that it is customary, especially in quantitative studies, to separate the reporting and the discussion of findings. However, the presentation of the data along with a discussion thereof produces a more holistic picture of the qualitative findings. It is important, therefore, that this discussion should not be equated to a positivistic or quantitative frame of reference.

The methodology regarding the use of observations and the essence of implementing a case study was discussed in Chapter 3. The results obtained from the observation concerning the group work done by a Grade 4 Mathematics class will be discussed. All the transcriptions obtained from the observations are attached as Appendix 1.

Section 3.5 outlined the selection of the participants and explained why the specific learners were chosen as participants. The two groups of learners were observed separately. Each group consisted of six learners who had been chosen according to purposeful sampling, as discussed in Section 3.5. The identities of the learners are protected by anonymity. I shall, for example, refer to "Group 1 Learner Four" or "Group 2 Learner Two", as the situation dictates. This approach protects the minors participating in the study. I categorised the collected data into two main groups. Each category answers one of the sub-research questions. The groups are:

- The use of language during the group work session.
- Writing number sentences and assigning meaning to word problems

4.3.1 The use of language during the group sessions

In this section, the first sub-research question, namely: *What problems do learners experience with developing mathematical understanding from the language of instruction,* will be addressed. The use of language during the group work will be investigated.

During my observation of Group 1, I realised that the learners were unwilling to interact spontaneously with each other while doing the group work. My presence as the teacher inhibited their spontaneous participation in the discussions. The learners used English as well as their home language, mainly Sesotho, during the discussions. I had to play a very active role in their attempts to formulate number sentences for the particular word problems. Group 1's session lasted twenty-six minutes. I believe that the discussion of the word problems by the members of Group 1 was not as successful as I expected it to be. The learners did not participate spontaneously. They did not formulate their own ideas. They waited for me to take the lead in the discussions. My presence as teacher put a damper on their enthusiasm. Before Group 2 started their group work session, I discussed my concerns with the technical staff of the laboratory in the Faculty of Education. They suggested that I leave the room at the point where the learners had to discuss the word problems.

While video recording Group 2's interactions, I left the room at the point where the learners had to start their discussion. Suddenly, the entire scenario changed. The Group 2 learners started to talk spontaneously to each other and mostly used their mother tongues, Sesotho and Setswana, during the discussion. They were, in fact, verbally dealing with the mathematical word problem on the worksheet in their mother tongue.

4.3.1.1 *The procedure followed during group work*

The following procedure was followed during the group work sessions. I introduced the learners to the order of work during the session. First, they had to assign a

number from 1 to 6 to each group member. This was for anonymity purposes. They then had to follow the instructions on the worksheet. There were two word problems, Word Problem A and Word Problem B. Word Problem A had to be done first and completed before they could start with Word Problem B. The learners had to read each problem by themselves and then rewrite the "story" in their own words. While they had to rewrite the story in their own words, no discussion was allowed.

While explaining the method of work to the learners, Learner Two in Group 1 wanted to know if this worksheet was another test? I explained the worksheet was not for assessment purposes, but it had to be done because I wanted to investigate their level of understanding of basic mathematical operations and whether they could assign meaning to the language used in the word problem. Learner Two of Group 2 wanted to know if they can help each other. I again explained that it is group work and that they would necessarily have to discuss the word problems. This would help them understand the problems better. However, at this stage where they had to rewrite in their own words, no discussions were allowed. Learner Three of Group 2 wanted to know if they had to rewrite the question. I explained to the learners that they had to use their own words to rewrite the "story". The results of the rewriting were done on the worksheets and each learner had to complete their worksheet individually.

After I explained the order of work to each group, they started with Word Problem A. The learners started to read the Word Problem A and then tried to rewrite the word problem into their own words. I explained to them that the reason for rewriting the "story" was so that I could note whether they understood what they had read. They had a time limit of two minutes to rewrite the "story". When they finished writing, I asked them to discuss the mathematical operation they wanted to follow in an attempt to determine an answer to the Word Problem.

4.3.1.2 *Language use with respect to Word Problem A*

Word Problem A reads as follows: Thabo has several toy cars; his brother gives him 28 more. Thabo has now 67 toy cars. How many cars did he have in the beginning?

The discussion of the word problems started at this point. Group 1 was inhibited by the presence of the teacher. The teacher had to lead them by asking questions that could give them clues to the suitable mathematical operation they had to perform. There was very little interaction among the learners. They concluded that it must be a minus sum, because they have a large known part and want to find the value of the unknown smaller part. They mostly used English throughout their discussions.

The teacher left the room when the learners of Group 2 had to discuss Word Problem A. The moment I left the classroom, the learners started to talk in their mother tongue. They even argued about using Sesotho or Setswana. The mother tongue of Learner Two of Group 2 was Setswana, but he agreed to speak Sesotho with the majority. The same learner suffers from Attention Deficit Hyperactivity Disorder and is using Ritalin to cope with his lack of concentration. He was concerned about the camera and the strange objects in the classroom and did not contribute to the discussion about the Word Problem at hand. Learner Four of Group 2 dominated the discussion with her body and verbal language. Learner Six in Group 2 suggested that they had to do a minus sum. Learner Four did not want to work with the group, because she believed that some members were not doing the Mathematics. Learner One of Group 2 reminded them to write a number sentence too and referred to it as numbering, but Learner Six made it clear that a number sentence is the numbers they have to use to write down the correct mathematical operation, which must be carried out.

4.3.1.3 *Language use with respect to Word Problem B*

Word Problem B reads as follows:
Boitumelo has R20 more than her brother who has R10. Her father has R50 more than her. How much money does her father have?

The Group 1 learners could not come to an immediate conclusion when dealing with Word Problem B. They started to speak Sesotho. Learner Three suggested a subtraction sum (*re tshwanetse re minuse*); Learner Two suggested a multiplication sum (*ke times wena*), and Learner Three told the group to do an addition sum (*ke boss plus plus*). Learner Two suggested that they should read the story again so that they could understand the story better. The teacher led them to understand that the sum had two parts and that they should bear that in mind when writing the number sentence. Learner Four tried to translate the whole sum in Sesotho, but she did not do it correctly. Her translation read as follows: "*Boitumelo o na le diranta tse mashome a mabedi. Abuti wa hae o na le diranta tse leshome fela. Mme ntate wa bons o na le diranta tse mashome a mahlano*" – Boitumelo has twenty rands. Her brother had ten rands. And their father had fifty rands.

Learner Three mentioned that "more than" means plus, and that they first had to find out how much money Boitumelo had; then they could work out the amount her father had. The teacher led them to first find an answer for the amount of money that Boitumelo had and then to find an answer for the amount of money the father had. The learners then understood that the sum had two parts and that they had to write two number sentences.

When Group 2 discussed Word Problem B, the teacher left the room. The learners immediately started to talk in Sesotho. Learner Four said in Sesotho: "*More ke eng? Ke more akere. E seng low*. *More!*" – (What does more mean? It's extra right? And not less. More.). Learner One tried to talk to Learner Three: "*Ke kopang ho bua Ofentse he ha a re explainele hobaneng re re ke plus ha a re explainele* … (May I please speak. Will Ofentse please explain to us why he says it's additions, please

explain…). Learner Three did not reply to Learner One and right then a lengthy argument developed and the group could not reach an agreement as to what kind of operation they had to follow. The learners talked in circles and started to argue about their incompetency to work in a group, instead of discussing the Word Problem at hand. The teacher entered the room and tried to rescue the situation. I led them to first determine how much money Boitumelo had and, from there, they could calculate the amount the father had.

4.3.1.4 *Developing mathematical understanding*

During the group work sessions, the learners had to use English, the language of instruction, to gain mathematical understanding of the word problem in order to construct number sentences. Word Problem A on the worksheet was an easier problem to solve than Word Problem B. Group 1 mainly spoke in English while discussing Word Problem A. When they discussed Word Problem B, Learner Six declared that she was going to speak Sesotho. "*Ke bua Sesotho*". At that stage, I was still in the room. I assumed that it was easier for the learner to develop mathematical understanding in her mother tongue, so I did not interfere with their language choice.

By rewriting the word problem in their own English words, the learners were forced to consider the context and the relationships between the concepts. The Grade 4 learners did not use their mother tongue when rewriting the word problem in their own words. An analysis of the learners' interpretations of the word problems and the way in which they rewrote them in the language of instruction gave a good indication of their real understanding of the mathematical problem at hand. Understanding the words of the word problems are discussed in Section 4.3.1.5, where the learner's written interpretations of the word problems are analysed.

While busy with Word Problem B, Learner Two of Group 1 mentioned that she thought they should read the story over again, because they did not understand it. I asked them if they would understand the word problem better if one of them could

translate the word problem in Sesotho? The entire group answered "Yes". The rest of the discussion of the specific problem was held mostly in Sesotho.

Group 2 mainly spoke Sesotho while discussing both word problems. Word Problem A started with: "A boy named Thabo had several toy cars ...". Learner Four of Group 2 translated "several" as "seven". She did not use the correct Sesotho word for seven, but used the word "*sevene*". This was how she translated 'seven' into Sesotho and I assume that this is the reason why she thought "several" meant 'seven'. How can she make sense of the language of instruction if she cannot find a Sesotho word to replace the word "several"? This indicates that learners are confused when they attempt to translate mathematical language of instruction into a mother-tongue mathematical language, as they cannot find mother-tongue words that correspond with the English descriptive words.

In addition, learners did not use Sesotho words to describe the mathematical operations. To translate "plus", they used "*ke plus*". To translate "divide", they used "*kappa divide*". For subtraction, they used "*minuse*" and for multiply, they used "times". It was clear that they did not know Sesotho words for the four basic Mathematics operations. They preferred to use the English version of the words.

The main observations regarding how learners in the study constructed mathematical understanding from the language of instruction can be summarised as follows. Learners prefer to translate word problems into their mother tongue when they have to construct number sentences. They understand the concepts of the word problem better when they translate it into their mother tongue. Unfortunately, learners translate word problems incorrectly into their mother tongue, because they cannot find the correct mother-tongue word for the English words used. Learners do not know the corresponding mother-tongue words to describe mathematical operations. This summary answers the first sub-question of this study, namely what problems do learners experience with developing mathematical understanding from the language of instruction, to a certain extent

4.3.1.5 *An analysis of learners' written interpretations of the word problems*

To expand on the developing of mathematical understanding, as discussed in Section 4.3.1.4, the learners' written versions of Word Problems A and B were considered. Word Problem A read as follows: Thabo has several toy cars, his brother gives him 28 more. Thabo has now 67 toy cars. How many cars did he have in the beginning?

The Group 1 learners wrote Word Problem A in their own words as follows:
Learner One: "He had 38 toy cars."
Learner Two: "A boy named Thabo. He had 67 toy cars; his brother wanted 28 toy cars. How many did ..." (did not complete the sentence).
Learner Three: "Thabo had several toy cars and his brother Andy gave him 28 more."
Learner Four: "Thabo had several toy cars. Then his brother Andy gave him 28."
Learner Five: "Thabo had many toy cars. They gave him 28 more toy cars. Now he had 67 toy cars. W ... (did not complete the sentence).
Learner Six: "Thabo has several toy cars. Then has ... (did not complete).

It is clear that Learners Three, Four and Five were more or less on track rewriting the word problem in their own words. They just could not come to a point where they could understand that it must be a minus sum and that the total number of cars that Thabo had was 67 and the cars that his brother gave him must be subtracted from that in order to know how many were the "several" cars which he had from the beginning. Learners One, Two and Six were completely lost in their attempt to rewrite the word problem.

The Group 2 learners rewrote Word Problem A as follows:
Learner One: "A girl named Palesa had a birthday. Her parents gave her R50.00 and she wanted to buy a doll. How much money is left?"

Learner Two: "A boy named Thabo had several toy cars. Then his brother Andy ... (did not complete the sentence).
Learner Three: "My grandpa is 75 years old and my grandma is 65. How much is my grandpa?"
Learner Four: "My mom brought me 7 apples and my pa gave me 2. How many apples did I get in the beginning?"
Learner Five: "I have 16 sweets and I gave my friend 8 sweets. I have 8 left. How many sweets do I have left?"
Learner Six: "I am Thabo. I have several toy cars. Then my brother Andy gave me 28 more toy cars. Now Thabo has ... (did not complete sentence).

Learners One, Three, Four and Five started with a new word problem and did not focus on the problem given. Learners Two and Six tried to rewrite the word problem in their own words, but it appears that Learner Six made the most meaning in his attempt. Learners One, Three, Four and Five probably misunderstood the instructions on the worksheet. However, the word problems they wrote down did not show a great deal of mathematical understanding. It appears that they tried to write down a word problem, but it did not contain any mathematical meaning; it was just a combination of words with no linguistic meaning.

Word Problem B read as follows: Boitumelo has R20 more than her brother who has R10. Her father has R50 more than her. How much money does her father have?

The Group 1 learners rewrote Word Problem B as follows:
Learner One: "Boitumelo has R20 and his brother has R10 and her father has R50, if we must plus we will get the ... (did not complete sentence).
Learner Two: "Boitumelo has R20. Her brother has R10 and her father has R50 more than Boitumelo."
Learner Three: "Boitumelo had R20 more in her pocket and her brother had R10 in his pocket. Her father had R50 more than Boitumelo."
Learner Four: "Boitumelo has R20, but his brother has R10 and his father has R50 more than Boitumelo and brother."

Learner Five: "Boitumelo has R20 more in her pocket. Her brother has R10 and her father has R50 more than Boitumelo. How much money does her father have?"
Learner Six: "Boitumelo has 10 sweets more; his brother has 30 sweets ...".

Learner One could not perceive the complexity of the word problem. She saw the entire concept as one idea. Learners Two, Three, Four and Five could more or less understand that the word problem had two parts, but none of them could come to the real mathematical understanding of the problem. Learner Six did not interpret the instructions well and used irrelevant words to rewrite the word problem.

The Group 2 learners rewrote Word Problem B as follows:
Learner One: "Boitumelo's father has R50, and Boitumelo has R20. Brother has R10; they ask how much money father has?".
Learner Two: "Boitumelo has R20 more in her pocket than her brother who has R10 in his. Her father has R50 more than Boitumelo."
Learner Three: "I have R30, my brother R50."
Learner Four: "Her father has more because her pa has R50 more than them."
Learner Five: "Boitumelo did have R20 more than her brother who has R10 less than Boitumelo. Her father has more than them; he has R50. Who has the least?"
Learner Six: "Boitumelo has R20 more than her brother who has R10; his father has R50 more than Boitumelo."

Learner One tried to break the word problem up into mathematical parts, but did so incorrectly. Learners Two and Six showed better understanding of the mathematical meaning of the word problem, but stopped too early with the meaning-making of the word problem. Learners Three and Four did not make any meaning of this word problem. Learner Five sounded confused and the word order of the sentence is incorrect.

When analysing the learners' written interpretations of the two word problems, it is clear that the wording of the problems did not make much mathematical sense to them. They could not redesign a simpler version of the word problems in order to

construct meaning from what was given. The development of mathematical understanding from the written language of instruction, was therefore extremely limited.

4.3.2 Writing number sentences and assigning meaning to word problems

Further results that emerged from the data concern the second sub-question, namely: *How do learners assign meaning to the various parts of a mathematical word problem?*

In order to answer the question, I investigated the behaviour of the learners during the group work, their contribution to the group work, and whether they could formulate a meaningful solution to each word problem.

4.3.2.1 *The behaviour of the learners*

The two groups of learners were observed separately. Each observation of the learners' interactions was video recorded. A language interpreter translated the conversations of each observation during the group work. While analysing the recordings, I focused on the behaviour of the learners in the two groups.

While I explained the work procedure of the group work, a learner from Group 1 asked if the worksheet was a test. I assumed that primary school learners are so used to continuous assessment that the moment they have to answer a worksheet, they interpret it as assessment. Group 1 mainly used English throughout the group discussions. This behaviour was due to the fact that the teacher (myself) was present. I realised that I would not obtain authentic data if the learners only use the language of instruction. Therefore, I adhered to the advice of the technical staff of the Faculty of Education at the UFS and left the room during the group discussion of Group 2. They made more use of their mother tongue throughout their discussions than did the Group 1 learners.

In general, the learners had a very positive attitude to taking part in the discussions. As mentioned earlier, Learner Two of Group 2 suffers from attention deficit and he behaved differently from the other learners. He could not concentrate on the work at hand and was more interested in the surroundings of the room than in the group work. Learners in both groups tried their best to keep to the prescribed work procedures and to understand the word problems by discussing them in order to construct a number sentence.

4.3.2.2 *Learners' contribution to the group work*

Grade 4 learners are well prepared for group work, as they are exposed to it from Grade 1. During the group work, the learners generally cooperated and tried to give meaningful inputs. It was obvious that they found it easier to communicate in their mother tongue than in the language of instruction.

4.3.2.3 *Reaching meaningful conclusions*

The learners' abilities to reach meaningful conclusions through discussions of the word problems were revealed. The preferred language they used throughout their discussions also emerged.

During the discussion of Word Problem A with Group 1, the teacher did most of the talking, because the learners did not talk to one another; they addressed the teacher instead of having a group discussion. Learner One stated: "We must find out how many cars did Thabo have in the beginning." This showed that she realised that they must break up the problem into smaller parts, but the teacher had to guide the learners' conversation to break up the word problem. The teacher stated: "67 is the biggest number. Is there a smaller number as well? Don't you think that if we take away the small number from the bigger number we shall get another small number?" The learners agreed and then they tried to write a number sentence and carried out the operation. The same work procedure occurred during the discussion

of Word Problem 2 with Group 1. The learners talked in the language of instruction and not in their mother tongue. Therefore, the conversation was not fluent and the teacher took the lead throughout the conversation.

During the discussion of Word Problem A, Learner Four of Group 2 took the lead with the discussions: *Ho thwile sum … Ho thwile number sentence ke number sentence ntho eo?* (We were told to do sums … We were told to do number sentence; is that a number sentence?). She reminded the group that they had to come up with a number sentence in an attempt to answer the word problem. She realised that, by formulating a number sentence, they could arrive at a correct mathematical operation and an answer. I returned to the room and told the whole group to write a number sentence and to stop the discussions. The learners wrote the number sentences and did the mathematical operations on their worksheets. We progressed to read Word Problem B which the group had to discuss again in order to arrive at a number sentence. I left the room at that stage.

During the discussion of Word Problem B, Learner Three of Group 2 mentioned the following:"*Nna ke re oa bona mona ke kgona ho understand Teacher akere mona o itse from the beginning ke tlase mona. Jwale mona teng re tlo e qetella ne neng?"* (You see here I am able to understand, the teacher told us to start here from the beginning. So, when are we going to be able to finish this part?). She realised that it would be easier if they could break up the problem into smaller parts in order to give meaning to each part. They tried to break up the word problem into smaller parts, but did not succeed. I returned to the room while Group 2 learners were still discussing Word Problem B. I asked them if they could arrive at a solution. Some of them answered "yes" and others "no". They could not break the word problem up into smaller parts without the teacher's guidance.

The learners of both groups, with the help of the teacher, recognised that they had to finish one part of the word problem before they could proceed to the next one. This corresponds to the literature in Section 3.2 where Xin *et al.* (2008:165) proposed the use of self-questioning prompts that emphasise the algebraic

expression of mathematical relations in word problem conceptual models, to assist meaningful representation and problem-solving.

Generally speaking*, part plus part equals whole* is a prevalent conceptual model in addition and subtraction word problems in which *part, part* and *whole* are the three basic elements. By contrast, *factor multiply by factor equals product* is a prevalent conceptual model in multiplication and division arithmetic word problems in which *factor, factor* and *product* are the three basic elements. In the *part plus part equals whole* problem types, basic word problem story grammar questions are "Which sentence tells us about the whole or combined quantity?" and "Which sentence tells us about one of the small parts that makes up the whole?". The recorded observation revealed that the learners' ability to recognise the different parts of the word problem in order to arrive at a conclusion, needs to be addressed.

The learners' completed worksheets, on which they had to rewrite the "story" of the word problem in their own words, revealed that they could not make a great deal of meaning of the language of instruction and that they could not recognise words that were technical Mathematics words which could lead them to discover the mathematical operation required. The availability of Sesotho words to match the English words, in order to make meaning of the word problems, was restricted.

The above discussion serves as answer to the second sub-question. The observed Grade 4 learners lacked the skills to assign meaning to the different parts of the word problems because of a language deficiency. Throughout, the data revealed that the learners could not make meaning of the individual parts of the word problem without the teacher's assistance. They could only reformulate and answer the word problems when directly guided by the teacher.

From the answers to the two sub-research questions, I could identify the following themes in order to identify the essence of this case study and to answer the main research question.

- Language use
- Words describing Mathematics operations
- Assessment
- Group work
- The role of the teacher

These five themes gave rise to sub-themes on which each of the twelve learners (research participants) were assessed. Tables 4.5 and 4.6 give an indication of how each learner responded to each sub-theme during the group work.

By referring to the tables, it is evident the learners find it difficult to communicate spontaneously with each other in the presence of the teacher. When the learners see a worksheet, they immediately view it as one or other form of assessment. The majority of the learners are Sesotho speaking. The learners find it easier to discuss the word problems when using their mother tongue. In Group 1, two learners did not take part in the group work. In Group 2, mainly Learner Six did not take part in the group discussions. The learners rely heavily on the teacher's guidance to determine a solution or answer. The teacher has to guide them with questions to help them formulate number sentences for the word problems. In the absence of the teacher, the learners discussed all the possibilities of the problems and their discussions were not restricted by thoughts to please the teacher.

Table 4.5: Group 1 learners' responses to the research themes

LEARNERS	1	2	3	4	5	6
Language						
The learner used English as the language of instruction	x	x	x	x	x	x
Sesotho is the learner's mother tongue	x	x	x	x	x	x
The learner used the mother tongue as a language during the discussion processes				x		x
Mathematical operational words						
The learner can recognise mathematical vocabulary such as "more than"	x		x		x	x
The learner used specific Sesotho words to describe mathematical operations						
The context of the word problem is appropriate for a Grade 4 learner	x	x	x	x	x	x
The learner can cope with the number sizes being used in the word problems	x	x	x	x	x	x
Assessment						
Thoughts of assessment reduce the learner's spontaneity		x	x			
Group work						
The learner can effectively work in a group		x	x	x		
The learner takes part in the discussions		x		x		
The learner makes a sensible contribution to the group discussion		x	x	x	x	
Role of teacher						
The presence of the teacher reduces the spontaneity of the learner	x	x	x	x	x	x
The learner aims to please the teacher in his/her discussion attempts instead of giving his/her real opinion			x		x	

Table 4.6: Group 2 learners' responses to the research themes

LEARNERS	1	2	3	4	5	6
Language						
The learners used English as the language of instruction	x	x	x	x	x	x
Sesotho is the learner's mother tongue	x		x	x	x	
The learner used the mother tongue as a language during the discussion processes	x		x	x	x	x
Mathematical operational words						
The learner can recognise mathematical vocabulary such as "more than"	x			x		
The learner used specific Sesotho words to describe mathematical operations				x		
The context of the word problem is appropriate for a Grade 4 learner	x	x	x	x	x	x
The learner can cope with the number sizes being used in the word problems	x	x	x	x	x	x
Assessment						
Thoughts of assessment reduce the learner's spontaneity			x			
Group work						
The learner can effectively work in a group	x	x				x
The learner takes part in the discussions	x	x	x	x		x
The learner makes a sensible contribution to the group discussion	x		x	x		x
Role of teacher						
The presence of the teacher reduces the spontaneity of the learner						
Learner aims to please the teacher in his/her discussion attempts instead of giving his/her real opinion	x			x		

Although it is difficult to uncover the genuine thought processes of another human being, the analysed data provides information regarding obstacles that prevent learners from successfully translating mathematical word problems into number sentences. These are presented by means of synthesis in the following section.

4.4 SYNTHESIS OF THE RESULTS PERTAINING TO THE MAIN RESEARCH QUESTION

A synthesis of collected data creates the opportunity to combine all the information and to form a new opinion of the answers to the research questions. Hancock and Algozzine (2006:63) state that synthesising information of a case study means combining, integrating and summarising findings. In order to do so, I used the themes, as indicated in Section 4.3.2.3., namely language use, words describing Mathematics operations, assessment, group work, and the role of the teacher.

Language use ⟶

- The language of instruction is English and the mother tongue of the learners is mostly Sesotho. The learners prefer to speak in their mother tongue when they discuss the mathematical operations which they should perform.
- The Sesotho language lacks Sesotho words to describe the basic mathematical operations. Learners then use English versions such as "*plus*", "*minus*", "*devide*" and "*times*".
- The learners talk to the teacher in English and they, therefore, always have to code-switch languages.

Words describing Mathematics operations →

- Grade 4 learners are able to recognise certain mathematical language words, such as "more than", "less than", "several", and "how much". They also know the mathematical implications of the words, but cannot apply these when they have to compile a number sentence. It appears that they cannot make meaning of the language of instruction in order to carry out mathematical operations.
- The learners could easily relate to the context used in both word problems; the value of the chosen numbers was also appropriate because the learners were anticipated to struggle with the language, I chose smaller values.
- Mathematical language is a new concept for the learners, because they do not have mother-tongue words for the mathematical operations. The learners should regularly be exposed to a variety of so-called mathematics vocabulary, such as more than, less than, in between, double, halve, bigger, smaller, how far, how near, a large amount, a small amount, wide, narrow.

Assessment →

- As a result of the present curriculum, learners are so used to assessment that they cannot complete a worksheet without regarding it as completing the worksheet "for marks". Learners are supposed to be critical thinkers, but too much assessment turns them into critical doers.

Group work →	• The majority of the learners can maintain themselves in a group and contribute sensibly to group discussions. They prefer to talk in their mother tongue during group discussions. Grade 4 learners are fairly sociable beings and it is second nature to use their mother tongue when they have to think and re-think certain mathematical operations. The learners could take part in the group work in an orderly manner.
The role of the teacher →	• The learners could function on their own to a certain point. They found it difficult to formulate number sentences for the word problems entirely on their own. They could agree on which operation to carry out, but could not formulate the number sentences. The learners were very willing to learn, but the teacher still had to guide them.

With reference to Chapter 2 paragraph 2.2, it is now evident that more attention must be paid in the classroom to the meaning of words that have a mathematical purpose. The conditions according to Hopkins (2007:123), which are always present when a child starts to talk, namely immersion, demonstration, engagement, expectations, approximations and use, are crucial when a child has to learn mathematical language in a language of instruction that is not his/her mother tongue. When teaching foundation-phase learners, more emphasis should be placed on using words that learners will use in the Mathematics classroom.

I also agree with Setati (2005:448) in paragraph 3.2 that part of learning Mathematics is to acquire fluency in the language of Mathematics which includes words, phrases, symbols, abbreviations and ways of speaking, writing and arguing that are specific to Mathematics.

4.5 SUMMARY

Chapter 4 focused on the research findings. The chapter explained how the research was done as a qualitative case study. The data was collected through observation by the researcher. Grade 4 learners were observed while they were performing word problems in the Mathematics class. The group activities were video recorded. The learners completed a worksheet which served as data source. An in-depth discussion of the results took place and were presented in this chapter.

Chapter 5 will focus on the rationale and conclusions regarding the study. Recommendations will also be made based on the findings of the study.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

In Chapter 4, the data were presented, analysed and discussed in relation to the research questions, namely:

What obstacles prevent learners from successfully translating mathematical word problems into number sentences?

What problems do learners experience with developing mathematical understanding from the language of instruction?

How do learners assign meaning to the various parts of a mathematical word problem?

Four major themes emerged from an analysis of the data, namely:

- participants' use of language during group sessions in the Mathematics class;
- the use of mathematical operational words when dealing with word problems;
- assigning meaning to the various parts of a word problem, and
- the role of the teacher during group work when dealing with word problems.

This chapter will highlight the main research findings and the recommendations based on the findings, as well as provide a short synthesis of the study. In view of the findings, recommendations will be made to a particular audience as well as recommendations for further research resulting from the findings.

5.2 RESEARCH FINDINGS

The following findings were made from data which were obtained by video recording the Grade 4 learners during group work.

5.2.1 The use of language during the group work sessions

The learners who participated in this study were mainly Sesotho speaking. Their language of instruction was English. They committed themselves to taking part in two group work sessions during which they had to discuss and construct number sentences to two word problems. The main language issues that arose during the group sessions were the language that the learners used during the group sessions; the use of language when constructing number sentences, and the developing of mathematical understanding. These issues will now be addressed individually.

5.2.1.1 *Learners' language use when dealing with word problems*

The learners were divided into two groups, as discussed in Section 3.5. The two groups reacted differently with respect to the use of language during the group work sessions. The recorded video revealed that Group 1 used mainly the language of instruction, which is English, when they discussed the two word problems. The presence of the teacher inhibited the spontaneous participation of the Group 1 learners. The learners did not feel free to use their mother tongue, because they believed that they had to accommodate the teacher and operate in the same manner as they normally do in the classroom. Under normal school circumstances, they are not allowed to talk in their mother tongue during class time. Group 2 reacted differently, because the teacher left the observation room before they started the discussions. The Group 2 learners mainly used Sesotho during their discussions. They dealt better with the word problems and their discussions provided more usable data to study than the discussions of Group 1.

This data revealed that learners prefer to discuss word sums in their mother tongue and can deal more efficiently with the word problems at hand when they speak in their mother tongue.

5.2.1.2 *The use of language when dealing with number sentences*

As part of the work, the two groups had to rewrite the number sentences of the two word problems in their own words on the worksheets provided. This rewriting implied the usage of the same information, but written in their own words. The Grade 4 learners were not able to rewrite the word problems. They could not use the information from the word problems and write it in their own words in order to show a better understanding of what they read. It seemed that the learners could not find other English words to simplify the word problems.

The learners' worksheets revealed that they apparently could not assign meaning to the language used in the word problems. It seemed that they read without comprehension. An understanding of the language used in word problems is crucial and will lead to understanding what mathematical operations must be carried out in order to determine an answer. If the learner understands the language used in the word problem, s/he can assign true mathematical meaning to the different parts of the word problem.

The learners' language of instruction is English as from Grade 1. They use their mother tongue for talking and listening, but not for reading and writing. I am inclined to think that a language that is not the learners' mother tongue prevents ideas from flowing from the child's mind. The child is mainly trying to remember how to write the words, and there is no time to give meaning to the words or to find other words to describe the situation more simply.

5.2.1.3 *Developing mathematical understanding*

The Group 2 learners mainly used Sesotho throughout their discussions. They argued in Sesotho while trying to give mathematical meaning to the written word problems. The recorded data revealed that the learners tried to translate the word problems into Sesotho in order to understand them better. However, it was obvious that there were no correct mathematical words in Sesotho to translate English words

that describe mathematical operations. The learners did not use Sesotho words for the mathematical operations, but used the English words as adopted in the Sesotho language.

5.2.2 The use of mathematical operational words when dealing with word problems

Grade 4 learners could concentrate while reading the word problems and could understand that they had to discuss what they read. However, the way in which they discussed the word problems indicated that they could not make a great deal of sense of what mathematical operations were required in order to solve the problem. The learners showed a lack of knowledge with respect to mathematical vocabulary.

5.2.2.1 *Mathematical operational words*

The majority of the Group 2 learners could argue about the implications of the words in the context of the word problems. They could form an idea that they had to carry out mathematical operations, but the words that had to lead them to determining the correct operation, confused them. Talking about the word problem in Sesotho could not provide them with the correct words to give mathematical meaning to the English words in the word problem.

5.2.2.2 *Mathematical vocabulary*

Certain English words can be defined as mathematical vocabulary: many, not many, more than, less than, big, small, bigger, smaller, long, short, longer, shorter, high, low, near, far, how long, how short, how near, how far, buying, selling, cost, price, profit, expensive, clear, cheap, wide, narrow, several, quick, slow, a long time, a short time, a large amount, a small amount, light, heavy, straight, curved, the whole, a part of, a fraction of, a half of, double, in the middle, between, last, second from last, first, second, third, and so on. The observation revealed that learners could relate to the context of the word problems, but could not find words in their

mother tongue to translate the English words. The content and context of the word problems were not too difficult for the learners and they could understand the purpose of the word problem; however, they found it difficult both to understand and to interpret the specific mathematical vocabulary and to decide what mathematical operations they had to carry out, because they could not find Sesotho words to translate the entire word problem.

5.2.3 Assigning meaning to the various parts of the word problem

At the beginning of each session with the learners, the teacher read out the instructions on the worksheet and the word problem. The learners could adhere to the instructions and work procedures on the worksheet. The learners' contribution to the group work revealed their ability to regard the word problems as a complex entity that had to be broken up into smaller parts. The learners also misconceived the worksheet as being a kind of assessment. They were, however, positive in participating in the group work and cooperated when asked to carry out the instructions on the worksheets.

5.2.3.1 *Learners' contribution to the group work*

As mentioned in Section 5.2.1, the learners were divided into two groups and each group did the same worksheets. During the session of Group 1, the teacher was present in the observation room; however, on the advice of technical staff, she left the room during the discussion session of Group 2. The Group 1 learners did not interact as spontaneously as those in Group 2. According to Table 4.5, learners Two, Three, Four and Five in Group 1 were active throughout the discussions. Table 4.6 shows that learners One, Three, Four and Six in Group 2 participated. Some learners did not make a sensible contribution to the discussions and commented on the surroundings and the environment instead of discussing the word problem. The data shows that Learner Two in Group 2 suffered from attention deficit and did not give any positive input during the discussions of the word problems.

In their attempts to rewrite the word problem in their own words, the learners clearly could not break up the sentences of the word problems into smaller shortened sentences in order to assign better meaning to the different parts of the problem. The learners could not separate the part of the word problem that gave the information they needed to identify the form of operation they had to carry out, from the part of the word problem that seeks the answer.

The Group 2 learners could argue more actively about what kind of operations they had to carry out, because they talked mainly Sesotho. However, they could not succeed in breaking up the word problem into easier parts and there was a lack of leadership in the group, as they nearly fought with one another at a certain stage of the discussions.

5.2.3.2 *Assessment*

Table 4.5 shows that Learners Two and Three of Group 1 thought the worksheet was for assessment purposes and Table 4.6 indicates that Learner Three of Group 2 thought that she had to answer the questions for assessment. The Grade 4 learners are overexposed to assessment because of the OBE approach followed in schools. They experience any form of questioning as a form of assessment. Such experience can also elicit a fear of failure and, therefore, restrict their spontaneous participation in the discussions of the word problems. Their fear of assessment can also contribute towards learners developing a fear of Mathematics. The teacher assured the learners that the worksheet and group work were not for assessment, but for research purposes.

5.2.4 The role of the teacher

The presence of the teacher had positive and negative effects on the outcome of the group work sessions. Her presence influenced the leadership dynamics of the groups, as well as the learners' usage of language and attitude.

5.2.4.1 *Leadership in the groups*

The teacher was present in the observation room when Group 1 was doing the group work. The teacher played the role of leader. The learners spoke mainly English and depended on the teacher to give them clues as to how to break the word problem up into smaller parts. The teacher also had to lead them to discover the appropriate mathematical operations for each of the word problems.

The teacher left the room during the discussions of Group 2 and, at first, the learners coped without the presence of the teacher. Learner Four took on the role of leader; however, she withdrew as the discussions progressed. The recorded data show that the group nearly fought verbally about the participation of the members and did not discuss the word problems at all at that stage. When the teacher returned to the classroom, she took over the leadership, enabling the learners to focus on the word problems.

5.2.4.2 *Language usage*

The teacher cannot speak the learners' mother tongue. The learners of Group 1 spoke mostly English, even though the teacher told them that they could use any language. I believe that they wanted to accommodate me, the teacher, in their discussions, that they were shy to talk in a language different from their language of instruction, and that they wanted to impress me by speaking English.

5.2.4.3 *The learners' attitude towards the teacher*

The learners of Group 1 could not work independently from the teacher. They constantly wanted to confirm with the teacher as to whether what they did was correct. It appeared that they wanted to please me instead of giving their own opinion. The learners of Group 2 had a very different attitude towards the teacher. I assumed that they felt empowered by using their mother tongue when I was out of the room. They neither sought confirmation from me nor wanted to please me with

their arguments. However, they could not reach a conclusion to carry out the needed Mathematics operations and I, the teacher, had to lead them to do so.

5.3 SYNTHESIS

This case study focussed on Grade 4 learners whose language of instruction differs from their mother tongue. During the observation, the learners immediately switched over to their mother tongue as soon as they were left alone to discuss the word problems. This shows that they feel more comfortable using Sesotho rather than English to discuss problems. It became clear to me that learners prefer to use their mother tongue to make meaning of word problems. They find it difficult to construct mathematical understanding from English, the language of instruction. It was also obvious from the worksheet, on which the learners had to rewrite the "story" of the word sum into their own words, that they lack correct English language to do so.

The results of the study provide the following information regarding the four themes that emerged from the data analysis:

- Grade 4 learners prefer to speak in their mother tongue when they have to discuss mathematical word problems during group work sessions.
- There are no Sesotho words describing mathematical operations. The learners use the English words adopted by the Sesotho language.
- Grade 4 learners are able to discuss word problems within a group, but find it difficult to compile a number sentence in order to arrive at a conclusion.
- The teacher plays an important role in the Grade 4 learners' final attempt to compile a number sentence for the word problem as well as breaking up the word problem into smaller parts so that they can make better meaning of the problem.

5.4 GENERAL RECOMMENDATIONS

I agree with Schleppegrell's (2007:156) point of view that teachers can become aware of the linguistic issues in learning and teaching Mathematics and develop tools for talking about language in ways that enable them to engage productively with learners in constructing mathematical knowledge. Teachers in culturally diverse school settings need to develop "tools" to enable learners to understand the mathematical vocabulary better via the language of instruction. The following recommendations regarding these tools can be made. Teachers from the foundation phase of learning must compile a Mathematics dictionary as part of their literature studies. These teachers must consult with language interpreters in order to find mother-tongue words for words that explain mathematical concepts. They must make a list of these words and repeat them regularly throughout their contact time with the learners, even if it is not the Mathematics period.

Learners must also do group work more regularly and be allowed to use their mother tongue during group work discussions. By building a better understanding of a mathematical vocabulary, as discussed in Section 5.2.2.2, the majority of learners will conquer their fear of failing Mathematics.

5.5 RECOMMENDATIONS FOR FURTHER RESEARCH

Further research on this main issue of the contradiction between mother tongue and the language of instruction, specifically in the Mathematics class, can be done on the principles of the theatre of the oppressed. Mathematics could be incorporated into drama in order to expand on teaching strategies and investigate how drama can contribute towards better Mathematics teaching methods. Frances (2010:229) stated that through the use of Forum Theatre, a modality of Boal's Theatre of the Oppressed, it came to light that through the power of drama the youth have the opportunity for collective problem solving. He also declared that drama as a process allows participants opportunities to dialogue, share ideas and learn from one another. A similar set up was created by the interactive group work that the

participants in this study were engaged in. In the context of this study, drama can be used in further research to improve mathematical language understanding by using narratives which embed the mathematical concepts in the context of the learners' real life situations.

5.6 CONCLUSION

Setati (2005:464) theorises that, in order to be successful as a Mathematics teacher in the multilingual classroom, it is important that the learners' mother tongue be used as legitimate language of instruction in a range of mathematical instructions.

This viewpoint summarises the content of this chapter. The rationale of the study states that, if the language of instruction is not the same as the mother tongue of the learners, the latter will experience problems in the Mathematics class where they have to translate words in the language of instruction into their mother tongue in order to make meaning of word problems. The conclusion to the main research question is, therefore, that the main obstacle that prevents learners from successfully translating mathematical word problems into number sentences is an insufficient knowledge of, and understanding in the language of instruction.

REFERENCES

Abedi, J. & Lord, C. 2001. The language factor in Mathematics test. *Applied Measurement in Education* 14(3):219-234.

Adams, T.L. 2007. Reading Mathematics: An introduction. *Reading and Writing Quarterly* 23(2):117-119.

Adams, T.L. & Lowery, R.M. 2007. An analysis of children's strategies for reading mathematics. *Reading and Writing Quarterly* 23(2):161-177.

Au, K.H. 1998. Social constructivism and the school literacy learning of students of diverse backgrounds. *Journal of Literacy Research* 30(2):297-319.

Berenson, S.B. & Vidakovic, D. 1996. Children's word meanings and the development of division concepts. In Puig, L. & Gutierrez, A. (Eds), *Proceedings of the 20th conference of the International Group for the Psychology of Mathematics Education,* Valencia, Spain: University of Valencia.

Bernardo, A.B. 2002. Language and mathematical problem solving among bilinguals. *Journal of Psychology* 136(3):283-297.

Bernardo, A.B. & Calleja, M.O. 2007. The effects of stating problems in bilingual students' first and second languages on solving mathematical word problems. *The Journal of Genetic Psychology* 166(1):117-128.

Chapel, M.F. & Thompson, D.R. 2007 Communication and representation as elements in mathematical literacy. *Reading and Writing Quarterly* 23(2)179-196.

Charles, R. 2005. *Writing to learn Mathematics: Strategies that work.* Glenview: Pearson Education, Inc.

Cuevas, G. 1983. Language proficiency and the development of mathematics concepts in Hispanic primary school students. In Escobedo, T.H. (Ed), *Early childhood bilingual education: A Hispanic perspective.* New York: Teachers College Press.

Crafford, G. & Maree, J.G. 2005. 'n Ondersoek na fasette van leerders in 'n privaat skool se studieoriëntasie en die verband daarvan met wiskundeprestasie. *Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie* 24(3):84-92.

Davis-Dorsy, J., Ross, S.M. & Morrison, G. 1991. The role of rewording and context personalization in the solving of mathematical word problems. *Journal of Educational Psychology* 83(1):61-68.

De Corte, E. & Verschaffel, L. 1991. Some factors influencing the solution of addition and subtraction word problems. In Durkin, K. & Shire, B. (Eds), *Language in mathematics education: Research and practice.* Milton Keynes: Open University Press.

De Corte, E., Verschaffel, L. & De Win, L. 1985. Influence of rewording verbal problems on children's problem representations and solutions. *Journal of Educational Psychology* 77(4):460-470.

Ellis, S.M., Maree, J.G. & Van der Walt, M.S. 2006. 'n Ondersoek na metakognisie in wiskundeleer in die senior fase. *Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie* 25(3):177-193.

Fasi, U. 1999. *Bilingualism and learning mathematics in English as a second language in Tonga.* Unpublished Ph.D. thesis. London: Reading University.

Fitzgerald, J. 1995. English-as-a-second-language reading instruction in the United States: A research review. *Journal of Reading Behaviour* 27(2):115-152.

Francis, D.A. 2010. 'Sex is not something we talk about, it's something we do': Using drama to engage youth in sexuality, relationship and HIV education. *Critical Arts* 24(2):228-244.

Flemming M., Merrell C. And Tymms P. 2010. The impact of drama on pupils' language, mathematics, and attitude in two primary schools. *Research in Drama Education* 9(2):177-182.

Gardill M.C. & Jitendra A.K. 1999. Advanced story map instruction: Effects on the reading comprehension of students with learning disabilities. *Journal of Special Education.*33(1)2-17.

Grant, M. (1978). *School methods with younger children.* 4th ed. Edinburgh: T. and A. Constable Ltd.

Gurney D., Gersten R., Dimino J. & Carnine D. (2001)Story grammar: Effective literature instruction for high school students with learning disabilities. *Journal of Learning Disabilities,* 23(3)335-348.

Halliday, M. 1974. Some aspects of sociolinguistics. In UNESCO, *Interactions between linguistics and the mathematical education.* Paris: UNESCO.

Hancock, D.R. & Algozzine, B. 2006. *Doing case study research.* London: Teachers College Press.

Hardbord, J. 1992. The use of mother tongue in the classroom. *Language Teaching Journal* 46(4):350-355.

Herbert, R.K. & Bailey, R. 2002. The Bantu languages: Sociohistorical perspectives. In Rajend, M. (Ed.), *Language in South Africa.* Cambridge: Cambridge University Press.

Hopkins, M.H. 2007. Adapting a model for literacy learning to the learning of Mathematics. *Reading and Writing Quarterly* 23(2):121-138.

Hodgskiss Jr., E. (ed). 1997. *A case study: tracing the development of emergent literacy in a Grade R class.* Master's thesis. Grahamstown: Rhodes University.

Jordan N.C., Kaplan D., & Hanrich L.B. 2002. Achievement growth in children with learning difficulties in mathematics: Findings of a two-year longitudinal study. *Journal of Education Phsychology,* 94(4):586-598.

Kelly, K. 2006. Calling it a day: Reaching conclusions in qualitative research. In Terreblanche, M., Durrheim, K. & Painter, D. (Eds), *Research in practice.* Cape Town: UCT Press.

Khisty, L.L. 1995. Making inequality: Issues of language and meanings in mathematics teaching with Hispanic students. In Walter, G.S., Fennema, E. & Adajian, L.B. (Eds), *New directions for equity in mathematics education.* Cambridge: Cambridge University Press.

Leedy, P.D. & Ormrod, J.E. 2005 *Practical research planning and design*. 8th ed. Hull, New Jersey: Prentice-Hall.

MacGregor, M. 1990. Reading and writing in mathematics. In Bickmore-Brand, J. (Ed), *Language in mathematics.* Portsmouth: Heinemann.

MacGregor, M. & Price, E. 1999. An exploration of aspects of language proficiency and algebra learning. *Journal for Research in Mathematics Education* 30(4):449-467.

Mercer, M. & Sams, C. 2006. Teaching children how to use language to solve maths problems. *Language and Education* 20(6):507-528.

Merriam, S.B. 1998. *Qualitative research and case study applications in education.* 2nd ed. San Fransisco: Jossey-Bass.

Maree, K. 2007. *First steps in Research.* Pretoria: Van Schaik Publishers.

Mestre, J.P. 1988. The role of language comprehension in mathematics and problem solving. In Cocking, R.R. & Mestre, J.P. (Eds), *Linguistic and cultural influences on learning mathematics.* Hillsdale,Virginia: Lawrence Erlbaum.

Murray, H. 2003. Word problems: A problem! *Pythagoras* 58(1)39-41.

Norton, D.E. 1991. *Through the eyes of a child: An introduction to children's literature.* 3rd ed. New York: Macmillan.

O'Donoghue, J. & Riordain, M.N. 2009. The relationship between performance on mathematical word problems and language proficiency for students learning through the medium of Irish. *Educ stud Math* 71(1):43-64.

Orton, A. & Frobisher, L. 1996. *Insights into teaching Mathematics.* London: Cassell.

Pape S.J. 2004. Middle school children's problem-solving behavior: A cognitive analysis from a reading comprehension perspective. *Journal for Research in Mathematics Education,* 35(2):187-219.

Pimm, D. 1987. *Speaking mathematically: Communication in mathematics classrooms.* London: Routledge & Kegan Paul.

Radhika, V. & Kala, M.S. 2012. Interference of mother tongue in learning a foreign tongue. *International Researcher* 1(3):99-105.

Salma, A. & Rodrigues, J.S. 2012. Language and Mathematical problem solving among bilinguals. *Journal of Psychology* 29(6):3-35.

Schleppegrell, M.J. 2007. The linguistic challenges of mathematical teaching and learning. *Reading and Writing Quarterly* 23(2)139-159.

Sedibe G.K. 2003 A comparison of isiXhosa-speaking learners' responses to word problems given in English and isiXhosa. M Ed. University of Stellenbosch, Stellenbosch

Setati, M. 2005. Teaching mathematics in a primary multilingual classroom. *Journal for Research in Mathematics Education* 36(5):447-466.

Silver, E.A., Saphiro, L.J. & Adam, D. 1993. Sense making and the solution of division problems involving remainders: An examination of middle school students' solution processes and their interpretations of solutions. *Journal for Research in Mathematics Education* 24(2):117-135.

Silver E.A. & Marshall S.P. 1990. Findings, issues and instructional implications. In Jones B.F. & Idol L. (Eds) *Dimensions of thinking and cognitive instruction.*(265-290). Hillsdale, NJ: Lawrence Erlbaum.

Silverman, D. 2011. *Qualitative Research.* 3 ed. London: SAGE Publications Ltd

Taber, K.S. 2007. *Classroom-based research and evidence-based practise.* London: Sage.

Thomas, W.P. & Collier, V.P. 1998. Two languages are better than one. *Educational Leadership* 12/97-1/98:23-26.

Vilenius-Tuohimaa, P.M., Aunola, K. & Nurmi, J. 2007. The association between mathematical word problems and reading comprehension. *Educational Psychology* 28(4):409-426.

Whang, W. 1996. The influence of English-Korean bilingualism in solving mathematics word problems. *Educational Studies in Mathematics* 30(3):289-312.

Xin, Y.P., Wiles, B. & Lin, Y. 2008 Teaching conceptual model-based word problem story grammar to enhance mathematical problem solving. *The Journal of Special Education* 42(3):163-178.

APPENDIX 1

Translation Group 1

Group 1

Teacher: We are going to start now and first of all Kananelo this is not for marks. Nothing you do here Atlehang is for marks. So don't be nervous, don't be, think or what or what is going to happen with me. Nothing is going to happen. We just need your cooperation. We just need your talkativeness; the thing that you can do very well. Right so you are group one and I am going to give you each a…

Child 2: Another test paper?

Teacher: Like an assessment yes. But this is not for marks Atlehang. It is not a test paper, it's group work and it's really not for marks.

Child 4: This thing of yours, this paper…

Teacher: Ok Mpho. Right now pay attention you will see there it's written group 1 instructions. Right, the first thing there what must we do? Draw a circle around the number you are representing. Right, do that. You know your number in front of your table there is a number. Just draw a circle around that number. Good. Right, now number two, read the word problem, write the word problem over in your own words on the lines provided. Number four in your groups discuss the word problem. Write the number sentences after the discussion and do the sums on the lines provided. So number one we have done. Now we are going to go to number two. You are going to read the word problem and here is word problem A. I gave you two word problems you will see it's word problem A. We will finish all the instruction on word problem A. And then we will turn the page and go to word problem B and do the same story again. Right, Ok, so we are now instruction number two. Read the word problem but you are going to read it soft. I am going to give you two minutes. Right, read it soft and then and you will see there is lines provided where it is

written in your own words. You rewrite the story quickly into your own words. It does not matter spelling, whatever, I want to see what you can understand from this story, right Letshego. Ok start, start to read.

Child 3: Can I write cursively?

Teacher: You can write cursive, print, anyway you like. So you are writing over in what you understand of that story. Just quickly, just short words. Palesa I see now you are counting. You do not count anything. You write the story. You write in English. You are going to write a story. You don't do any calculations now. You just write down the story in your own words.
Are you nearly done?
Right, stop now; if you are not finished don't worry. Just stop there where you are. Now it's the instruction number four. In your group discuss the word problem. Now it's the time you are going to talk. Now think about the story you wrote there or if you are not finished, the things you want to write there. Let us all again read this together.

Everyone reads the story

Right now you can talk about the story. Who can start? Matshego you start first; tell everybody what do you think is happening here.
Child 3: Thabo had several toy cars and his brother Andy gave him 28 more.

Teacher: Right, he had several toy cars and his brother gave him 28 more. Right, now we must go to an answer. Now what is happening here? How do you think, where did he get that toy cars. He had it but he did not tell us where he got it from. He had that amount. Now what do you want to say Atlehang?

Child 2: A boy name Thabo had several toy cars then his brother Andy gave him 28 more toy cars now Thabo has 67 toy cars.

Teacher: And what do we want to know?

Child 2: Then we should discuss it.

Teacher: Ok, you can discuss it now. To tell them what you want to say, I think, don't think of me now, tell each other what kind of sum do you think what happened here, why, how they, we want to know how many cars did he, what exactly do we want to here? We want to know how many cars Thabo had in the beginning. Right they say there he had several toy cars, they did not tell us how much, just several, his brother Andy gave him. On a certain day he had this amount of toy cars then his brother Andy gave him a certain amount. Now he has 67 but we want to know how much did he start with? Right, talk to one another about it and tell one another what you think. Begin to talk you can talk in any language, talk Sotho, yes tell them what is happening here Atlehang?

Child 1: Nna ke nahana hore o ne a na le tse 47. (In my opinion I think he had 47).

Teacher: Don't come to an answer but what kind of sum you think we must do? Talk to one another.

Child 5: I think minus, like 67 minus 28 and then we will get the answer.

Teacher: Why do you think that Palesa?

Child 5: Because mam it's right to say 28 plus, because we will struggle to get the answer…

Teacher: You'll struggle to get the answer but how do you, what made you decide to do a minus sum? Come Atlehang tell us your story.
Kananelo come?
Yes Dudu.

Child 1: Mam, me I think if we do the minus we will get the answer

Teacher: You do the minus you will get the answer. Ok. But what tells you that you must minus?

Child 3: Because it's going to be hard when plus the cars with the number of toys Thabo that had
Teacher: Ok.

Child 1: We find out how many cars did Thabo have at the beginning.

Teacher: So if we leave out that thing, do you agree if we say we have a big answer ne? What is our biggest answer there? What is the biggest number?

Group: 67

Teacher: 67 that is how much he had now. It's the biggest number. Now do we have a small amount there?

Group: Yes.

Teacher: What is it?

Group: 28.

Teacher: Ok 28. Now if we take the big amount and we take away the small amount. Will we get another small amount?

Group: Yes.

Teacher: Yes? Who says yes? And who says no?

Right, so, now please discuss this thing in Sotho you can use your mother tongue. Ok. Then you must go to 4.1. Always for a word sum you must have a number sentence. And after the number sentence you do the sums. You have two minutes to do that. Do not think that I am here, just now, talk and say what you are going to do.
Matshego now tell them what you are going to do?

Child 3: I am going to write that, I am going to write 67 minus 28 is equals to how much

Teacher: Ok, and you Kananelo?

Child 6: The same mam.

Teacher: Ok, you start.
Right if you are finished with number sentence you can do the sums.
It does not matter. Remember this is not for marks. I am actual very not interested in your answers I want to see the method.

Child 5: Mam can we say that…

Teacher: Yes.
In the sums there underline.
Ok, turn to page 2 those who are finished. Now children this is the same story but you know what you talk too much not too less. Here there is nobody it's just me and you. And you know each other too well plus you know me. So now I am going to leave you I am going to stand there on the other side. Then you do this the 6 of you together. Ok Palesa finish so that you can also do this. So you are going to read here and then you do the whole process. You must tell each other why you decided to do this and this and this. Right you understand?

Group: Yes mam.

Teacher: Mpho you also must give some inserts. Right. Word problem B right you start.
Don't think of an answer now. Don't think of a method. Just write the story over and when you are finish with that then you go to the method.
Right let us quickly read it together and then relax. Relax I see that you are a bit nervous because you know about the answer and this answers are bothering you. This is a bit more difficult than the previous one. Let us read.

Everybody reads

Now you must discuss who has money right? How many persons are there that have money?

Group: 3

Teacher: Ok, do it like that. Start from the beginning and see how many persons have money. Then what is the actually thing we want to know. Ok, start to tell one another. Start to talk to one another. You can use any language you want to. Don't tell me but tell your friends.

Child 5: Boitumelo has 20 rands in her pockets and her brother who has 10 rands in his. Her father has 50 rands more than Boitumelo. How much money does her father have more than her brother?

Teacher: What are you saying Palesa?

Child 5: Mam I did not add the sum…

Teacher: Do you want to speak Sotho will it be better?

Child 5: What should we do here? Should we minus, divide, times or…

Child 3: Plus

Child 4: Why do you think so?

Child 3: Because their father had 50 rands more than they had.

Child 2: I think it's a minus

Child 3: Why should we minus?

Child 2: Oh…

Child 4: When we plus or minus which one is the better way?

Child 2: I think we should plus.

Child 4: Are you sure?

Child 3: Yes.

Child 5: Before we rush into this can we talk about Nkosi?

Child 2: You won't understand you have too many questions

Child 6: Ke bua Sesotho. (I am going to speak Sesotho)

Child 5: Maybe they want to plus, 2 plus, maybe they want to say 50 plus 20 plus 10.

Child 3: Why don't we say 20 plus 10 minus 50?

Child 4: 20 plus 10 minus 50? No we can't.

Child 5: Let's start with a big number.

Child 2: 50 minus 20 plus 10.

Child 4: Do we all agree?

Child 2: I think we should read this story again.

Teacher: I think you should listen to what Atlehang is just saying now. Tell them again Atlehang.

Child 2: I think we should read the story all over again because we don't understand.

Teacher: You read the story all over again because you do not understand. Now don't you think if we read it and somebody, one of you translates it into Sotho you will understand it better?

Group: Yes mam.

Teacher: Ok let us read it again.

Everybody reads the story

Child 4: Boitumelo o na le diranta tse mashome a mabedi. Abuti wa hae o na le diranta tse leshome fela. Mme ntate wa bona o na le diranta tse mashome a mahlano. (Boitumelo has 20 rands. Her brother had 10 rands. And their father had 50 rands).

Child 2: O na le tjhelete e kae ho feta ya Boitumelo? (How much extra money do they have more than Boitumelo's?)

Child 4: Ya Boitumelo. (Of Boitumelo)

Child 5: Re tshwanetse re minuse. (We have to do subtraction)

Group: Aa. Kapa divide (Or maybe divide)

Child 3: Ke boss plus plus (We add, it's additions)

Group: Everyone giggles

Child 5: Ke times wena. (It's multiplication)

Child 3: Oh, 20, no, 15 times 20 for to be 100

Teacher: What is more than? More than means plus. Ok let us read the first sentence.
Boitumelo is a girl and she has 20 rands and her brother has 10 rands right. But I was wrong Boitumelo does not have 20 rands but she has 20 rands more than her brother has right. If you think of Sotho you think like that?

Group: Yes teacher.

Teacher: Who said that in Sotho?

Child 2: Mpho mam.

Teacher: Ok Mpho what did you say at that time?

Child 2: That Boitumelo has 20 rands more money than her brother.

Teacher: Very nice she has more money than her brother. How much more?

Child 3: I think she has more…

Teacher: How much more does she have?

Group: 20 rands.

Teacher: How much does the brother have?

Group: 10 rands.

Teacher: Now how can we know how much money Boitumelo has?

Child 2: We must do 20 plus 10.

Teacher: Then we know how much Boitumelo has. Right. Now that is not the end of the story. The story goes on. Her father has 50 rands more than Boitumelo. Now how much does the father have? First we have to know the answer of Boitumelo's. Then we can go to the answer of the Father. Now see if you can find the number sentences. How many number sentences do you think we will have there?

Child 3: I think 3.

Teacher: You can talk while writing the number sentences. You can talk to one another this is group work. You can one another what you think.

Child 3: 20 rands plus 10 rands.

Child 6: plus 50.

Child 3: Plus 50?

Child 6: Aa. Ke a botsa. (No, I'm just asking)

Child 4: Re kopantshang ya Boitumelo pele aker? (We are doing Boitumelo's sum first right?)

Child 3: 20 rands plus 10is thirty rands plus 50 it's 80.

Child 4: So?

Child 3: Ya Boitumelo it's 80 rands.

Teacher: No it's not 80

Child 2: So Boitumelo has 30 rands.

Teacher: How are you going to write down the number sentences?

Child 3: We are going to say 20 rands plus 10 rands is equals to 30 rands

Child 5: We must add the 50.

Child 3: 20 rands plus 10 rands plus 50 is equals to 80. Or is it easy like this 30 plus 50?

Teacher: Mm. But first you must write a number sentence for the first part of Boitumelo. And then a number sentence for the second part of the father. And if you don't have the number sentence you quickly write down the sum.
You are done?

Child 3: Yes mam.

Teacher: Before you do that are you finished with the sum?

Child 1: Yes mam.

Teacher: Ok close your things. Thanks children just leave your papers on the table. Now we are done. Was it that difficult?

Group: No.

Teacher: Just leave it here and I will collect it. You can take your space cases. The other group is coming.

APPENDIX 2

Translation Group 2

Teacher: Right you will see that on top it is written group 2 right.

Child 2: Do we help each other?

Teacher: You will get time for that. Right, it's group work, group 2.
Now let's start to read, you will see on top it is written instructions. Right this instruction will tell you what to expect from this paper. What you must do. Right number one let us read together.

Everyone reads the story

Right, there is the numbers do some. Ok, then the next one is? Read the word problem. Before we go on you will see there, there is word problem A and on the other side of your sheet is word problem B. First of all you are going to read that word problem. Then number 3 tells you write the word problem over in your own words on the lines provided. You can use your own words any words, any language you would like to use. To rewrite that but like a story you don't go for answers, you don't calculate anything. You just rewrite I want to see if you understand everything you read there. Ok, then number four that is what Lerato asked me now; in your group discuss the word problem. There you are going to talk right? And on this page I am going to go outside. I am going to leave you. You are going to talk here in your group about this story about this word problem. And then 4.1 write a number sentence after the discussion. And 4.2 do the sums right on the lines provided. So first you write down the story in your own words. Then after you discuss it you write down the number sentences. And then you do the sums. But you must discuss it. And when you discuss it 'Hloni' you know you like to talk. You can use any language to try to convince each other what kind of sum you think it is. And how we must come to the answer of it Ofentse. You think you will be able to do it ne?

Group: Yes.

Teacher: Right, now let us read soft, you are first going to read soft and then you write it over in your own words.
Are you finished reading?

Group: Yes

Teacher: Quickly write down the story in your own words. Don't think of an answer. Just rewrite the story in your own words. You have one minute for that you must hurry up.
Listen children you must not write a new story but you write about what you read here. About Thabo, we want to know about Thabo's things. Leave it, leave it if you have done something else leave it. I give you only 30 seconds and then I go out. And then you are going to discuss this. So if you finish there where you are you just stop.

Child 3: Must we write down the question?

Teacher: Ok, ok, stop. Let us read. Before we go on I forgot to tell you that this is not for marks. You can see there is no marks allocation on there. So don't be nervous and start to think that this will influence you maths marks or anything. Let us start to read.

Everybody begins to read

Things you must discuss is what is the right thing we want to know? Who has toy cars? Who give him more toy cars? How much do we have now? How much do we have in the beginning? That is the thing. I am going to go out now and you are going to discuss it. Use any language you'd like to right. All of you must say something and also you Ntando. And then you compile a number sentence. And then you do the sums. Hloni huh?

Child 2: Yes mam.

Teacher: Now I am leaving and you are on your own. No one is going to harm you, you don't have to fear nothing will happen to you. Please talk I told you it's time to talk now alright. See you in four or five minutes.

Child 2: Teacher what is there that is lighting?

Teacher: It's the light mirrors alright but don't look at that go on with your sum. And if you say something please speak loud.

Child 2: we want to highlight there mam…

Teacher: Ok start.

Child 4: Nna ke a tseba... (I know…)

Child 2: O tlameile o bue language ya hao… (You have to speak your own language)

Child 4: Sesotho

Child 2: Setswana wena (Hey you Setswana)

Child 3: Hayi Sesotho (No Sesotho)

Child 1: Nna ke re oa bona mona ke kgona ho understand Teacher akere mona o itse from the beginning ke tlase mona. Jwale mona teng re tlo e qetella ne neng? (You see here I am able to understand, the teacher told us to start here from the beginning. So when are we going to be able to finish this part?)

Child 4: E qeteng ka speed. (Do it quickly then)

Child 1: He wena ha ho ntse ho rutwa bona ho na le dintho tsane tse mane ke tsona tsane tse... (Hey do you see those things over are the same ones that…)

Child 4: He wena ntate yane yena ka di computing ka mane di tjena fela ntho tseo tsa hae, ha ho na di ipone ka moo… (You see that guy in there, with the computers on the other side, there are so many of those things in there and there are no mirrors in there.)

Child 2: Oa bona dintho tseo dingotswe… (You see those things over there are written…)

Child 1: Hayi wena tlohela dintho tseno. (No, leave those thing.)

Child 3: Ha re a tlela dintho tseno mona. (We did not come here for those things)

Child 4: Ok a re yeng guys. (Come on let's work guys)

Child 1: (looks at Child 2) Do you have a question?

Child 4: Hayi ke wena number 1. (No you are number 1 you should start)

Child 1: Ke buile. (I spoke already) Akere Thato o ne o ntse o re ha o understand eng? (Thato what is it you said you did not understand?)

Child 2: A re bue Sesotho jwale? (Aren't we speaking Sesotho now?)

Child 3: He tau bua tau… (Dude speak)

Child 1: Nna ke qetile (No, I am done)

Child 4: Nna ne ke nahana hore akere ere… (but I think it says…)

Child 2: Ho na le moshemanyana… (There's this boy…)

Child 4: Sh! Thabo o ne a na le le di toy tse 28 in the beginning… (Sh! Thabo had about 28 toys in the beginning…)

Group: Hee ee. (No!)

Child 6: Ba mo file tse 28 (They gave him about 28)

Child 2: A be a di kopanya… (And he combined them together)

Child 1: Nna ke a kgona, o ho ho tjhong Thabo o ne a na le dintho tse 30 (Ok, I see, this means that maybe Thabo had about 30 things)

Child 6: Ke kopa ho bua… (Can please say something…)

Group: Tse 7 (About 7)

Child 4: (is counting)

Child 6: Ke minus. Ke 67 minus 28. (It's a minus. It is 67 minus 28)

Child 4: 67 minus 28 kena ka mona ntwana (67 minus 28, yes, give me a high five dude)

Child 1: (is counting) 67 a re shebeng (67 let's have a look)

Child 3: Haa! (No!)

Child 4: Jwale wena monna o batlang? (Come now dude what's up?)

Child 3: Ha ba dinka ba mo file tse ding ha ba dinka (No they did not take them but they gave them to him)

Child 1: Ba mo file tse 28 (They gave him about 28 of them)

Child 1: Ke plus (It's a plus)

Child 4: O ne a na le tse kae? (How many did he have?)

Child 6: Several

Child 4: Several? Several ke bo kae? (How much is several?)

Child 1: Tloho ke le bolelleng… (Come let me explain to you guys…)

Child 2: Ke sevene… (It's seven)

Child 3: O maka ke sevene (No you are lying it's seven)

Child 1: Ke kopa ho buang hleng… (Can I please say something…)

Child 5: A re tloheleng ntho tsena mahn… (Let us leave these thing guys)

Child 1: Ke kopa ho buang hleng nna ka re ntho tsena o tshwantse o plus, bonang hleng, le a bona he, ha re no sebetsa ha re hlola re bua. (Can I please say something guys I think we have to combine this things, check here guys, we will not be able to cope here if we are always talking like this.)

Child 3: A re tholeng re tloheleng ho bua. (Can we stop it, stop talking)

Child 4: nna ke tla sebetsa ke le mong. (I think I will work alone)

Child 1: Le nna ke tlo sebetsa ke le mong hobane ha le batle re bua. (I think I will also work on my own because you guys don't want to keep quiet)

Child 4: Ba re shebile (They are watching us)

Child 1: Tlo ke le bolelleng ntho e na e tjena Thabo o ne a na le di toys tse ding ba be ba plus ka 28 hore di be 67. (Let me explain to you guys Thabo had his own toys and his were multiplied with about 28 extra to bring the total to 67)

Group: Eya (Yes)

Child 4: Jwale o tlo plus eng? (So what are you going to add it with?)

Child 3: Ke bo kae hore e be 67? (How much was it to bring the total to 67?)

Child 4: Eya. (Yes)

Child 1: Akere nna ke a tseba hore ke tlo etsang hore e be jwalo (I know very well what I am going to do to make it like that)

Child 2: He tau ba re utlwa ka di ding ena tau ke yane e shebe akere? (That is what they use to listen to us dude look at it, isn't it?)

Child 1: Oa bona ha o ka oa minus, oa bona ha o ka oa minus (If you can we can just subtract this number, if we can we subtract it)

Child 4: Ha re tlo e fumana answer… (I don't think we are going to find the answer to this…)

Child 2: That's why teacher areng re hoeletse ke hore die ding e kgone ho re shoota. (I think that is why the teacher told us to speak load so that they are able to record us.)

Child 6: Ke minus tau (It's a subtraction dude)

Group: Ke minus!! (It's subtraction)

Child 4: Ho thwile sum… Ho thwile number sentence ke number sentence ntho eo? (We were told to do sums… We were told to do number sentence it's that a number sentence?)

Child 1: (is counting)

Child 2: Se ke la lwanang (Don't argue)

Child 4: O bala tje ke hobaneng? Etsa jwalo ka mokgwa oo re hlotse re etsa ka classeng. You are wasting time Lerato. (Why are you reading like that? Please do it like we normally do in class. You are wasting time Lerato.)

Child 5: Mo botse (Ask her)

Child 2: You are wasting my time.

Child 1: 41. Ke 41 (It's 41)

Child 4: Lerato akere re tla kgona fela jwalo ka ha re etsa di Maths ka classeng. Huu Lerato, Lerato, Lerato hobaneng re sa kgone ho etsa plus ya ne eo re kgonang ho e etsa ka classeng? Hobaneng? Atjhe nna ke tla iketsetsa dintho tsaka. (Lerato we will manage just like we normally do Maths in class. No Lerato, Lerato, Lerato why aren't we able to add this like we normal do sums in class? Why? Oh no, I think I will work on my own.)

Child 5: Eya hobaneng? (Yes why?)

Child 1: Re etsa mane ho number sum be re etsa teacher o itse re etse number sentences. Jwale re a numbera ena (We sums, and also teacher told us to do number sentences. So now we are numbering)

Child 5: Mo botse. Mo botse. (Ask her, ask her)

Child 1: Ke mo botsitse klaar (I asked her already)

Child 5: Mo botse, mo botse, rona ha le sa batle ho bua mo. Rona re shebuwe ha re tsebe ba ntse ba re etsetsa eng eng. Thabo has… (Ask her, ask her, if you do not want to speak… They are watching us and we do not know what are they doing in there.)

Child 1: Ha e qale ho number 6… Number 6 qala. (Let's start with number 6)

Child 6: Nna ke nahana ho re re re 67 minus 28 (I was thinking we should say 67 minus 28)

Child 1: Teacher o utlwile o itse o re fa 4 or 5 minutes (Teacher said she is giving us 4 to 5 minutes)

Child 4: Ke e ngotse nna number sentence ya ka… (I did my own number sentences)

Child 3: Oa rasa (You are making noise)

Child 1: A re boneng hore o e ngotse le rona re kgone ho e ngola (Let's check how she did so that we may be able to do it as well)

Child 2: Ha e kutlwi o a rasa. (He can't even tell that he making a noise)

Child 4: Eya e ngoleng (Yes go ahead do it)

Child 3: Motho enwa o ngotse (But this guy has already done it)

Child 6: Eya re bontshe o tshwanetse hore o re bontshe (Yes show us you are supposed to show us)

Child 1: Eya o tshwanetse o re bontshe re ka group (Yes you should, we are working as a group here)

Group 6: Re tshwanetse re thole answer e i 1 (We have to find one answer together)

Group 1: E i 1 (Just one)

Child 3: Utlwa oa tsheha tsa mo tsheha ha lona kwana (Listen to this she's laughing go and crack yourself away from here)

Child 6: O tsheha eng… (What are you laughing at…)

Child 4: Ngolang akere le a tseba re ngola sum, re tlo ngola 67 minus 28 (Just write it down, you know when we do sums, we will subtract 28 from 67)

Child 6: Ke number sentence le yona (It's also a number sentence)

Child 3: Sum eo yona re tlameile re e ngole mona (But we are obliged to write down that sum here)

Child 2: Teacher they are fighting mam.

Child1: I found it…

Child 4: Teacher the number sentence…

Teacher: Ok. Write the number sentence. Write the number sentence. Ok, you are already finished with that now do your sum

Child 1: Se ke wa nqopitsa. (Do not copy my answers)

Child 4: It's a group mos

Teacher: It's a group work the group must go together. Go on Lerato write down a number sentence. If you are done you just turn to the next page. Where is your staff Thato? Don't read now. If you think you are done turn over your paper so that I can see that you are done. If you have the answers then write in your answer and then you turn around. Are you done (to child 3)? Hurry up quickly. Are you finished you Hloni?

Child 2: No mam.

Teacher: Pick up Ntando. Now can we go on class?

Group: Yes mam.

Teacher: Now we are going to word problem B. Now children again quickly read it. And then you write that story over in your own words. But it must not take long. You must just read there and what you understand from that word problem you write it over in your own words. Right? Ok start.

Teacher: Are you done?

Group: No Mam.
Teacher: Ok are you happy Lerato? Are you done? And you Ntando? Ok stop, stop right there. Let us read it together. All of you read together with me.

Everybody reads the story

Right I am going to leave again. You are going to discuss it right ask yourself more questions, and start to read again. Where do we start? With which child do we start? What is it that we want to know at the end? Discuss it, talk to one another I am going to leave and then you must write again a number sentence and then do the sums. I will be back in five minutes.

Child 1: Ntando qala (Ntando you start)

Child 6: Nna ke a tseba… (I know)

Child 2: Ke wena o buang. (You should speak)

Child 5: Mona na re tlo bua, re tlo e discuss re le kaofela… (This one we are going to talk about it, and we are going to discuss it as a group.)

Child 6: Ke 50 minus 30… (It's 50 minus 30)

Child 3: He tau die man oa bua yong… (Hey dude keep quiet that guy is talking…)

Child 6: Jwale ha re sa ntsane re tlo e etsa di minus re tlo e tsa di plus or times or divide… (We are no longer doing subtractions, we are going to do additions, multiplications and we will divide)

Child 4: Eya ke plus. Ke 50 plus 30 e tlo etsa 80 kaofela oa bona. (Yes we add. It's 50 plus 30 and it will give us 80 in total you see that)

Child 5: E etsa 80 kaofela. (It's 80 in total)

Child 2: Aa ke minus. (No it's a minus)

Child 1: (They say) Hothwe Boitumelo has 20 rands more in her pockets than her brothers.

Child 3: O maka. (You lie)

Child 4: More ke eng? Ke more akere. E seng low. More!! (What does more mean? It's extra right? And not less. More)

Child 2: Tse ngata. (More)

Child 3 & 6: More is more!

Child 5: More money that we spend.

Child 6: You can't say more means less more means more.

Child 5: It's 'pimples' (everyone laughs)

Child 1: Ofentse ke kopang ho buang hleng. Ofentse ke kopang ho buang hleng. Bua wena Thato hle, wena ha o kgone ho etsa group, ka nako yane o re siile, ba bang ha ba tsebe hore na… (Ofentse may I please speak. Ofentse may I please speak. Thato will you please speak, you can't work in a group, the last time you left us, some don't even know that…)

Child 4: Teacher o itse re tswellepele mos. (The teacher told us to continue)

Child 1: Ke kopang ho bua Ofentse he ha a re explainele hobaneng re re ke plus ha a re explainele… (May I please speak will Ofentse please explain to us whey he says it's additions, please explain)

Child 4: O maka o itse ke minus… (You lie you said it's a minus)

Child 3: 50 plus 20 ke bokae? (How much will 50 plus 20 be?)

Child 4: Ke 70. Plus 10 ke bokae anthe? Ntate wa hae o na le 30 ranta. (It's 70. And when you add 10 how is it then? His father had 30 rands)

Child 3: Ntate wa hae o na le bokae? (How much did his father have?)

Child 4: 30.

Child 5: O maka 50 ranta. (You lie, it's 50)

Child 1: 50 ranta. (50 rands)

Child 4: 70

Child 3: O na le 70 (He had 70)

Child 5: O maka o na le 50 ranta (You lie he had 50 rands)

Child 2: 50 ranta (50 rands)

Child 4: 70

Child 3: Ha e no kgona ho ba 80 (It's impossible it won't be 80)

Child 2: Ke 50 (It's 50)

Child 1: O ne a na le 70 (He had 70)

Child 4: 10 ranta e batlang. 10 ranta e batlang moo? (And what about the 10 rand? What happens to the 10 rands?)

Child 2: Ke minus. (It's a subtraction)

Child 1: Ke minus (Subtraction)

Child 3: (To child 1) O maka. O ntse o re ke plus. (You lie. You have been saying it's an addition)

Child 1: O maka ha se nna a ntseng a re ke plus ke itse minus (You lie it was not me who said it's an addition I said it was a subtraction)

Child 3: (To child 4) O mo utlwile akere o its eke plus? (You heard him he said it's an addition right?)

Child 1: Nna ke itse ke minus. (I said that it was a minus)

Child 5: Nna ke a ingolla. (I am working on my own now)

Child 4: A re ingolle, a re ingolle. (Let's just do it ourselves.)

Child 1: 70 minus 10.

Child 6: Bona ba na ha ba batle ho sebetsa le batho ba bang… (Look at this guys they don't want to work with other kids…)

Child 5: Ntse re sebetsa kaofela mos… (We are working together afterall…)

Child 1: Ofentse ke kopa o re bolelle hore number sentences re e ngola jwang? (Ofentse will you just explain to us how we do the number sentences)

Child 4: Ere number 2 a bue. (Give to number 2 to say something)

Child 3: Bua ntate. (Speak dude)

Child 2: A ke re papage… a ke re Boitumelo o ne a na le… (So his father… So Boitumelo had…)

Child 1: Nna ke tlo re 50 minus… (I think I will say 50 minus…)

Child 2: O na le 20 ranta aker. Hothwe more in her pocket than her brother… (He has 20 rands right?)

Child 3: (To number 4) Ha a tlohela ho tsheha hle monna… (No man stop laughing)

Child 2: O na le e ngata ho feta ya abuti wa hae. Jwale ke minus… (He has more money than his brother. So it's a subtraction)

Child 5: Rush e na kaofela, rush e na kaofela e ya back sit… (This 3, all of you are going to be seated at the back in a classroom…)

Child 3: Nna ke ya back sit nna… (I will be sitting at the back)

Child 2: 10 minus 50. Ke 10 minus 50. Ke 10 minus 50. (10 minus 50, it's 10 minus 50, it's 10 minus 50)

Child 6: Nna o tlo kwe o re number 6. (If I should hear you saying number…)

Child 1: Bua hle Teboho a ko bue re tlo luza dintho hle Teboho… (Teboho please say something if you can only say something we are going to lose out here)

Child 2: 20 minus 10

Child 3: Di eng? Re tlo luza di eng? B (What exactly? What are we going to lose?)

Child 1: Le ha re sa luze nix mare bona re a utlwuwa mos. (Even if we do not lose anything but look here I am sure they are listening to us here)

Child 2: 20 minus 10

Child 1: Ke ka hoo teacher a reng re bue loud. Motho eo o ntse a bua loud and e mong le yena o bua loud. Teacher o itse ho bua motho a i1. (That is why the teacher told us to speak out loud. When one person is speaking the other one just speaks as well but the teacher said it should be one person at a time.)

Child 5: Mona re tlo etsa… (Here we are going to…)

Child 2: Ke 20 minus…

Child 3: (To child 2) Oa rasa… (You are making a noise)

Child 5: Ke plus, plus not minus, not divide not times. Re tlo etsa plus… (It's an addition, not a subtraction, not divide and not multiplication. We are going to add…)

Child 3: Haa! (No)

Child 1: Ke minus (It's a minus)

Child 4: Nna ke qetile. (I am done)

Child 5: Boitumelo has 20 rands more

Child 1: 80 minus 10 rands…

Child 5: More…

Child 2: Than her.

Child 4: More. More is more.

Child 5: More in her pocket.

Child 4: Nna ke qetile he. (I am done)

Child 3: Ho tjhong o na le 30 he. (So meaning he ha 30)

Child 2: O na le engata ho feta ya abuti wa hae. (He has a lot more than his brother)

Child 1: Ho tjhong Boitumelo o na le 30 ranta. (Meaning that Boitumelo has 30 rands)

Child 4: What?

Group: Eya. (Yes)

Child 4: Eya. (Yes)

Child 1: Hobane ntate wa hae o na le 50 ranta. (Because his father 50 rands)

Child 4: It's going to be 80 rands.

Child 1: Jwale? (So?)

Child 4: Oh you people… Duh!

Child 1: Jwale o tlo e tsang? O tlo re 50 divided… (but what are you going to do? 50 divide by…)

Child 4: E pluse, pluse… (Yes plus, plus…)

Child 3: Nna ke a e plusa… (I am going to do additions)

Child 1: 50 plus 80 ranta, 30 ranta… (50 plus 80 rands, 30 rands…)

Child 2: Ha e kgone. E tloba 90 plus 10 ranta eo yona? (It can't. It's going to be 90 plus that other 10 rand how much then?)

Child 5: Ha Lerato Shabane (Lerato Shabane)

Child 1: Eya 10 ranta eo. Ha o utlwe ha hothwe 70 ranta plus 10 ranta… (Yes that other 10 rand. They say 70 rand plus 10 rant…)

Child 4: Sheba. Ho tjhong lona ha re rutiwa Maths sekolong ha le mamele (Watch this, so you guys never pay attention at school when we being taught Maths?)

Chilld 3: E tloba 80. (It is going to be 80)

Child 2: Number 3 ea bua. Number 3, number 3, number 3… (Number has something to say, number 3, number 3, number 3…)

Child 3: Nna ke shapo nna. (I am fine)

Child 4: Ha mare Mpho ha a bue Ofentse ha a ha a. Ke kopa ho bua something. (But guys Mpho is not saying anything Ofentse can I speak?)

Child 1: Bua he. (Speak then)

Child 4: Mare hobaneng re e tsa strike? (But why are we arguing like this)

Child 2: Eya. Eya. Eya. Retshwanetse re bue hantle mona. (Yes you are right we have to speak well and in order)

Child 5: A re etseng difficult re ngoleng he… (Let's make it difficult then so that anyone can do his or her own work)

Child 4: A re etseng difficult everybody a ngole his or her work aker. (Yes so that everyone can focus on their own work)

Child 3: A re ngoleng once. (Let us start then)

Child 1: Ke kopang ho bua? Ke kopang ho bua? (May I please speak? May I?)

Child 3: Re bolelle answer he… (Please give us the answer)

Child 1: 70 plus 10. 70 plus 10 ranta ke bokae? Ke 80 ranta aker? (70 plus 10, how much is 70 plus 10 rands? It's 80 rands right?)

Child 4: O bua shit. O bua shit. (You are talking shit. You are talking shit)

Child 1: Ke eng he o batla ho mpolella hore ke eng he, ke 70 ranta he. (What? What is it, do you mean to tell me that it's 70 rands?)

Child 3: Ok.

Child 4: Ho itswe this is not for marks… (We were told that this is not really for marks)

Child 2: Play nice. Play nice…

Child 4: Ho itswe we have to see if you understand nna ke qetile. (We were told we have to see if we understand but I am done)

Child 6: Nna ke qetile. (I am done)

Child 1: Hey Ntando ba o shebile. (Ntando they can see you)
Child 6: Khombi ke e bone. (I saw the taxi)

Child 3: O lasting ne (You are very naughty)

Child 5: Nhlanhla o tlo tjhikuwa (Nhlanhla they are going to yell at you)

Child 4: Teacher is back

Teacher: Right are you with an answer?

Group: some say yes some say no

Child 5: The answer is 80

Child 2: I am telling them is minus they say no mam…

Teacher: How do you come to 80 Teboho?

Child 5: Teacher is more…

Teacher: More than means?

Child 2: Less

Teacher: More than means?

Group: More

Child 2: Bigger

Child 4: If I have 10 rands and you have… if I have 50 rands and you have 20 rands I have more than you. It's like this…

Child 2: Yes ke 70.

Teacher: Yes it's bigger nhe. But first we must see who has money first. Who has the money first?

Group: Boitumelo

Teacher: Boitumelo. How much money does she have?

Group: 20 rands…

Teacher: More than her brother. Who has?

Group: 10 rands.

Teacher: So Boitumelo does not have 20 rands. She has twenty rands more than her brother. How much does the brother have?

Group: 10 rands.

Teacher: So how much does she have?

Child 1: 30 rands.

Teacher: Now how did you come to 30?

Child 4: Plus.

Teacher: Plus

Child 4: You see… They were telling us no…

Teacher: Why did you say minus Lerato? Why did you think it's a minus? Just tell me? Nobody will say…

Child 5: These 3 says it's a minus…

Child 3: Hayi it's not me tau it's this one.

Teacher: Why did you think it's a minus? (to Child 3)

Child 3: No I did not think that…

Teacher: But why did you think so first?

Child 5: 20 and 30 and then…

Teacher: What did you want to minus?

Child 1: Mam I wanted, Ofentse wanted to minus 10 rand and 70 rand…

Teacher: Ok. But can you write something for Boitumelo another sentence?

Group: Yes

Teacher: And when we read further we say her father has 50 rand more than Boitumelo. Now we want to know how much does the father have?

Child 4: 80 rands.

Teacher: How did you come to that?

Group: 70 rands

Teacher: it's Boitumelo's what? And her father's what? What about those two? Now quickly do the number sentences and sums. If you are done close your paper and put it up. Ok you must do a sum Ntando? I will not watch you. Ok you must start to finish.

Child 1: Teacher we must do the sum too mam.

Teacher: Done Ntando?

Child 6: No I am not mam.

Teacher: Hurry up… Right guys thank you. Was it difficult for you?

Group: No mam

Teacher: Did you enjoy it?

Group: Yes

Teacher: Right thanks a lot.

APPENDIX 3

Requests for permission to conduct research

CM Joostehuis
Oranje Meisieskool
Bloemfontein
9300

The Principal
Kruitberg Primary School
Andries Pretorius Street
Bloemfontein
9300

Dear Principal

Research for Masters Degree

I am Amaria Reynders and I am busy with my master's degree in Education. I would hereby request to make use of grade four learners at your school to act as a sample for my qualitative study.

The planned research is a case study. Therefore I want to make use of a grade four Mathematics class to be observed as a group to collect data that will be analysed. The observation will be done by me and a person who will video tape the group discussions. I need a class list and ID numbers of the learners in a Mathematics class that will be chosen by you and the Mathematics teacher. The duration of the observation will not be longer than half an hour. If possible I want to make use of a classroom at your school that is familiar to the learners. I shall contact you again on a later stage to confirm other arrangements such as date and time.

I shall also write a letter of consent to the parents of the learners involved. I shall visit the class before the observation to introduce myself to them and to inform them of the study and all the procedures.

It will be an honour if you could grant me this request as I need to do the research at a school with a diverse component of learners.

Yours faithfully

_____

A Reynders

APPENDIX 4
Letter of consent to Parents

CM Joostehuis
Oranje Meisieskool
Bloemfontein
9300

Dear Parent / Guardian

Research for Masters Degree

I am Amaria Reynders and I am busy with my master's degree in Education. I am studying at the University of the Free State.

The grade four Mathamatics classes that your child attends have been chosen by the principal of the school to act as a sample group for my research. The learners will be video tape while busy with group work on Mathematics word problems.

As I am also a teacher I can give you the assurance that your child shall benefit from this observation class and that no harm could possibly be done to your child during participation.

Please complete the tear off slip and return it to the school with your child.

Me A Reynders (Researcher) Me M Fourie (Principal)

_____ _____

Date: _____
I _____ parent/guardian of _____ (child's name) in grade four, hereby ***give / do not give*** my permission that my child can take part in this group discussion as part of a research project.