

Reading literacy in the content areas: The development of an instructional support framework

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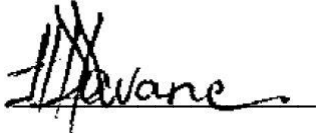
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DECLARATION

I the undersigned, hereby declare that the work contained in this dissertation / thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

A handwritten signature in black ink, appearing to read 'Dlavane', with a horizontal line underneath it.

Fio Dolly Gaebeng Dlavane

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DEDICATION

This thesis is dedicated to my dearest parents:

Bessie Selloane (1942 - 2011) and Jonas Radiphoko
Mokatsane (1934 – 2009).

Although both of them did not live long enough to see and celebrate the value of all their efforts, they still remained my greatest source of inspiration in that they were my first educators who taught me the virtues of lifelong learning, resilience and to always aspire to achieve the exceptional.

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ABSTRACT AND KEY TERMS

Across the country, there is a perception that our learners in the intermediate phase are not acquiring the knowledge and skills needed to effectively function in today's global economy. This perception is fuelled by both national and international reports. Grade four marks a transition point from learning to read to reading to learn. Within the South African context, Grade 4 also signals the move from mother tongue instruction to English as medium of instruction for many learners. From Grade 4 onwards learners must be able to process longer, multi-syllable words and read accurately and quickly, especially in the content areas. The finding that vocabulary is strongly related to general reading achievement has long been acknowledged. Although research into the area of math vocabulary is limited, researchers report that vocabulary and concept knowledge are an important part of mathematics.

The purpose of this study was to determine what the reading literacy profile of Setswana-speaking Grade 4 learners whose LoLT is English looks like in terms of oral reading fluency, retell and reading comprehension as well as their composite basic early reading literacy score; what an analysis of Grade 4 learners' performance on a collated teacher-developed mathematics paper indicated as well as to determine what an analysis of Grade 4 Maths language (e.g. vocabulary) in teacher-developed assessments and textbooks revealed and to ascertain what teachers' and learners' perceptions of mathematical language problem areas revealed.

A mixed method research design was used and research results were interpreted within a pragmatic research paradigm. Research participants included grade 4 learners and grade 4 teachers whose home language is Setswana, but who received instruction in mathematics via the medium of English. The results indicated that the grade 4 learners were reading below a grade 3 level, which means that they are not able to read fluently and accurately; they have trouble decoding basic English language words in text format. The results, therefore, imply that these learners will also have trouble decoding and reading for meaning sentences in mathematical assessment papers. A frequency analysis of the learners' performance on a maths assessment indicated that approximately 80% of the learners were experiencing problems in all mathematical focus areas covered in the Grade 4 curriculum.

The qualitative analyses focused on a document analysis of teacher developed mathematics assessments and textbooks as well as learner workbooks and teacher manuals. In addition, semi-structured interviews and focus groups were held with the teachers and learners, respectively. It emerged from the qualitative analysis that mathematical words may cause confusion in comprehending the math questions because of a number of factors such as sharing the terms with English, unfamiliar mathematics words, words with more than one meaning, homonyms, the irregularity of English spelling, compound nouns, and words that are used interchangeably in math. The study shows that the interaction between mathematics and English vocabulary is real. In addition, the analysis of learner textbooks, workbooks and teachers' manuals also shows that the math resources use "difficult words" (as identified by both teachers and learners) such as words that are taught in pairs which causes confusion in understanding the meaning of such distinct words, mathematics terms that are found only in mathematical contexts, words that are shared between everyday English and mathematics but have different meanings in both contexts, math words that are used in other disciplines, math concepts that are verbalized in more than one way, and finally prepositions in word problems. The analysis of teacher interviews supports the quantitative data analysis in this study. It emerged from the teachers' interviews that learners' English proficiency is low to non-existent. The learners prefer being taught in Setswana. The teachers indicated that the learners could not do the assessments because they could not read the questions. The results of this study clearly show the impact of learners' language background on their math performance

The literature review and empirical research led to the development of a vocabulary instructional support framework that can help content area teachers integrate reading literacy within their subjects taking cognisance of the LoLT as well as the mother tongue of the learners.

Key terms:

Setswana, Grade 4, Reading literacy, Mathematics, Home Language, Language of Learning and Teaching, Vocabulary, Reading Strategies, Content Area, Reading Instruction.

KHUTSHWAFATSO LE MAFOKOMAGOLO

Go ralala kontinente, go na le temogo ya gore bana ba rona ba kgato ya magareng ga ba bone kitso le bokgoni tse di tlhokegang gore ba dire ka matsetseleko mo ikonoming ya gompiano ya lefatshe lotlhe. Temogo e e fetelediwa thata ke dipego tsa bosetšhaba le tsa boditšhaba. Mophato wa bone e kaya nako ya phetogo go tswa go go ithuta go buisa go ya go go buisa go ithuta. Mo boemong jwa Aforikaborwa, Mophato wa bone o supa gape go tswa mo go rutiweng le go ithuteng ka leleme la ga mme go ya kwa go Seesimane e le puo ya go rutiwa le go ithuta mo barutwaneng ba bantsi. Go simolola mo Mophatong wa bone go ya kwa pele barutwana ba tshwanetse go diragatsa sebaka se seleele, mafoko a a dinokontsi le go buisa ka manontlhotlho le ka bonako, bogolosegolo mo dirutweng tsa diteng. Phitlhelelo ya gore tlotlofoko e amana ka tsenelelo le phitlhelelo ya puiso ka kakaretso e amogetswe bogologolo. Le fa patlisiso mo lephateng la tlotlofoko ya mmetshe e tlaela, babatlisisi ba bega gore tlotlofoko le kitso ya kgopolo di botlhokwa mo mmetsheng.

Maikaelelo a thuto e ne e le go batlisisa gore tebego ya puisokwalo ya barutwana ba Mophato wa bone ba Seisemane e leng puo ya bona ya go rutiwa le go ithuta ka Seisemane e lebegang jang go lebilwe puiso ka molomo ka thelelo, go boeletsang motlotlo le tlhologanyo, gape le motheo wa tshimololo ya puisokwalo; tshekatsheko ya phitlhelelo ya barutwana ba Mophato wa bone mo tlhatlhobong e e tshamilweng ke morutabana e e supang le go batlisisa gore tshekatsheko ya puo ya mmetshe ya Mophato wa bone (sk. tlotlofoko) mo ditlhatlhobong tsa barutabana le dibuka tsa serutwa e se tlhagisang le go netefatsa ditemogo tsa barutabana le barutwana tsa dikgwetlho tsa puo ya mmetshe e e di tlhagisang.

Mokgwa wa tlhakanyo wa popego ya patlisiso o dirisitswe mme diphitlhelelo tsa patlisiso di ne tsa ranolwa ka tiriso ya tebo ya tiragatso wa patlisiso. Batsayakarolo ba patlisiso ba ne ba akaretsa barutwana ba Mophato wa bone le barutabana ba Mophato wa bone ba Setswana e leng leleme la gae, mme fela ba rutiwa le go ithuta mmetshe ka Seisemane. Diphitlhelelo di supile gore barutwana ba Mophato wa bone ba ne ba buisa ka ka maemo a a kwa tlase ga Mophato wa boraro, se se raya gore ga ba kgone go buisa ka thelelo le ka manontlhotlho; ba na le kgwetlho ya go ranola mokwalo wa mafoko a puo ya Seisemane se se bonolo mo setlhangweng. Ka jalo diphitlhelelo di raya gape gore barutwana ba ba tlaa nna gape le mathata a go ranola mokwalo wa

mafoko le go buisetsa go bona bokao dipolelo mo dipampiring tsa ditlathobong tsa mmetshe. Tshekatsheko ya nako le nako ya tiragatso ya barutwana mo tlathobong ya mmetshe e supile gore barutwana ba ka ne ba le 80% ba ne ba itemogela mathata mo dikarolong tsotlhe tsa mmetshe tse di rutiwang mo kharikhulamong ta Mophato wa bone.

Patlisiso ya boleng e ne e lebile tshekatsheko ya ditokomane tsa ditlathobo tsa mmetshe tse di tlamilweng ke morutabana le dibuka tsa serutwa le dibuka tse ditirwana le dibuka tsa barutabana. Gape, dipotsolotso tse di sa tlhomamang le ditlhotshwana tsa barutwana di ne tsa tsholwa le barutabana le barutwana, ka tatelano. Go tlhagile mo tshekatshekong ya boleng gore mafoko a mmetshe a ka tlhola ketsaetsego mo go tlhaloganyeng dipotso tsa mmetshe ka ntlha ya mabaka a mmalwa jaaka go abelana mareo le Seisemane, mafoko a mmetshe a a sa tlwaelegang, mafoko a a bokaobontsi, madumatshwana, mopeleto o o fetofetogang wa Seisemane, mainatswako, le mafoko a a dirisiwang ka thefosano mo mmetsheng. Thuto e supile gore kamano fa gare ga tlotlofoko ya mmetshe le Seisemane ke boammaruri. Gape, le tshekatsheko ya dibuka tsa serutwa le tsa ditirwana tsa serutwa tsa barutwana le dibuka tsa barutabana e supa gore didiriswa tsa serutwana di dirisa mafoko a a thata (jaaka go supile barutabana le barutwana) jaaka mafoko a a rutiwang ka bobedi se se tliholang ketsaetsego mo go tlhaloganyeng bokao jwa mafoko a a itlhaolang jalo, mareo a mmetshe a a fitlhelwang fela mo bokaong jwa mmetshe, mafoko a a abelanang le a puo ya ka metlha ya Seisemane le mmetshe mme a na le bokao jo bo farologaneng mo bokaong joo ka bobedi, mafoko a mmetshe a a diriswang kwa makaleng a mangwe a thuto, dikgopolo tsa mmetshe a a buiwang ka ka ditsela tse di fetang gangwe, lwa bofelo dipopi mo palofokong. Tshekatsheko ya dipotsolotso tsa barutabana e tshegetsa tshekatsheko ya boleng ya thuto e. Go tswa o dipotsolotsong tsa barutabana go tlhagile gore bokgoni jwa barutwana jwa Seisemane bo kwa tlase go ya go go sa nneng teng. Barutwana ba rata go rutiwa ka Setswana. Barutabana ba kaile gore barutwana ba ne ba sa kgone go kwala tlathobo ka ntlha ya gore ba ne ba sa kgone go buisa dipotso. Diphitlhelelo tsa thuto e di supa sentle kamego ya lemorago la puo la barutwana mo tiregong ya bona ya mmetshe.

Tlathobo ya dikwalo le patlisiso ya bonnete (*empirical*) di tlhodile kago ya letlhomeso la tshegetso ya go ruta le go ithuta la tlotlofoko le le ka thusang barutabana ba dirutwa

tša diteng go lomaganya puisokwalo le dirutwa tša bona ba tlhokomela puo ya go ruta le go ithuta le leleme la gam me tša barutwana.

Key terms:

Setswana, Mophato wa bone, Puisokwalo, Mmetshe, Puo ya gae/Leleme la gam me, Puo ya go ruta le go ithuta, Tlotlofoko, ditogamaano tša go ruta, Serutwa asa diteng, Thuto ya go ruta puiso.

ABBREVIATIONS AND ACRONYMS USED IN THIS DISSERTATION

AE	Academic English
ANA	Annual National Assessment
BEDMAS	Brackets Exponents Division Multiplication Addition Subtraction
BICS	Basic Interpersonal Communicative Skills
CALP	Cognitive Academic Language Proficiency
CAPS	Curriculum and Assessment Policy Statement
DBE	Department of Basic Education
DIBELS	Dynamic Indicator of Basic Early Literacy skills
DORF	DIBELS Oral Reading Fluency
EAL	English Academic Language
ELL	English Language Learners
EMI	English as Medium of Instruction
L1	First language
L2	Second language
LiEP	Language in Education Policy
LOLT	Language of Learning and Teaching
ME	Maths English
NAEP	National assessment of educational progress
NASBE	National Association of State Board Of Education
NCES	National Centre for Education Statistics
NICHHD	National Institute for Child Health and Human Development
OE	Ordinary English
ORF	Oral Reading Fluency
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Student Assessment
SA	South Africa
SDCOE	San Diego County Office of Education
UNESCO	United Nations Educational, Scientific and cultural Organization
USA	United States of America

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CHAPTER 1: INTRODUCTION AND PROBLEM STATEMENT

1.1 Introduction

The aim of this chapter is to give the necessary background so that the research topic *Reading literacy in the content areas: The development of an instructional support framework* can be contextualized. In addition, the formulated research questions as well as the central theoretical statement is formulated. This is followed by an explanation of the research methodology that was applied during the empirical investigation. To conclude the chapter, a brief overview of the other chapters of the study is provided.

1.2 Problem statement

Across the country, there is a perception that our learners in the intermediate phase are not acquiring the knowledge and skills needed to effectively function in today's global economy. This perception is fuelled by systemic evaluation reports (RSA DoE, 2005), 2016 Progress in International Reading literacy Study (PIRLS) (Mullis *et al.*, 2017), SACMEQ studies (Hungu *et al.*, 2010), and the 2014 Annual National Assessments. In the systemic evaluations, grade 6 learners averaged 38% for language (LOLT), 27% for mathematics and 41% for natural sciences. A significantly higher percentage of learners across all three learning areas are functioning at the "Not achieved" level (63% in Language, 81% in Mathematics and 54% in Natural Sciences). SACMEQ III results indicate that South Africa's grade 6 learners from poor backgrounds are the second-worst readers from a group of 15 countries in Southern and Eastern Africa (Kruger, 2011). The 2014 Annual National Assessments indicate that the Grade 6 learners, in the North West Province, achieved 58.1% for Language and 36.5% for Mathematics (RSA DoBE, 2014) whereas Grade 4 learner achieved an average percentage of 30.8% for Mathematics and 53.8% for Home Language.

In spite of a Language of Learning and Teaching (LoLT) Education policy that supports an approach of additive multilingualism (De Witt, Lessing & Dicker, 1998:118-123), the reality in many schools in South Africa is very different. In schools where English or Afrikaans has not been the medium of instruction in the Foundation Phase, grade 4 signals a shift in the medium of instruction for all learning tasks to English, coinciding with a change in the focus of learning from concrete, basic skill development to

progressively more abstract, thinking and learning tasks across a variety of learning areas/subjects. Without a thorough conceptual foundation in the mother tongue, learners are not given the opportunity of personal and educational development (Cummins, 2000; Skutnabb-Kangas, 2000). Dyers (2003:61) highlights that teachers, in certain schools in the country, feel that the current South African Language in Education Policy (LiEP) (1997), which calls for the switch to English instruction after Grade 3 in schools where the majority of learners are English second language speakers and learners, is contributing to educational failure amongst learners. Furthermore, Dyers (2003:61) contends that educators are struggling to respond adequately to the increased linguistic diversity found amongst learners in their classrooms. As Heugh (2006:9) affirms, most learners who have to make the transition to “reading to learn” in Grade 4 “simply fall into the gap between learning in the mother tongue and learning through a second language of education, English. Most teachers do not know how to help their learners successfully bridge this gap”.

Despite a 30-year history of documenting reading comprehension difficulties among young adolescents and the increasing literacy demands on them, most reading research has been conducted with children of elementary school age or younger, and has focused on word reading and other basic reading processes (Snow, 2002). The community of researchers in adolescent literacy has clearly identified this lack of basic research in reading comprehension in two documents: the RAND Reading for Understanding report (Snow, 2002) and a statement on research needs in adolescent literacy from the National Institute for Child Health and Human Development (NICHD, 2000). The RAND Reading for Understanding report, commissioned by the Office of Educational Research and Improvement (now the Institute of Education Sciences), points out that research is lacking on the relationship between comprehension and vocabulary knowledge, strategy use, and how these develop over the adolescent years. Similarly, the NICHD statement on research needs, developed from workshops on adolescent literacy called for research “to understand the continued learning and development that takes place during adolescence in the areas of reading and writing” (NICHD, 2000:2).

Literacy development is a complex, multi-layered, and ongoing process that does not end in the Foundation Phase. Today’s language and literacy demands are expanding

exponentially (Allington, 2002). Adolescents are expected to process and critically evaluate incredibly large amounts of information in print and multi-media formats. Adolescent literacy refers to “the set of skills and abilities that learners need in grades 4 through 12 to read, write, and think about the text materials they encounter” (Berman & Biancarosa, 2005:6). Adolescent literacy requires one to understand content not only literally but critically.

There’s much more to reading than the basics, and that becomes especially clear as soon as learners start to study the academic content areas. After the Foundation Phase (i.e., Grade R – Grade 3), not only do reading assignments become longer and more full of content; they also become increasingly varied in their style, vocabulary, text structure, purpose, and intended audience (Heller & Greenleaf, 2007). For example, science textbooks differ from textbooks in history and mathematics. Moving from one subject area to the next, learners must tap into entirely different sets of vocabulary and background knowledge. It has become common among literacy researchers to describe the distinct ways of reading and writing and communicating among different groups as “social practices” (New London Group, 1996; Street, 1995). Every academic discipline, or content area, has its own set of characteristic literacy practices. For example, Mathematics is more than just numbers and operations. Mathematics is rich with concepts and terminology. The language of instruction in math classrooms and wording in textbooks and on tests includes complex vocabulary, terms, phrases, and symbols. To do well in math, learners need to have a solid understanding of math vocabulary and concepts as well as strong listening and reading comprehension skills. According to Harmon, Hedrick, and Wood (2005), some learners do poorly on math tests because they have trouble reading and understanding the language of the problems presented to them. “Mathematics presents challenging reading because this content area has more concepts per word, per sentence, and per paragraph than any other area” (Harmon, Hedrick, & Wood, 2005: 266).

Reading is a critical academic skill, one which is necessary for success in all academic domains. However, the empirical research base on adolescents who struggle with reading comprehension is very small (Curtis, 2002; Underwood & Pearson, 2004), and the quantitative portion of that research base is even smaller. It is important to

understand what young adolescents who struggle with reading comprehension struggle with in order to design future effective educational interventions.

Reading researchers have therefore clearly identified a need for basic research to understand reading comprehension in adolescents, specifically, research on different components of reading comprehension in the content areas.

1.3 Literature overview

There are a variety of reasons why many intermediate phase students struggle to read. Firstly, it is important to recognize the breadth of literacy skills and strategies that older learners must use to grapple with texts that are expository, dense, and full of new and difficult vocabulary (Matjila & Pretorius, 2004:4). To meet the performance standards across content areas, learners need to transact meaning from disciplines that have unique organizational structures and concepts. Students are expected to locate and paraphrase information found in lengthy, complex passages in texts dealing with literature, social studies, science, and math. Competencies at this level include the ability to connect interrelated ideas, synthesize information, and draw conclusions about main ideas and the author's purpose.

Secondly, Grade four marks a transition point from learning to read to reading to learn. Students are expected to read and comprehend greater amounts of complex expository material each year. Hence, the primacy of early literacy has been well established: students who are not reading moderately well by grade 3 will likely encounter difficulties reading throughout their school career (Snow *et al.*, 1998). The good news is that scientists estimate that with proper instruction, 95 percent of all children can be taught initial reading (Moats, 1999). Research indicates that even children who begin with a disadvantage in letter, sound, word, and concept knowledge can learn to read and write well with explicit, systematic instruction in key areas: the phonological system (phonemic awareness and phonics), fluency, vocabulary and comprehension.

The bad news is that after grade 4, far too many older children are not getting the individual instruction (beyond incidental teaching) they need to read increasingly more content-area texts. This apparent stall in most children's achievement at grade 4 has been referred to as the "4th-grade slump" by Jeanne Chall and her colleagues and,

more recently, the “4th-grade plunge” by the American Federation of Teachers (Chall & Jacobs, 2003).

Research indicates a number of factors that impact advanced literacy skills and the ability of adolescents to understand and learn from what they read. These include: speed and accuracy when reading text, vocabulary, background knowledge, and comprehension (McCardle & Chhabra, 2004). By the time learners reach Grade four, they should have developed the ability to apply the alphabetic principle, that is, the ability to manipulate the sounds of oral language and phonics and to correlate speech sounds with parts of words. Research shows, however, that about 10 percent of learners enter middle and high school with deficits in their ability to decode print that will impair their fluency and comprehension (Pretorius & Ribbens, 2005). Excellent instruction is the best intervention for all children (Snow *et al.*, 1998). Yet, without explicitly designed instruction to accelerate skill acquisition, gaps in children’s vocabulary, language, and reading development widen over time. Studies show that children proficient in reading at the end of 1st grade see twice as many words of running text as those struggling to read. As a result, learners continue to lose ground in decoding, automaticity, fluency, and vocabulary growth, resulting in as much as a four-year gap in reading performance by high school (Snow *et al.*, 1998; NICHD, 2000).

From Grade 4 onwards learners must be able to process longer, multi-syllable words and read accurately and quickly. Reading fluency, in fact, distinguishes skilled from less-skilled readers throughout adolescence (Snow, 2002). Through extensive and repeated processing of text, learners develop the capacity for rapidly, accurately, and automatically recognizing an increasingly large store of words, which results in fluent reading. Fluency of word identification is not sufficient for comprehension. Yet, it is an important prerequisite for it. If learners read slowly and laboriously, their comprehension of texts will likely be limited. In a national study of 4th-graders in the United States of America (USA), the National Assessment of Educational Progress (NAEP) (2005) found that 44 percent of learners lack reading fluency, even with grade-level stories. Understanding, interpreting, and responding to texts requires a substantial amount of cognitive resources. If these resources are expended in the

identification of words, that is, in decoding, the understanding, interpretation, and critical response to text will suffer.

The finding that vocabulary is strongly related to general reading achievement has long been acknowledged. There is growing consensus that children's vocabularies need to grow at a rate of about 2,500 to 3,000 words a year during the elementary grades (i.e., foundation and intermediate phases) and some analyses suggest that the figure may be even higher (NASBE, 2004). Yet, enormous variations exist in the number of words children encounter through written and spoken language, contributing to large differences in learners' vocabularies and comprehension abilities. Hart and Risely (1995) documented large differences in learners' familiarity with unusual words, standard pronunciation, and complex syntax before school entry. They found that learners from low-income families were exposed to one-third to one-half the words that high-income learners encountered. Another study identified large differences in amounts of daily reading among learner that varied from 8 to 4.7 million words per year. Torgesen (2005) acknowledges that even though the impact of preventive programmes is powerful, learners continue to read below level on US state assessments because it is so much more difficult to "close the gap" in broad knowledge and verbal skills than it is in word reading skills. He contends that this challenge must be met by integrating literacy support throughout content learning and infusing specific strategies to broaden vocabulary and concepts across domains.

Vocabulary knowledge is as essential to learning mathematics as it is to learning how to read. In language arts, mathematical words conjure up graphic representations of the objects they label. But when it comes to abstract mathematical concepts, words describe activities or relationships that often lack a visual counterpart. Yet studies show that children grasp the idea of quantity, as well as other relational concepts, from a very early age (Dehaene, 1997). As learners develop their capacity for understanding, language, and its vocabulary, becomes a vital cognitive link between a child's natural sense of number and order and conceptual learning.

Although research into the area of math vocabulary is limited, researchers report that vocabulary and concept knowledge are an important part of mathematics. For example, Stahl and Fairbanks (1986) found that vocabulary knowledge greatly improves comprehension. If learners do not know the meanings of words used in math

instruction, and do not understand math specific words in textbooks and math problems, they likely will struggle to learn and to perform well when tested. Pierce and Fontaine (2009) also report that language skills are becoming more and more important in math instruction and learning.

According to the San Diego County Office of Education (SDCOE, 2007), math contains three distinct language elements: symbolic language, content vocabulary, and academic language. In the past, math instruction has primarily emphasized the symbolic language. Symbolic language refers to numbers, tables, graphs, formulas, etc. Content vocabulary refers to math's technical language (e.g., fraction, equation, degree, exponent, etc.). Academic language refers to the language often used in the instruction of math and academics in general—terms such as summarize, simplify, evaluate, convert, etc. When learners do not understand the meaning of content vocabulary words and/or academic knowledge terms, they will not accurately comprehend verbal instructions, written language in textbooks and workbooks, or terms in word problems, and they will struggle to explain their approaches to problem solving.

Fletcher and Santoli (2003) found that math vocabulary is often not taught directly in math classrooms and stressed the need to teach it. They administered vocabulary checklists to high school learners to assess their knowledge and understanding of mathematical vocabulary terms. The results demonstrated that many high school students had difficulty defining even the simplest of math vocabulary terms.

Blessman and Mysczak (2001) found a correlation between the reading comprehension scores of fifth-grade learners and their understanding of math concepts. In their research, learners did not possess adequate vocabulary to explain their approaches to problem solving in mathematics. Further, they found that learners showed significant improvement in math when learning strategies, such as math journals, learner-created math dictionaries, and literature to reinforce concepts were incorporated into the math instruction.

Larson (2007) studied the effect of incorporating math-related vocabulary teaching into math instruction. He worked with a group of 6th grade students. As part of their math instruction, the learners kept vocabulary folders in which they held lists of

relevant math vocabulary words, vocabulary word search puzzles, pictures created out of vocabulary words, and vocabulary word definitions. Additionally, the learners took weekly math vocabulary quizzes and these were kept in the vocabulary folder for periodic review. Larson demonstrated that learners' understanding of math concepts and their scores on standardized assessments could be improved with such teaching techniques.

The National Reading Panel (2000) suggests that in order for children and adults to fully appreciate and understand word meaning, they must encounter the word in multiple contexts. This does not mean that repetition and drill of definitions is recommended. Rather, reading the words, discussing the meaning, and using the words in a variety of contexts will help to store the definition in memory and to give it true meaning.

Beck, Perfetti, and McKeown (1982) developed a programme of robust vocabulary instruction. In this teaching approach, learners learn how new words are related to words they already know and they also learn how to use the words in different situations. Repeated interactions and opportunities to use the words are important elements in this approach. Deep level understanding of vocabulary is accomplished using a variety of procedures, including word associations, word networks, sentence completions, and word games.

The large number of learners who perform poorly on national and international reading assessments lack higher-level comprehension skills such as making inferences, explaining the main idea, identifying the author's style and purpose, and making connections between the ideas in the text and his or her own background knowledge (NCES, 2002). Across subject domains, there is a call for advanced literacy skills that should drive classroom practice in fundamental ways that maximizes content learning. Reading abilities are facilitated when readers use strategies that require the active engagement in processing texts, which at upper levels are more conceptually demanding, and often address topics that are unfamiliar. Under these circumstances, even able readers can benefit from explicit instruction and effective instructional support in the use of reading strategies (NASBE, 2004).

There is widespread agreement that becoming a strategic reader is a developmental process; it occurs over time as students encounter increasingly difficult texts and new situations. These strategies, individually, are not as important as a “strategic approach” whereby students respond differently to different topics, texts, genres, and tasks. Strategies are not easy to acquire; students typically require good explicit instruction over considerable time in order to gain control of a strategic approach (NICHD, 2000; Snow, 2002).

The support provided to learners in grades 4-12 in applying comprehension strategies, learning vocabulary, and building fluency are sporadic at best. Durkin’s studies showed that teachers spend little time teaching comprehension: only 20 minutes of comprehension instruction was observed in 4,469 minutes of reading instruction (Durkin, 1978-1979). Teachers depend on classroom instruction to convey key ideas and concepts rather than placing demands on learners to interpret and elaborate on material through analyses of content material.

The literature review indicates that reading is complex, multifaceted, and developmental. Learners are diverse in their reading literacy abilities such as fluency, vocabulary and reading comprehension. The analysis of differences in learners’ reading skill components should inform the type and intensity of strategic reading instruction. An instructional support framework should target improving literacy skills by teaching them within the context of challenging content instruction, rather than apart from instruction of core academic subjects (Ryder & Graves, 1994:7).

The following research questions are addressed in this study:

- What does the reading literacy profile of Setswana-speaking Grade 4 learners whose LoLT is English look like in terms of oral reading fluency, retell and reading comprehension as well as their composite basic early reading literacy score?
- What does an analysis of Grade learners’ performance on a collated teacher-developed mathematics paper indicate?
- What does an analysis of Grade 4 Maths language (e.g., vocabulary) in teacher-developed assessments and textbooks reveal?

- What are teachers' and learners' perceptions of mathematical language problem areas?

1.4 Purpose of the study

The purpose of this study is to determine/develop:

- what the reading literacy profile of Setswana-speaking Grade 4 learners whose LoLT is English looks like in terms of oral reading fluency, retell and reading comprehension as well as their composite basic early reading literacy score.
- what an analysis of Grade 4 learners' performance on a collated teacher-developed mathematics paper indicate.
- what an analysis of Grade 4 Maths language (e.g. vocabulary) in teacher-developed assessments and textbooks reveals.
- the teachers' and learners' perceptions of mathematical language problem areas.
- an instructional support framework that helps content area teachers integrate reading literacy within their subjects taking cognisance of the LoLT as well as the mother tongue of the learners.

1.5 Central theoretical statement

The problem with Grade 4 learners' mathematics, whose Home Language is Setswana, seems to be English.

1.6 Research process

1.6.1 Research paradigm

All scientific research is conducted by viewing one's research material in a specific way. This way of viewing or assumptions about the world is the research paradigm (De Vos *et al.*, 2011; Firestone, 1987). The roots of quantitative and qualitative approaches extend into different philosophical research paradigms, namely that of respectively post positivism and constructivism (Creswell, 2003). The difference in philosophical paradigms raised the question whether the research problem of this

study should be addressed exclusively by a single research approach or by both approaches.

The research problem and accompanying research questions are of a multifaceted nature. For this reason, both quantitative and qualitative approaches are selected for this study. The combination of research approaches led to the adoption of a pragmatic position to conduct the research (Creswell, 2003). Pragmatism has been considered the best philosophical foundation for justifying the combination of different methods within one study (Maree, 2007:263). Pragmatists believe that the truth is “what works” best for understanding a particular research problem. A pragmatic approach offers a practical, “middle ground” orientation in relation to the post positivism paradigm of quantitative research and interpretivism which is the paradigm of qualitative research (Johnson & Onwuegbuzie, 2004). According to Creswell (2003:12), “... pragmatism opens the door to multiple methods, different worldviews, and different assumptions, as well as to different forms of data collection and analysis.”

1.6.2 Research approach

The nature and complexity of the research problem and research questions, called for both a quantitative as well as a qualitative research approach.

Quantitative research aims to objectively measure variables in some numerical way (Firestone, 1987, Maree, 2007, Leedy & Ormrod, 2005). Description, explanation and prediction are the most common research objectives in quantitative research. The nature of observation in quantitative research is an attempt to study behaviour under controlled conditions. Variables are measured with structured and validated measuring instruments to collect data, which is analysed by means of statistical computer programmes. These programmes determine statistical relationships between variables whereafter a quantitative report is compiled which includes different numbers, calculations and results of statistical importance in order to accept or reject the stated hypotheses (Johnson & Christensen, 2010, Leedy & Ormrod, 2005).

Qualitative research aims to obtain, analyse and understand rich descriptive data pertaining to a specific subject or context (Maree, 2007). This research approach is concerned with understanding the processes and the social and cultural contexts which underlie behavioural patterns. Qualitative approaches focus on phenomena that

occur in natural settings as well as studying these phenomena in all their complexity (Leedy & Ormrod, 2005). Strauss and Corbin (1990) claim that qualitative methods can be used to better understand any phenomenon about which little is yet known. This approach is ideal to address the questions on teachers' perceptions and behaviours related to language and mathematics in this study. Qualitative research is not simply the analysis of a few open-ended questions and quotes from transcripts, but is directed at thorough analysis of the data.

In the present study, a quantitative approach is similarly suitable as numerical data about the mathematical analysis of learners' responses on mathematics test papers as well as basic reading profile, specifically oral reading fluency, retell and reading comprehension was obtained from a sample of the Grade 4 learner population in a district in a province within South Africa.

A qualitative approach however is also applicable as narrative data in the form of document analysis (i.e., mathematics test papers and mathematics textbooks), semi-structured interviews with learners to determine how and with what they experienced problems in the mathematics test papers and with the textbooks, and focus group discussions were conducted with Grade 4 teachers to determine their perceptions of learners' reading-related problems in the mathematics tests and while working with the mathematics textbooks.

As both a quantitative and a qualitative approach are needed in this study, a mixed method research design was adopted.

1.6.3 Research design

The mixed method research approach draws from the strengths of quantitative and qualitative approaches. According to Maree (2007), the combination results in richer and more reliable research results. The combination also ensured that findings are not a single reflection of a specific method and enable the attainment of broader and more in-depth results to avoid insubstantial evidence (Denzin & Lincoln, 2005).

The purpose of the mixed method approach in the context of this study is to collect numerical data on the Grade 4 learners' reading profiles as well as their performance on the teacher-developed mathematics tests (quantitative), as well as to collect

descriptive/narrative data from learners and teachers about their perceptions of possible reading-related problems experienced during the answering of mathematics tests and while teaching or learning from the mathematics textbooks (qualitative). This increases the validity of the research by the convergence of the results from the different methods as mixed methods research is regarded as a form of triangulation (Rocco, Bliss, Gallagher, Pérez and Prado, 2003). Creswell and Clark (2011) have identified three procedural considerations that determine the choice of a specific mixed method research design, namely timing, weighting and mixing; these aspects are discussed in chapter 3.

1.6.4 Participants

Non-probability, purposive sampling was used to select the participants for this study. This means that I purposely selected the potential participants who are “fit for purpose” (May, 2011:100), who would give me rich data that would allow me to answer my research questions. Sampling is the use of subset of the population to represent the whole population, whereas a population is the totality of persons with which the research problem is concerned (Maree, 2007:147).

This study has two sets of participants:

- Grade 4 learners whose HL is Setswana, and are taught mathematics through their FAL, English. These learners participated in both quantitative and qualitative data collections. They wrote a math assessment and completed the oral reading fluency, retell and reading comprehension assessments during the quantitative data collection, and they participated in focus group discussions during the qualitative data collection.
- Grade 4 teachers of the said learners participated in a focus group during the qualitative data collection because they were most suitable participants to answer one of the research questions.

1.6.5 Data collection methods

As this study makes use of a convergent parallel mixed method research design, quantitative as well as qualitative methods are used for data collection.

1.6.5.1 Quantitative data collection methods

Data collected by means of reading assessments that enabled the researcher to develop a profile of the Grade 4 learners.

1.6.5.1.1 Oral Reading Fluency

DIBELS Oral Reading Fluency (DORF) is an indicator of advanced phonics and word attack skills, accurate and fluent reading of connected text, and reading comprehension. According to Good *et al.* (2013), the Retell portion of DIBELS Oral Reading Fluency provides an additional check on comprehension for the small number of learners who read a minimum number of words correct per minute, but for whom oral reading fluency alone may not be a good indicator of comprehension.

1.6.5.1.2 DAZE Reading Comprehension

Daze provides an indicator of silent reading comprehension. It is a different way of measuring comprehension than DORF retell and provides an additional measure of comprehension. As an assessment of reading comprehension, Daze provides an indication of whether or not a learner understands what he or she has read. Reading comprehension is the ultimate goal of all reading instruction and assessment activities. It is the ability to understand what is read by interacting with print.

1.6.5.2 Qualitative data collection methods

Qualitative data collection methods consisted of documents analysis, focus group discussions and semi-structured interviews. The qualitative methods are discussed in detail in chapter 3.

1.6.5.2.1 Document analysis

Document analysis is a systematic procedure for reviewing or evaluating documents. Document analysis requires that data be examined and interpreted in order to elicit meaning, gain understanding, and develop empirical knowledge (Corbin & Strauss, 2008). The following documents were collected for analysis in this study:

- A Grade 4 mathematics test and examination papers.

- Grade 4 prescribed mathematics textbooks.

1.6.5.2.2 Focus group discussions

From writings and research studies on the topic (Barbour & Kitzinger, 1999; Litosseliti, 2003) it is possible to establish a working definition of what constitutes a focus group as a group interview without the alternate question-answer sequence found in typical interview sessions. The hallmark of focus group interviews is the explicit use of group interaction as data to explore insights that would otherwise remain hidden. Typically, groups of between five and ten people gather together to voice their opinions and perceptions about a study topic in a non-threatening and comfortable environment. Interaction is based on a carefully planned series of discussion topics set up by the researcher who also acts as a moderator during the group interaction (Litosseliti, 2003). Participants are encouraged to talk to one another, ask questions, exchange anecdotes and comment on one another's experiences and points of view. Although the researcher as moderator initiates the topics for discussion and thus exercises a certain control over what is to be discussed, s/he does not offer any viewpoints during the talk-in-process session.

A focus group discussion was held with one Grade 4 class from each of the three schools. The focus group discussions enabled the researcher to record and gather data on learners' perceptions of the problems they experience in mathematics test papers and with their mathematics textbooks.

1.6.5.2.3 Semi-structured interviews

This technique is used to collect qualitative data by setting up a situation (the interview) that allows a respondent the time and scope to talk about his/her opinions on a particular subject. The focus of the interview is decided by the researcher and there may be areas the researcher is interested in exploring. The objective is to understand the respondent's point of view rather than make generalisations about behaviour. It uses open-ended questions, some suggested by the researcher ("Tell me about...") and some arise naturally during the interview ("You said a moment ago...can you tell me more?"). The researcher tries to build a rapport with the respondent and the interview is like a conversation. Questions are asked when the interviewer feels it is appropriate to ask them. The questions may be prepared or they may occur to the

researcher during the interview. The wording of questions are not necessarily the same for all respondents.

Interviews yield a great deal of useful information and are good ways of accessing people's perceptions, meanings, definitions of situations, and constructions of reality (Leedy & Omrod, 2001). An interview is a verbal face-to-face interchange in which a researcher tries to elicit information from another person or participant. It is a two-person conversation initiated by the interviewer for the specific purpose of obtaining relevant information and for the researcher to focus on content specified by research objectives of systematic description, prediction or explanation (Cohen, Manion, & Morrison, 2011).

In this study, the recorded semi-structured interviews were conducted with the three teachers responsible for the teaching of Mathematics to Grade 4 learners. Data on the teachers' perceptions of the reading-related problems learners experience when completing a mathematics test and examination as well as when using their mathematics textbook.

1.7 Data collection procedure

The researcher received the necessary permission from the Tlhapi District¹ and the three randomly selected schools, namely school N, school B, and school L to administer the reading assessments, the mathematics assessment as well as to conduct the semi-structured interviews (i.e., Grade 4 teachers) and the focus group interviews (i.e., learners). Examples of Mathematics tests and examination papers and Mathematics workbooks and textbooks, used by the Grade 4 teachers, were collected for documents analysis. For a detailed description of the data collection refer to chapter three of the research methodology and design.

1.8 Data analysis

The data collected in this study by means of semi-structured interviews, focus group interviews and documentation was analysed according to themes that were identified from the data. Wood (2012) says data analysis is an inductive process by means of

¹The Tlhapi District is a pseudonym used for ethical purposes.

which patterns and themes can be identified from the data. In this study, different data analysis techniques (cf. chapter 3) were used.

The qualitative data analysis in this study was done according to a qualitative content analysis process. The data was coded according to themes identified in the data. Coding is a process by means of which large quantities of data are broken up into smaller segments. The data is categorised to bring about a framework of thematic ideas (Bailey, 2007). Corresponding statements of the participants are grouped under one code, and the aspects that are out of the ordinary also come to the fore in the process. Strauss (1987) explains that qualitative research does not intend to count items, but to break up data and reorganise it into categories that show up similarities and differences so that data can be used to support and investigate theoretical concepts.

The data from the semi-structured interviews, focus group interviews and the documents were analysed by means of content analysis. “Content analysis is an inductive and iterative process where we look for similarities and differences in text that would corroborate or disconfirm theory” (Maree, 2007:101). A qualitative content analysis involves the following procedures:

- Recording of data by means of note taking and audio recording of responses.
- Responses from the interviews and focus groups were transcribed verbatim.
- The responses were analysed by making use of the coding process.

Coding is a process by means of which large quantities of data are broken up into smaller segments (Maree, 2007). The aim of coding is to look for trends and patterns that reappear in a single interview, focus group interview or among various interviews and focus group interviews. Corresponding statements of participants are for example grouped under one code, and the aspects that are out of the ordinary also come to the fore in the process. The coding process consists of three coding steps namely open coding, axial coding and selective coding (De Vos *et al.*, 2011).

The coding process enabled the researcher to identify trends and patterns, and themes then emerged. Next, thematic relationships were determined and this lead to the development of a framework of thematic ideas. The analysis of all data is described in detail in Chapter 3.

DIBELSnet was used to report on the DibelsNext assessments

Dibelsnet is a data management and reporting system that provides automated reports designed to help teachers, administrators and researchers make instructional decisions based on their learners` performance (cf. chapter 3).

1.9 Ethical issues

Prior to participation, potential participants received sufficient information to make decisions about their involvement in the study. They signed informed consent forms which detailed their involvement and the study`s purpose. Participants were also informed of their right to withdraw at any time and of the terms of confidentiality for this study.

The project obtained ethical clearance from the Ethical Committee of the NW University before commencement.

1.10 Chapter division

This study is organised into five chapters. Chapter 1 discussed the background context, purpose, problem statement and a brief review of the literature relating to reading in the content area, namely Mathematics. A theoretical framework and literature review is presented in Chapter 2. Chapter 3 outlines the research methodology including the research paradigm, the research approach and design, participant sampling, data collection methods and procedures, data analysis procedures, reliability, validity and trustworthiness of the procedures. The quantitative and qualitative results of the study are presented and discussed in Chapter 4. Chapter 5 merges the results by addressing the formulated research questions, it presents an academic reading support framework, limitations of the study, recommendations for further research as well as a conclusion.

CHAPTER 2: THEORETICAL FRAMEWORK: READING LITERACY IN THE CONTENT AREAS

2.1 Introduction

“It must be obvious to all that incomprehensible education is immoral” (Spolsky, 1977: 20). The quotation stresses the importance of learners understanding what they are learning or as King and Benson (2004: 247) argue, “Adoption of a medium of instruction that learners comprehend is also effective pedagogy ...”. One of the crucial aspects to consider when engaging with the mother tongue and medium of instruction debate is to consider how the language of choice will facilitate learning, or as Ridge (2002: 14) says “help real people get the most out of the linguistic resources available to them”.

The purpose of this chapter is driven by pedagogical motives in that the purpose is to determine how the learning process for learners can be facilitated so that they acquire knowledge of content areas (Mathematics in this study) as well as proficiency in both their mother tongue (Setswana) and the language of learning and teaching (English) from Grade 4 onwards. This chapter starts by contextualising the mother tongue debate in South Africa, by situating it within a number of theoretical constructs, and then addressing the major topics that are interrelated in this study, namely content area reading instruction, including reading strategies, the connection between content area reading instruction and mathematics, including the difficulties of language, the use of textbooks, and assessment.

2.2 Contextualising the mother tongue debate

My experience as teacher and teacher educator has made me think about two aspects, namely learners’ inadequate subject knowledge and conceptual development, and secondly, the challenges they experience with English as medium of instruction. Language plays a crucial role in learning as it is through language that children develop ideas or concepts of the world around them; it is through language that children make sense of the input they receive in the classroom from the teacher and the written texts; and it is through language that children express their understanding of what they have learnt from this input (Cummins, 2000; Gibbons, 2002; Probyn, 2008), thus emphasising the importance of comprehension of written

material which has implications for language comprehension. But when the language used for teaching and learning is not a language familiar to the learners, it becomes a barrier to learning (Benson 2009; Brock-Utne, 2010; Heugh & Skutnabb-Kangas, 2010).

It is generally in multilingual societies that the issues of mother tongue education, bilingual education and second language acquisition arise (see Alidou 2004; Cummins 2009; Hornberger 2008; Lo Bianco 2008; Tollefson 2004). But, as societies differ widely, it is important to distinguish between their dynamics, so that a single solution is not sought for very diverse and complex situations. Research indicates that there is a world of difference between those who are learning an additional language voluntarily to expand their linguistic repertoire, and those who are forced to learn an additional language in order to gain access to education and to participate in the wider society.

The axiom that it is best for a child to learn through his or her mother tongue has been a strong element in language struggles for many years. It grew in general currency after the finding of the UNESCO Committee of 1953 which took the position that the language school children can use most effectively should be selected as the medium of instruction (Fasold, 1989). In the words of the Committee:

It is axiomatic that the best medium for teaching a child is his mother tongue. Psychologically, it is the system of meaningful signs that in his mind works automatically for expression and understanding. Sociologically, it is a means of identification among the members of the community to which he belongs. Educationally, he learns more quickly through it than through an unfamiliar linguistic medium (UNESCO, 1953: 11).

In evaluating the arguments for or against the use of the mother tongue in formal education, proponents of either perspective have recourse to different linguistic/cognitive constructs. However, given that these arguments are usually posed in a multilingual context, the debate is often polarised as either promoting a case for mother tongue or for an international language of wider communication. In South Africa, this polarization plays itself out as a tension between promoting English and promoting African languages (Trew & Desai, 1992). The pull of the force of globalisation in the twenty-first century makes it almost impossible for any country to

even contemplate any isolationist policy of ignoring global influences and “going it alone”, as it were. In linguistic terms, such isolationist policies would mean a case for local languages at the expense of international languages of wider communication. However, it would be more sensible to go for a twin-pronged approach - guaranteeing access to local languages as well as guaranteeing access to an international language of wider communication. In the South African context, this would mean promoting both African languages as well as English, though not equally. Heugh and Skutnabb-Kangas (2010: 19) state that:

It may appear unnecessary to many readers, but at this point we need also to draw attention to a common misconception about MTM education, where its antagonists construct a false dichotomy of either the MT or the international language. ... (T)here are no serious proposals anywhere in the world which suggest that children at school in the 21st century can do without substantive access to a language of power, usually one of the big international languages. ... (T)here is, quite simply, no other choice than to proceed with strong additive bilingual and multilingual options.

2.3 Theoretical constructs

Given the contextualization in terms of the mother tongue versus an international language of wider communication in the previous section, the constructs forming the theoretical point of departure for this study take cognizance of this tension.

2.3.1 Additive and subtractive bilingualism

The term *additive bilingualism* is used to refer to a situation where a second language (L2) is acquired without any loss of the first language (L1), learners retain their L1 and learn L2 as an additional language. The term was first coined by Lambert (1975) cited in Cummins (1979: 229). The St Lambert's immersion experiments in Canada in the 1960's are a good example of additive bilingualism within a particular context (Cooper, 1989). This experimental project arose out of the desire on the part of English-speaking parents in St. Lambert, a middle-class suburb of Montreal, to improve their children's French by having them immersed in French as a primary language of instruction experimental programme. Cooper (1989: 54-55) provides the following description of the project:

Two classes of children were followed from kindergarten through elementary school. ... These children's education was conducted exclusively in French during kindergarten and the first grade. From grades two through four, instruction was primarily in French, except for two half-hour daily periods of English-language arts. ... (T)he achievements of three "control" classes, two from English-speaking homes, following a conventional English- Canadian academic program, and one from French-speaking homes, following a conventional French-Canadian academic program were described as well. One of the English control classes was a comparison first-grade class of learners attending the same school in St. Lambert as the experimental classes. ... Control and experimental classes were equivalent in social-class, background and in measured academic aptitude.

Cooper (1989: 55) proceeds to report on the findings:

The investigators found that at the end of the fourth grade, the experimental classes were doing just as well in home-language skills as their peers in the English control classes. The experimental classes' achievement in mathematics as well as their measured intelligence was as high as that of the control classes. The French-language proficiency of the experimental classes, while distinguishable in some skills from that of the French controls, was still strikingly higher than that of the English controls. All in all, the comparisons with the control classes demonstrated that the experimental program resulted in excellent command of the second language with no accompanying deficits in home-language skills or in non-language subjects.

Cooper (1989: 56), however, makes the following cautionary comments:

The children enrolled in the St. Lambert experimental classes differed in two important respects from most ethno-linguistic minority children. First, the experimental children's home language is regarded as valuable by the larger community. There are many opportunities for its practice outside the home and neighbourhood. It is supported by institutions outside the school. Second, the experimental children's parents were middle-class, well-educated persons, mainly life-long residents of the community. Absent were the disadvantages associated with poverty, dislocation, and powerlessness.

Given the above description, a working definition of additive bilingualism would be reasonably good competence in two (or more) languages, one of them being the mother tongue or first language (L1). More recently, Cummins (2009: 26) indicates:

The term additive bilingualism refers to the form of bilingualism that results when learners add a second language to their intellectual tool-kit while continuing to develop conceptually and academically in their home language.

The new or second language then is seen as “adding to” and enriching language experience, rather than replacing the first language (Kleifgen & Bond, 2009; Broom, 2004:508; Cummins, 2000:175).

The Department of Education in South Africa also outlines additive bilingualism as the goal of its language in education policy (Department of Education, 1997). There are, however, different ways in which one can become additively bilingual. These are:

- The use of both mother tongue and the additional language as media of instruction, also described as a dual medium approach. This was the model used in the early bilingual schools for English and Afrikaans learners in South Africa.
- The use of the mother tongue as the medium of instruction and learning the additional language as a subject, a model used in countries such as the Netherlands and Iceland. The use of a second language as the medium of instruction whilst learning the mother tongue as a subject, the model used in the St Lambert's immersion experiments in Canada. Such a model works best when the learner's mother tongue is a dominant language, such as English (Cooper, 1989: 56).

There is unanimity among language-in-education researchers that additive bilingualism is the best approach in multilingual settings as it empowers an individual in acquiring or learning “a second or foreign language without detracting from the maintenance and development of his or her first language” (Kleifgen & Bond, 2009:52). Abdi and Cleghorn (2005:112) state that the results become subtractive when learners are submerged in a foreign L2 as the LoLT and there is shift from learning via L1 to the L2 and no further teaching via L1.

Subtractive bilingualism, on the other hand, refers to a situation where the L1 is gradually (but often, not so gradually) replaced by a more prestigious L2 (Cummins, 1979: 229). This usually happens in situations where the mother tongue is not a

dominant language and has a low status. Learners from immigrant communities in countries like the USA or the UK would fall into this category as they usually have to learn in their second language, whilst their mother tongue is rarely acknowledged. It is also a situation in which many African language speakers (and their children) in South Africa, and elsewhere on the African Continent, find themselves. As a result of subtractive bilingualism, learners sometimes fail to develop full competence in their L2 or lose the L1 competence that they have already acquired because “the two are in competition”, as phrased by Phakeng (2016). Both additive and subtractive bilingualism are outcomes of particular approaches to language in education, but they are outcomes which are heavily influenced by contextual factors such as the status of the mother tongue, power relations in that society with regard to speakers of different languages, the quality of teaching, and the availability of resources such as reading materials in particular languages.

2.3.2 The threshold hypothesis

The *threshold hypothesis* was first postulated by Cummins (1976) and Toukomaa and Skutnabb-Kangas (1977). They suggest that research on cognition and bilingualism is best explained by ‘the idea of two thresholds’ (as cited in Baker, 1993:136). The first threshold is a level for a child to reach to avoid the ‘negative consequence of bilingualism’ – being inadequately competent in either language. The second threshold is a level required to experience the possible positive benefits of bilingualism. The threshold hypothesis assumes that the positive effects of bilingualism will only come into being once a child has attained a certain minimum level (second threshold level) of competence in the L1 and L2. However, the threshold cannot be defined in absolute terms; it is likely to vary according to the child's stage of cognitive development and the academic demands of different stages of schooling. Consequently, when the child has low levels of competency in both L1 and L2, both poor cognitive and poor academic competency result. It is therefore important for the child to maintain L1 competency so that she can attain a higher threshold level of competence and have cognitive benefits.

As the curriculum content becomes more symbolic and requires more abstract formal operational thought processes, the child’s “surface” L1 (and/or L2) competence must be translated into deeper levels of competence in the language. The development of

adequate literacy skills is obviously crucial in this respect (cf. Cummins 1979: 229-233) as the child can become “proficient in using the logical or ideational functions of language” (Olson, 1997 in Cummins, 2000:231). Cummins (1979: 232) argues that the findings of several research studies (e.g., Cummins & Mulcahy, 1978) suggest that maintenance of L1 skills can have cognitive benefits for minority language children. It is useful to note that such research findings are evident in situations as varied as the USA and Nigeria.

What is important about the threshold hypothesis is the notion that the benefits of bilingualism are not automatic. Benefits emerge under certain conditions, and in a particular context (Cummins, 1979: 229). One of the essential ingredients for such conditions is the maintenance and development of the learner's mother tongue. For instance, for L2 reading performance to realize, significant contribution of L1 reading and L2 linguistic knowledge is vital. Another ingredient is the development of learning materials in the learner's mother tongue so that adequate literacy levels are developed. Drawing on international research, the Programme for International Student Assessment (PISA) data, Cummins stresses that active engagement with literacy is fundamental to learners' academic success. The PISA data on the reading attainment of 15 year olds in almost 30 countries showed that “the level of a learner's reading engagement is a better predictor of literacy performance than his or her socioeconomic background, indicating that cultivating a learner's interest in reading can help overcome home disadvantages” (OECD, 2004: 8 as cited in Cummins, 2009: 30-31). This is particularly significant for South Africa where there are not many written materials in African languages; in particular there is very little creative literature in African languages, in many classrooms available in areas such as the Tlhapi district, in the North West Province of South Africa.

Instructionally, as posited by Cummins (1996:6), bilingual classes that are designed to promote the bilingual students' cognitive academic language proficiency should address the three components of the construct, which are cognitive [the instruction should be cognitively challenging and require learners to use high order thinking skills], academic [academic content should be integrated with language instruction], and language [critical language awareness should be fostered throughout the programme]. Finally, Cummins (2000:38) argues that instructionally, teachers should

“focus students’ attention on language and help them become more adept at manipulating language in abstract academic situations”.

2.3.3 The developmental interdependence hypothesis

This brings us to the *developmental interdependence hypothesis* also espoused by Cummins (1979: 233). This hypothesis states that the development of competence in an L2 is partially a function of the type of competence already developed in the L1 at the time when intensive exposure to the L2 begins. In other words, the acquisition of L2 is influenced by the learner’s level of development in the L1. Cummins suggests that differences in the way in which children’s L1 has developed by their linguistic experiences prior to school contribute to the differential outcomes of a home-school language switch in minority and majority language situations. This could be one of the factors accounting for the success of the Canadian immersion programmes such as the St Lambert experiment of the 1960s (Cooper, 1989).

Cummins develops this construct further by drawing on research done in the United States (August & Shanahan, 2006). He argues that the “interdependence hypothesis involves much more than just linguistic transfer” (Cummins, 2009: 25). According to him (2005:3), the following five types of transfer are possible:

- Transfer of conceptual elements (e.g., understanding the concept of photosynthesis).
- Transfer of metacognitive and metalinguistics strategies (e.g., strategies of visualizing, use of visuals or graphic organizers, mnemonic devices, vocabulary, acquisition strategies, etc.).
- Transfer of pragmatic aspects of language use (e.g., willingness to take risks in communication through L2, ability to use paralinguistic features such as gestures to aid communication, etc.).
- Transfer of specific linguistic elements (e.g., knowledge of the meaning of *photo* in *photosynthesis*) – this has to do with the formation of words.
- Transfer of phonological awareness – the knowledge that words are composed of distinct sounds.

A pedagogical implication of the above would be that teachers would need to explicitly encourage learners to transfer knowledge and skills across languages, instead of forbidding them to use their L1s, as is often the case.

2.3.4 Basic Interpersonal Communication Skills (BICS) and Cognitive Academic Language Proficiency (CALP)

An important aspect of academic work is the ability to extract information efficiently from the printed text. Subsequent educational progress largely depends upon how well this task is accomplished. Fluent reading skills are therefore quite crucial. As Smith (1971, cited in Cummins, 1979: 237) points out, such skills require that the reader's knowledge of language is used to make inferences or predictions about information in the text. The child's ability to process language that is decontextualised, or context-reduced as Cummins puts it (1984:12), normally part of L1 development, is likely to influence his or her ability to read successfully.

Following the work of Skutnabb-Kangas and Toukomaa (1976), Cummins (1979) made a distinction between L2 “surface fluency” and more cognitively and academically related aspects of language proficiency, fundamentally differentiating between the two differing kinds of language proficiencies. He argued that in assessing learners' proficiency in a language, both surface fluency, what he calls *basic interpersonal communication skills* or *BICS* (Cummins, 1980: 177), and academic language competence, which he calls *cognitive academic language proficiency* or *CALP*, have to be taken into account. Cummins distinguishes between the two by defining CALP as:

those aspects of language proficiency which are closely related to the development of literacy skills in L1 and L2. ... BICS in L1 such as accent, oral fluency, and sociolinguistic competence may be independent of CALP for a variety of reasons (Cummins, 1980:177).

In a school context, this would refer to a level and type of proficiency necessary for carrying out a specific academic task. According to Cummins (1984:9), it took immigrant learners who arrived in Canada after the age of six, 5-7 years, on the average, to approach grade norms in academically-related aspects of English proficiency, whilst it took about 2 years to reach similar grade norms in face-to-face communication. In defense of the two terms, BICS and CALP, he states:

The distinction was formalized in this way in order to facilitate communication to practitioners involved in educating language minority pupils...[T]he failure of educators to take account of this distinction was (and is) actively contributing to the academic failure of language minority pupils. ... Similarly, pupils are frequently exited from bilingual classrooms on the assumption that because they have attained apparently fluent English face-to-face communicative skills, they are therefore, “English proficient” and capable of surviving in an all-English classroom.

As Cummins (1980: 177) had argued in an earlier paper:

(I)f the purpose of language proficiency is to assign bilingual children to classes taught through the language in which they are most capable of learning, it is essential that these measures assess CALP. Thus, if natural communication tasks do not assess CALP, their relevance to the educational performance of bilingual children under linguistically different conditions can be questioned.

The BICS-CALP distinction, or variants of it, has been taken up by many other writers working in the broad area of language and education (cf. Benson 2009; Heugh 2006, 2009; Skutnabb-Kangas, 2009).

In a 2009 publication, Cummins (2009: 22) re-echoes his initial views on this distinction:

The language abilities required for academic success are very different from those operating in everyday conversational contexts (Italics in original). Sustained development of academic language proficiency across the grade levels requires expansion of vocabulary, grammatical and discourse knowledge far beyond what is required for social communication.

A crucial aspect of such development is of course achieved through literacy development, ideally in both the mother tongue and the L2. In a framework developed to take the BICS-CALP distinction further, Cummins (1983:131) proposes that in the context of bilingual education in the United States, “language proficiency” can be conceptualized along two continuums. He presents this framework diagrammatically as follows (cf. Figure 2.1):

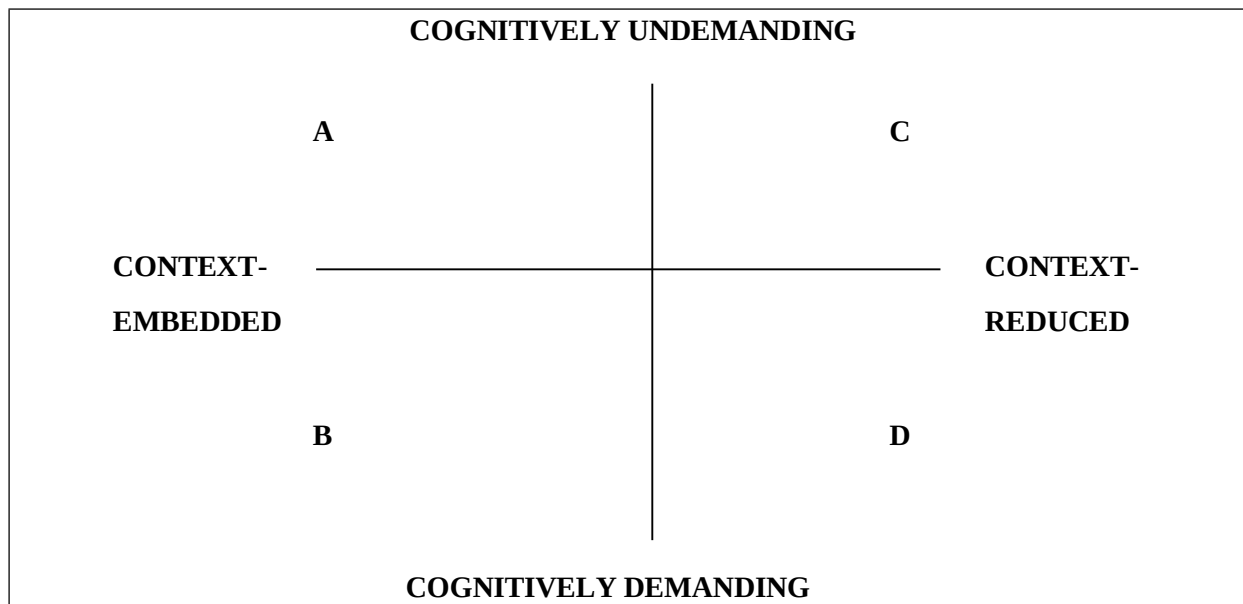


Figure 2. 1 Cummins's Framework on Language Proficiency
(Cummins, 1983: 131)

The horizontal continuum relates to the range of contextual support available for expressing or receiving meaning. The extremes of this continuum are described as context-embedded and context-reduced communication, with the former providing opportunities for negotiating meaning whilst the latter relies primarily on linguistic cues. Basically, context-embedded communication arises during inter-personal interaction, whereas in context-reduced communication, the linguistic cues have to be precise to minimize misinterpretation. A face-to-face conversation on a personal matter and writing an academic article would be the two ends of the continuum (Cummins, 1984: 12-13).

The vertical continuum refers to “the degree of active cognitive involvement in the task or activity” (Cummins, 1984: 13). The upper end of the continuum relates to communicative tasks and activities that do not require much cognitive involvement, whilst the lower end of the continuum involves activities such as “writing an essay on a complex theme”. The framework provides the basis for a task analysis of measures of ‘language proficiency’ and, as such, could provide practical suggestions to practitioners on assessing language proficiency in both L1 and L2.

In concrete terms, CALP can therefore relate to the kind of proficiency needed to use a language as a medium of instruction successfully. This is a point taken up by

Macdonald (1993) in her writings on African primary education in South Africa. She advocated the need to introduce a subject called English as medium of instruction (EMI), in addition to English as subject, for those pupils who did not have English as their mother tongue but were forced to study through that medium. If the interdependence hypothesis is valid, the L1 and L2 CALP should relate strongly to each other. Cummins (1980: 179) does, however, state that the transfer of CALP abilities from the L1 to the L2 (or vice versa) is not necessarily automatic. Factors such as motivation and attitudes can have a negative effect on such transfer.

A host of criticisms (e.g., Edelsky *et al.*, 1983; Martin-Jones & Romaine, 1986) were levelled at Cummins for some of the concepts he developed, such as the BICS/CALP distinction. Cummins (2000) rebuts these criticisms by clarifying misconceptions regarding the constructs of conversational and academic language proficiencies. He pursues this line of argument in his later work when he distinguishes between “three very different aspects of proficiency in a language: (a) conversational fluency, (b) discrete language skills and (c) academic language proficiency” (Cummins, 2009: 22). According to him, in contexts where minority learners have extensive contact with the majority language, as is the case in many immigrant situations such as in the United States or United Kingdom, peer-appropriate conversational fluency in the majority language develops within a year or two of intensive exposure to the language. It takes much longer for learners who are only exposed to the majority language in the context of schooling (Cummins, 2009: 23). As far as academic language proficiency is concerned, he states:

Numerous research studies have shown that at least five years (and often considerably longer) is required for linguistic minority learners to catch up to grade expectations in the majority language. ... Because academic language is found primarily in books (including textbooks) and classrooms, it is important to encourage reading as a means of enabling learners to gain access to this language... Encouragement of extensive writing, across multiple genres, is also a crucial element in enabling learners to gain a sense of control over academic language that is active rather than just passive.

He argues that if *academic language proficiency* or *CALP* is accepted as a valid construct, then there are certain implications for instruction. Cummins (2000:98) states that:

Extensive reading is crucial for academic development since academic language is found primarily in written text. If bilingual learners are not reading extensively, they are not getting access to the language of academic success.

Despite the criticisms against Cummins' writings, his theoretical contributions continue to play a part in discussions, research and policy development in the field of bilingual education, as Baker and Hornberger (2001) demonstrate in their collection of his writings.

The linguistic/cognitive constructs outlined above are supported by the elementary pedagogic principle of moving from the familiar to the unfamiliar in educational practice (Gibbons, 2002; Pattanayak, 1988). It is self-evident that learners, especially within the intermediate phase are likely to learn new concepts and content more effectively through the medium of a language that they know best. As Pattanayak (1988: 387) puts it:

If both the form (i.e. the language) and the content (for instance, scientific concepts) are foreign at the time of the presentation, you make the task impossibly difficult for the child, and defy the pedagogical principle.

In the next section, the focus is on language, and specifically reading, in the content areas, and what challenges English language learners (e.g., mother tongue speakers of Setswana) face in the content areas, specifically Mathematics.

2.4 Content area reading

Although reading skills are taught in the foundation phase, in the intermediate phase learners are expected to read, gather information, and comprehend in many subject areas (Barton, 1997; Little, 2005). Learners of all ages and ability levels are expected to use their existing knowledge to interpret and construct meaning as they are reading (Anderson & Pearson, 1984). Many learners, however, lack critical reading skills and the ability to interact with text in meaningful ways. Content area reading consists of literary reading or informational reading and is often different from the story formats the learners are accustomed to seeing in primary (Foundation Phase) reading materials (Fang *et al.*, 2006; Lesley, 2005). The textbooks used in the intermediate phase are designed around content, and if they are to be understood by learners in

those grades, the learners must possess content area reading skills. Since the teacher directs the instruction in the classroom, the textbook and the teacher become the main sources of learning. Learners often find textbooks too difficult to read and to understand because of the topic-specific concepts, language, and structure (Draper, Smith, Hall, & Siebert, 2005; Nathan, Long, & Alibali, 2002; Radcliffe, Caverly, Hand, & Franke, 2008).

In mathematics, learners are not necessarily taught the processes to read mathematics (Adams, 2003; Brennan & Dunlap, 1985), even though content area reading skills are critical to understanding mathematics texts and content (Allington, 2006; Draper *et al.*, 2005). Even if literacy skills are taught in other content-area classes, the learners may not automatically transfer the reading strategies to mathematics or read well in mathematics (Borasi, Siegel, & Fonzi, 1998; Bossè & Faulconer, 2008; Brennan & Dunlap, 1985; Fisher & Ivey, 2005; Freitag, 1997; Gardner, 2004; Robb, 2003). The reading demands in mathematics are different from those in other subjects. For example, most learners learn to read books in the foundation and intermediate phases from left to right. In mathematics, it is necessary to read from left to right, right to left, top to bottom, bottom to top, and diagonally. In addition, tables, graphs, charts, symbols, and illustrations are a part of mathematics reading and are critical to comprehension of mathematics concepts (Barton & Heidema, 2002; Bossè & Faulconer, 2008; Brennan & Dunlap, 1985). In addition to specialized content area reading skills (such as reading charts and graphs), learners need to be able to apply generic content area reading skills (e.g., make inferences, make predictions) while reading mathematics textbooks and reading and completing assessments.

Although many learners manage to master basic and even intermediate literacy skills, many never gain proficiency with skills that would enable them to read challenging texts in science, history, literature, mathematics, or technology (Grigg, Donahue, & Dion, 2007; Shanahan & Shanahan, 2008). Draper (2002: 524) noted that:

Learners in math classrooms may need assistance reading and creating mathematics texts because either they lack mathematical content knowledge or they lack an understanding of how to use and manipulate mathematical signs and symbols. Mathematics teachers, who are

experts at reading and creating math texts, are in the best position to help their learners engage in this kind of literacy.

Teachers do not feel comfortable teaching something they do not know well or understand (Draper, 2002). Their expertise is the chosen subject matter or content; therefore, they do not see themselves as teachers of reading. Teachers often view content area reading strategies as an add-on that will detract from the content, yet content area reading strategies help to facilitate learning (Richardson, 2008), and there are many content area reading strategies that teachers could use to improve the learners' comprehension of the subject. Reading strategies that learners apply while reading are those that will help them comprehend the material of that subject (Morrison, 1982). In order to be literate in a content area, teachers and learners must be able to read beyond the words; linguistic familiarity is not enough. Roth (2002:18) states that, "Knowing requires...translating back and forth between experience and texts, and familiarity with sign conventionsSimply exposing students to new [forms of] texts through books and lectures will not do." Depending on the reader's ability to comprehend the material in the textbooks, just asking learners to read what is on the page may not result in readers who understand and apply what they read.

There is evidence that content area teachers need to integrate literacy skills and strategies to assist learners struggling to comprehend the material (Draper *et al.*, 2005; Gee, 2001; Lapp *et al.*, 2008; Siegel & Fonzi, 1995). Fang (2008) states that learners experience difficulties making the transition from learning-to-read to reading-to-learn. Some learners have more experience with the storybook type structures, and when confronted with more expository texts in the intermediate grades they begin to struggle with reading. The skills needed to read expository texts at the intermediate grades are different from those used in reading storybooks (Fang *et al.*, 2006). By the time learners are being challenged by content area texts, literacy instruction often has evaporated altogether (Shanahan & Shanahan, 2008).

Teaching content along with the content area reading strategies helps learners improve their reading and their comprehension (Alvermann, 2000; Barton & Heidema, 2002; Billmeyer & Barton, 1998; Donahue, 2003; Hall, 2005; Moore & Readence, 1983; O'Brien, Stewart, & Moje, 1995; Siegel & Fonzi, 1995; Vacca & McKeon, 2002). There is no single programme or way to teach reading strategies,

the research supports building from a foundation of assisting learners in connecting what they know to what they are reading and applying that knowledge to their learning (Allington, 2001; Barton & Heidema, 2002; Billmeyer & Barton, 1998; Moore, Alvermann, & Hinchman, 2000; Zemelman, Daniels, & Hyde, 2005).

2.4.1 Academic English (AE)

According to Scarcella (2003:9), academic English “is a variety or a register of English used in professional books and characterised by the specific linguistic features associated with academic discipline”. As has been indicated in section 2.3.4, two perspectives of academic language, namely CALP and BICS, have been advanced by Cummins. Voluminous research has it that CALP is Academic language and Academic language is CALP. This is the language that can help learners to communicate well in academic contexts, whereas BICS focuses more on social communication. Though Academic English and communicative English are not separate languages, Academic English (AE) is highly structured, more demanding and complex than everyday language which is not strict in grammar and many other language features. To English Language Learners (ELLs), CALP is a second or foreign language, and a language of learning. This is the kind of language that learners need for reading and understanding the study materials, written and oral, the language that is evidently weak in ELLs. In studying Academic English learners should take cognisance of its features, some of which are specialised vocabulary, use of linguistics components such as verbs, adjectives, possessives, adverbs, etc.

To intermediate phase learners, the nature of academic English becomes more demanding and intense because they shift to doing “discipline-specific work with academic and discipline-specific language” (Scarcella, 2003:3). Academic subjects vary in vocabulary and expression, the types of texts used, and how these texts are structured and used. In content areas like mathematics, science, history, and geography, teachers need to teach academic vocabulary explicitly to develop the content knowledge.

Kern (2000, in Scarcella, 2003:3) proposed that academic English is a diverse mixture of multiple, dynamic, inter-related competencies which can be described in three dimensions – linguistic, cognitive, and sociocultural/psychological. Scarcella (2003:11)

divides the linguistic component into phonological, lexical, grammatical, sociolinguistic, and discourse, whereas the cognitive dimension comprises the knowledge component, higher order thinking, cognitive, and metalinguistic strategies. The discourse dimension is important for the study as it enables readers “to gain perspective on what they read, to understand relationships, and to follow logical lines of thought” (Scarcella, 2003:19) which comes handy when reading in content areas such as mathematics. Both the linguistic and cognitive, including strategic dimensions, can help students in learning content areas if used well in the content area classrooms. The cognitive and strategic dimensions involve the critical literacy on the part of the learners – strategically obtain factual information, reading for intentions, question sources, do more than associate sounds, graphemes, meanings, and words (Scarcella, 2003:22). In addition to the above mentioned linguistic features, academic English requires the development of advanced grammar and vocabulary. Research has it that the non-native English learners must be taught the academic English language features in different grades because they do not automatically acquire them in communities. Academic English requires a much greater mastery of a range of the above mentioned linguistic features than ordinary English (Scarcella, 2003:27).

In learning mathematics, learners need knowledge of academic English, mathematical English and “ordinary” English. The three are interrelated as one is the prerequisite of the other. For example, number words in ordinary English function as adjectives where five is an adjective in five books (Setati, 2005:80). Mathematical language can be confusing because it uses both academic language and ordinary language. The word “any” is ambiguous because it can mean every item or may mean one specific item. These two examples are some of the academic English words that make mathematical English difficult.

2.4.2 Reading strategies

The research defines strategies as conscious and flexible plans readers apply and adapt to a variety of texts and tasks (Pressley, *et al.*, 1989). They are intentional and deliberate plans under the control of the reader. Good readers make decisions about which strategy to use, when to use it, and how to adapt it to a particular text (Afflerbach, Pearson, & Paris, 2008; Pressley *et al.*, 1989). By making a decision as to what reading strategy will be used, readers become better able to decode the text,

understand which strategy works best with a particular text, and construct meaning from the text being read. Strategies should be flexible and adaptable. Content area reading strategies assist readers by emphasizing reasoning and applying critical thinking as readers construct and reconstruct evolving meanings from the text. Readers modify strategies for different kinds of text and different purposes (Dole *et al.*, 1991).

Content area reading strategies are tools for learning. To understand how these strategies help learners learn the content, it is helpful to examine how these strategies correlate with general principles of learning. In their 1999 book, *How People Learn*, Bransford and his colleagues described three broad principles of learning and the connections to education (Applebee, Langer, Nystrand, & Gamoran, 2003; Zemelman *et al.*, 2005). Examining reading strategies using the lens of the three principles described by Bransford *et al.* (1999) illustrate how critical these principles are in supporting learners' learning.

The first principle of learning, according to Bransford *et al.* (1999), is that learners come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, learners may fail to grasp the new concepts and information that are taught, or they may learn them for the purpose of a test but revert to their preconceptions outside the classroom. This means teachers must work with learners to uncover, explore, and understand pre-existing understandings and learning that the learners bring into classrooms. There are reading strategies that can assist with activating prior knowledge of the learners before they read. Some call these before reading, preactive, or introductory reading strategies (Applebee *et al.*, 2003; Barton & Heidema, 2002; Billmeyer & Barton, 1998; Fang *et al.*, 2006). Research indicates that when background knowledge is well developed and accurate, learners understand and remember more of what they read (Anthony & Raphael, 1987).

Reading with a purpose is a research-supported practice for use by content area teachers when working with learners prior to any reading. When teachers provide a purpose for reading assignments, learners can focus and filter the reading based on that given purpose. When they have been presented with a purpose, learners have an idea of what is deemed important and what is not. This practice of giving learners

purpose for reading not only gives focus to their reading, but also creates a scaffold for them to use while reading (Fang *et al.*, 2006; Wilson, 2004).

Purposeful reading combined with activating prior knowledge gives learners a way to grasp the text and uncover the concepts so that they understand more of what they are reading. Many readers use information from their own existing knowledge and experiences to relate to text. Background knowledge helps build a model of meaning from the text. The activation of background knowledge encourages readers to extrapolate from or elaborate on their ideas and concepts while they are reading, and this may assist them in filling in any missing information (Anderson & Pearson, 1984).

Determining importance is another reading strategy that can be used before reading or during reading. Determining importance is tied to a reader's background knowledge and is used as a filter to decide what is most important to the reading or problem solving and what might be extraneous information (Afflerbach *et al.*, 2008; Anderson & Pearson, 1984). While determining importance, drawing inferences and prioritizing information become crucial to comprehension of the material (Hansen & Pearson, 1983). By setting a purpose, accessing a learner's background knowledge, or helping learners read to determine importance, teachers are better able to focus on what learners know and what they need to know next in the lesson.

The second principle outlined by Bransford *et al.* (1999) relates to the development of competence in an area of inquiry. Learners must: a) have a deep foundation of factual knowledge; b) understand facts and ideas in the context of a conceptual framework; and c) organize knowledge in ways that facilitate retrieval and application (Donovan, Bransford, & Pellergrino, 1999: 16). Teachers need to assist learners to develop a deep understanding of the content, organize it in meaningful ways, interpret the pieces of information, analyze it to see patterns or relationships, and apply the learning to new situations. When learners see or read words with multiple meanings, it is helpful to make connections to prior understandings of the words and the mathematical meaning of the work so that they can develop definitions based on their own experiences (Coulombe & Berelson, 2001). By helping learners make connections, teachers are developing the learner's deep factual knowledge and organizational skills to possibly be able to apply what is learned. The content of learning and reading have to be engaging and authentic. Teachers need to take cues

from learners, drawing on each learner's deep understanding of a topic and using that as a starting point in their learning and planning (Zemelman *et al.*, 2005).

During reading strategies and after reading strategies used in content-area instruction provide opportunities for learners to take the new knowledge and develop patterns and relationships with what they already know. Using these strategies connects the old and new knowledge; thus they can be used to apply, integrate, analyze, or synthesize the information (Fang *et al.*, 2006; Vacca & McKeon, 2002; Wepner, Strickland, & Feeley, 2002; Wilson, 2004; Zemelman *et al.*, 2005). Having made these connections, learners are then able to construct their knowledge with what they already know and apply it to the new learning.

Learners need to master cognitive strategies for reading and thinking in complex situations in which texts, skills, or requisite knowledge are not always clearly understood. One way to practice and master these skills is to monitor comprehension, which is defined as a process of becoming aware of one's own understanding during reading (Dewitz, Carr, & Patberg, 1987; Shanahan & Shanahan, 2008). While monitoring comprehension, readers ask questions of the text, whether it is to find a definition of a word, to solve a problem, or to connect to information that the reader already knows. The second principle of learning builds content knowledge and assists learners to organize and integrate their learning. The during and after reading strategies provide teachers with ways to help learners connect the content and learning.

The third principle relates to a metacognitive approach to instruction that can help learners to take control of their own learning by defining learning goals and monitoring their progress in achieving them (as cited in Donovan *et al.*, 1999: 17). Inquiries, dialogue, reflections, and monitoring learning all are ways to apply this principle of learning. Learners show their thinking when they are reading. They can summarize or predict to help think about what is being read. They are interacting with the text, which helps them create connections to their knowledge. Teachers model their thinking while they are problem solving or reading to give learners a demonstration of how to be reflective about the work that they are doing to continue to make connections and build upon their knowledge base. In mathematics, as in other

disciplines, learners are expected to integrate their linguistic, cognitive, and metacognitive skills to comprehend text (Mather & Chiodd, 1994).

Questioning the texts while reading, using critical thinking strategies, and problem solving are research-based instructional practices in education. These practices help learners think about their own thinking and learning, which then increases their ability to comprehend. Barton (1997) explains that when readers can recognize problems in their own understanding, they can identify what may be wrong and why the problem occurred. Readers identify strategies that might remedy the problem, and then select and apply the most appropriate strategy. Once the strategy has been used, the reader then decides whether using the strategy is successful, or whether another strategy needs to be used. By using after reading strategies such as summarizing, learners may be able to comprehend more and use what was learned to problem solve or critically think about what they read.

All three principles of learning complement the content area reading approaches and put the cognitive and the developmental needs of the learners at the forefront. The usefulness of a structure for learning has to do with the ability of learners to comprehend the structure and use it as an organizing factor in their learning. Providing a variety of strategies enables learners to use and select the strategy that best fits the content and the material being read. The research-based best practices provide content area teachers some tools for teaching their content with reading strategies as a part of their instruction.

2.4.3 Reading in Mathematics

Brennan and Dunlap (1985: 153) define reading in mathematics as a meaningful interpretation of printed symbols/pictures and of the arrangement of symbols in expressive charts, graphs and tables. Barton and Heidema (2002: iii) define mathematics reading as “the ability to make sense of everything that is on the page...any resource that learners might use to learn and apply mathematics”. Research about reading in mathematics shows that learners need to understand all that is on the page, and that knowing is not just reading what is on the page (Roth, 2002; Shanahan, 2006; Shuard & Rothery, 1993).

School materials are often written at variable levels of reading, so they can pose a challenge to learners if the level is higher than they have achieved. In addition, learners are often not taught the processes for effectively reading those materials; the reading processes and strategies are taught in other classes and may not transfer to mathematics (Brennan & Dunlap, 1985; Shanahan & Shanahan, 2008). Research describes the factors that make reading in mathematics difficult. Learners often attempt to read mathematics texts for the gist or general idea, but do not understand that each word has a precise meaning and that each word needs to be understood specifically in service to that particular meaning (Shanahan & Shanahan, 2008). Leiva (2006) suggested that possibly learners just imitate what the teacher does without fully understanding the problem and its solution.

Abstractions, specialized symbols, concepts, and mathematical vocabulary make reading mathematics more difficult than reading other textbooks, which creates the need for strategic reading of mathematics texts even more crucial (Brennan & Dunlap, 1985). Reading in mathematics appears to be more complex because the texts are written in a succinct style in which there are more concepts per word, per sentence, and per paragraph than in any other kind of text (Brennan & Dunlap, 1985; Culyer, 1988). For example, many ordinary words may have different meanings from those learners may be more familiar with. For instance, compare these two sentences:

Sentence one: Thapelo will set the table.

Sentence two: Let A be a set of all of the male children in the Mokatsane family.

In the first sentence, the word set is used as a verb, and it means—to put or place. In the second sentence, set is a collection or group of objects, numbers or other items. Learners who have difficulties reading may have a tendency to resort to the more familiar, often less technical definition of a word (Kane, Byrne, & Hater, 1974). Using the less technical or content specific term may hinder learners' understanding about the content (Fang *et al.*, 2006). Nasir and Hand (2006) concluded that because mathematics language has its own symbols and abstract language, as well as its complex syntax and register, it complicates the communication process. In mathematics, it is sometimes necessary to read the text of the word problems or the

instructions from left to right; some number lines are read from right to left; tables are read from top to bottom; graphs are sometimes read from bottom to top; and the points on a graph may be read diagonally. In addition, as Bohlman and Pretorius (2002:197) have indicated, “mathematics texts are also hierarchical and cumulative in the sense that understanding each statement or proposition is necessary for understanding subsequent statements. However, even more complex than directionality is the reading comprehension skills required to comprehend mathematics textbooks. The longer text passages in the integrated textbooks are filled with visuals. Additionally, they have more words on the pages and in the word problems, which presents another obstacle in the struggle to read mathematically, words which may be abstract and or conceptually dense.

Readers are often asked to read text on the page, and then to read a graph or table while simultaneously remembering and comprehending what was previously read on the page, and finally to compute and solve the problem. Reading and understanding tables, graphs, charts, symbols, equations, and illustrations is critical in order to be successful in mathematics (Barton & Heidema, 2002; Bossè & Faulconer, 2008; Brennan & Dunlap, 1985). As Draper and Siebert (2004) explained, “Mathematics cannot be separated from the texts in which meanings are created, conveyed, and negotiated, just as literacy cannot be separated from the content that defines how the texts are to be read and written”. In addition, as asserted by Vacca and Vacca (2002:14), “the text, by its very nature, is language, written language” and that “teaching with texts requires its fair share of strategy”.

One facet of reading in mathematics is word problem solving. Learners in a study conducted by Xin (2007) performed 10 -30% worse on word problems than on those in numeric form. Researchers attribute difficulty in solving word problems to difficulty in comprehending abstract or ambiguous language (Borasi *et al.*, 1998; Cummins *et al.*, 1988). Cummins *et al.* (1988:406) described this added layer of complexity:

Like narratives, word problems require skillful mapping of text input onto the reader’s knowledge base if proper comprehension is to be achieved. ...In the case of narratives the reader must map linguistic input onto world knowledge concerning (e.g.) actors and their motives. In the case of word problems, the solver must map linguistic input onto knowledge of the problem domain.

Since solving word problems requires learners to read, a closer look at word problem solving is warranted. If learners are asked to read the problem and then look at other parts of the page or book for more information, their problem solving abilities may be compromised. Research also indicates that learners who have lower memory skills are not as able to maintain the shift that occurs when they are asked to read part of a problem and then look at a chart or graph. When reading mathematics problems, unsuccessful learners use a direct translation model. They identify key words, plug the information into an algorithm, and then attempt to solve the problem. More successful learners use a problem solving model to solve problems. They read the problem and first translate each statement and connect it to what they know, and then determine a process to sort out the relevant information. Successful learners then create a plan to solve the problem (Hegarty, Mayer, & Monk, 1995).

The greatest difficulty in reading word problems is that learners are challenged by connecting the problems to relevant contexts and that often the way in which the problems are stated can cause misunderstanding or interfere with the learner's ability to solve the problem. Although research indicates that even when the word problems are written to make the situation in the problem relevant, learners may not see the relevance of the problem to their lives and may not take the problem seriously (Mayer, 1998).

Research has also focused on the difficulty of word problems. Weaver and Kintsch (1992: 419) asserted that word algebra problems are challenging for most learners and that teachers give well-meaning advice as such as "Read, and reread the problem until what is stated is clear". In fact, just re-reading a problem may not result in deeper understanding, especially if learners are not using reading strategies. In a 1988 study conducted by Riley and Greeno with first graders who solved word problems, the researchers found that non-mathematical factors such as language understanding and text comprehension can influence the difficulty of word problems considerably.

2.4.4 Mathematical discourse

Mathematical discourse has a number of distinctive features, including some aspects which are particular to mathematics classrooms. Bohlman and Pretorius (2002:197)

distinguish mathematical discourse by its features of complex and more compact relationships than normal discourse. Mathematical discourse has a specialist mathematical vocabulary, which includes:

- technical terms specific to mathematics (e.g., equilateral, quotient, probability);
- specialist use of more general terms (e.g., line, factor, frequency); and
- mathematical terms that use everyday words used for unrelated ideas (e.g., function, expression, difference, area).

Learners learning English Academic Language (EAL) need to be aware of the interaction between ordinary English and mathematical English and learn relevant mathematical vocabulary because the mathematics register belongs to the language of mathematics which a language must express for mathematical purposes (Pimm, 1978 in Vithal, Adler & Keitel, 2005:78). Learners of EAL may also need to appreciate how mathematical terminology relates to everyday usage. Strategies might include vocabulary matching activities; use of word lists and dictionaries; providing plenty of opportunities for learners to use words in spoken and written form. Mathematical discourse includes specialist syntax, particularly in relation to the expression of logical relationships. Thus, the use of *and*, *of*, *or*, *a*, *if* and *then* to define mathematical relationships are all significant. Such words, are, however, easy to overlook. Strategies to support the development of syntax could include the use of writing frames or partly structured sentences (e.g., matching a set of 'if' clauses with a set of 'then' clauses).

Thompson and Rubenstein (2000:569) advise on the following issues to consider when comparing the language of mathematics and everyday English:

Mathematical discourse involves the use of mathematical symbols. Such symbols range from numerals to more specialised notations. These symbols have a syntax of their own, so 2×2 and $2 \times$ mean different things. The first 2×2 means two multiply by two of which the answer is 4, while the second $2 \times$ may mean two twos. Again, matching tasks could support the connection of symbols with the related words.

Mathematical discourse includes specialised ways of talking, including written and spoken forms of mathematical explanation, proof or definition, as well as text types like word problems. These broader ways of using language are important in expressing mathematical ideas and reasoning. Strategies for supporting the development of mathematical ways of talking have to involve creating rich opportunities for students to explain their thinking. Thus, structured pair or group work is likely to be supportive (Thompson & Rubenstein, 2000).

Finally, in classrooms, mathematical discourse also includes a social dimension: the particular ways that students and teachers talk in mathematics classes that are not specifically mathematical, but that are associated with mathematics. Instructions, for example, might include expressions like 'simplify' or 'complete the following'. Teachers often use 'we' to refer to 'people who do mathematics' (e.g., we use x to represent an unknown). And word problems, like the example above, 2×2 , are to be interpreted in a way that is specific to mathematics lessons.

2.4.5 Textbooks

Over the past 20 years, changes in practice in mathematics classrooms and teaching methodologies have led to concerns regarding the quality of mathematics textbooks (O'Keeffe & O'Donoghue, 2011). Robitaille and Travers (1992) express the view that textbook content and how such textbooks are used are factors that impact directly on learners' learning. Schoenfeld (1988: 163) argues that while good teaching might compensate for the inadequacies of the textbook, "there is evidence to suggest ... that it does not". While it is widely accepted that the curriculum is central to influencing the choice and treatment of subject matter in mathematics classrooms, one of the key factors in implementing this content is the mathematics textbook (Schmidt, McKnight, Valverde, Houang & Wiley, 1997).

The Department of Basic Education (DBE) (2013) stated that there is a need for teachers to focus on the correct use of the mathematical language and terminology, and to be wary of the possible interplay between everyday language and mathematical language. The terminology used in the mathematics textbooks requires from the teachers to explain and clarify it for the benefit of the learners. This need is greater where English is a second language for most of the learners and

especially those living in rural communities, with limited access to English literature. The motivation for studying teacher mediation of the mathematical language used in textbooks was that mastery of correct language improves the learners' conceptual understanding and procedural fluency (DBE, 2013). This mastery can be facilitated by the teachers' interpretation and simplification of the textbook language. As Warren (2006: 169) puts it: "In relation to language, it is believed that one of the main reasons children experience difficulty in mathematics is in understanding the mathematical language".

Haylock and Thangata (2007) found that technical vocabulary and syntax used in the mathematics textbooks presents language difficulties for the learners. Terms like 'odd', 'the difference between' and 'multiplication' require teachers to explain, simplify and use in such a way that learners grasp their specific meanings in mathematics. Bertoch (2014) says that how language is used in mathematics textbooks is important to study because textbooks are a primary instructional tool available to the teachers and learners. Learners may experience difficulty in understanding the language of mathematics textbooks because mathematics is a language with peculiar vocabulary, symbols and pictorial forms, calling for close attention to detail.

2.4.6 Reading, Mathematics and Assessment for English Language Learners

English Language Learners (ELL) continue to be one of the fastest growing demographics in schools, a reality that presents new assessment challenges for schools and teachers that have never experienced such linguistic and cultural diversity in their classrooms before (Ferrara & DeMauro, 2006; Young *et al.*, 2008). In many schools, the responsibility for all content assessment, namely, testing in subjects such as math, science, geography, and history, falls to classroom teachers who have little background in principles of assessment or second language acquisition (Cizek, 2007). Nonetheless, these teachers are charged with the task of evaluating the content mastery of all learners, including ELLs and non-ELLs alike.

Formal classroom assessment, in the form of tests, is a primary means by which ELL academic achievement is evaluated. Defined as "the collection, evaluation, and use of information to help teachers make better decisions" (McMillan, 2004: 8),

classroom assessment is an important source of information by which learners' scholastic performance is measured. These marks affect subsequent, consequential school and classroom-level decisions like progression (Gottlieb, 2006; Willingham, Pollack, & Lewis, 2002).

Up to this point, the literature related to classroom assessment for ELLs has focused heavily on assessments of English language proficiency. Within the language testing literature, the majority of classroom-based work has related to English proficiency tests (Davison, 2004; Llosa, 2012; McNamara, 2001), which has left questions about ELL school assessment in content areas like math and science largely unanswered. Abedi and Lord's (2001:232) study where ELLs achieved lower performance in Math tests than the English proficient learners, "suggested that unfamiliar infrequent vocabulary and passive voice constructions may affect comprehension for certain groups of students and average and low-achieving students may be at a relatively greater disadvantage in answering mathematics items with complex language". This means that being assessed by use of unfamiliar words may affect comprehension and reading ability of the learners. Teachers should take cognisance of the importance of teaching learners the related vocabulary before they assess them. Thompson and Rubenstein (2000:568) maintain that language of mathematics is an important component of the instruction because it plays three crucial roles in the classroom, which they mention as follows

- We teach through the medium of language. It is our major means of communication.
- Students build understanding as they process ideas through language.
- We diagnose and assess students' understanding by listening to their oral communication and by reading their mathematical writings.

A concern when assessing the mathematics knowledge of ELLs using tests in English is that items with excessive linguistic complexity will reflect their lack of English proficiency rather than their mathematical skills, ultimately making the test not valid and fair for this population of students (August & Hakuta, 1997). Language skills are important for understanding and solving mathematical problems used not only in large-scale assessments, but also in classroom assessments and instruction. However, the

important role of language in understanding and communicating mathematical ideas is not generally acknowledged by teachers of ELLs in their teaching practice.

For ELLs, the teaching of mathematics can no longer be conceived as separate from the teaching and learning of language. Teachers of ELLs must provide sustained linguistic scaffolding for ELLs while encouraging the process of mathematical meaning-making (Anhalt, Civil, Horak, Kitchen, and Kondek, 2007). Addressing the educational needs of ELLs requires mathematics teachers to attend to both content instruction and language development support.

2.5 Summary

The theoretical and conceptual framework that guided this chapter drew essentially on the link between the development of learners' mother tongue (home language) and the acquisition of academic language proficiency in both the mother tongue and a second language in multilingual contexts. The framework incorporated additive and subtractive bilingualism, the threshold hypothesis, the interdependence hypothesis as well as BICS and CALP. It drew substantially on the foundational works of Cummins (1976, 1979, 1980, 1984b, 1986). However, the work of Cummins was complemented by more recent writings such as Alidou *et al.* (2006); Heugh *et al.* (2007; 2010); Skutnabb-Kangas (2009) and others. Perhaps more than any other subject, teaching and learning Mathematics depends on language. Mathematics is about relationships: relationships between numbers, between categories, between geometric forms and between variables. In general, these relationships are abstract in nature and can only be brought into being through language. Even Mathematical symbols must be interpreted linguistically. Thus, while Mathematics is often seen as language free, in many ways learning Mathematics fundamentally depends on language. For learners still developing their proficiency in the language of the classroom, the challenge is considerable. Indeed, research has shown that, while many English language learners are quickly able to quickly develop a basic level of "conversational" English, it takes several years to develop more specialized "academic" English to the same level as a native speaker. If English language learners are to succeed in Mathematics, they need to become proficient in all dimensions of Mathematical English, since to some extent the structure of Mathematics is reflected in the structure of its language.

In this chapter mathematical content area reading literacy was reviewed as having an important role in helping learners understand and interact with Mathematics. Content area reading literacy plays an important role in the academic success of English Language Learners in the mathematics classroom. Mathematics teachers don't need to become reading specialists in order to help learners read mathematics texts, but they do need to recognize that learners need their help reading in mathematical contexts. Teachers should make the strategic processes necessary for understanding mathematics explicit to students. Teachers must help learners use strategies for acquiring vocabulary and reading word problems for meaning. Being aware that learners' prior knowledge and background affects their comprehension is vastly important, as is explicitly analyzing the organization of mathematics texts.

CHAPTER 3: RESEARCH METHODOLOGY AND DESIGN

3.1 Introduction

The research methodology and design are important for any study as it structures the content and supports the specific research paradigm of the study. The purpose of this chapter is to explain the research methodology and design used in this study to gather information about grade four learners' reading in the content area (i.e. mathematics).

This chapter describes the outline of a systematic and focussed investigation of the empirical research process according to the following topics: research paradigm, research approach, research design, sampling, data collection methods, validity, reliability and trustworthiness of the data collection methods, data collection procedures, analyses of the data, ethical considerations and the role of the researcher.

3.2 Literature review

The function of a literature review is to find and describe theoretical perspectives and previous research findings regarding the topic of research (Leedy & Ormrod, 2005:64). A thorough literature review enabled the researcher to identify lacunae or gaps in knowledge which then directed the researcher to pinpoint the topic of this research study and to position it in the context of previous research findings (De Vos *et al.*, 2011: 134; Baker, 2016:265).

The NWU library offers a powerful search platform through the electronic interface Onesearch which automatically searches through many databases such as EBSCHO Host, RSAT, SABINET and NEXUS, to name but a few. In addition, Google Scholar database, as well as the catalogue of the NWU library was also consulted. The reference lists of relevant articles were also thoroughly searched for additional relevant information pertaining to the identified themes. The research process furthermore entails focussed reading and sifting through all the information to obtain the maximum amount of information relevant to the current study. This approach is supported by Leedy and Ormrod (2005:65) who suggest that the researcher should endeavour to cover an extensive scope of the literature on the topic being researched.

The literature review process began with identifying keywords linked to the topic of research. These key words are: *reading literacy, content area, adolescent, mathematics, reading comprehension, vocabulary, oral reading fluency*.

I have reviewed literature on content area reading, which entails the ability to interact with informational or discipline-specific texts. Textbooks are some of the main texts that are used in classrooms to provide subject specific information. These textbooks are dense with specific concepts that use discipline-specific language. Even so, the grade 4 learners are expected to comprehend information in content areas such as mathematics, which they may find challenging because of the structure, language, content, and length, some have maps, graphs, tables, various visuals, etc. Furthermore, mathematics has a different discourse from other subjects, as a result, learners may need assistance reading and interpreting these mathematics texts because reading and linguistic demands are different in math to those of other subjects. According to Thompson and Rubenstein (2000:573), the language of mathematics in mathematics learning and teaching is a vital tool for student learning. Therefore, enculturating learners in the vocabulary, phrasings, and meanings of mathematical language is a dimension of instruction that needs specific attention. In this regard, teachers become by nature providers of assistance to struggling readers as they are the creators of the complex content texts.

Researchers concur that in facilitating learning, teachers can use reading strategies which are viewed as powerful tools to improve the learners' comprehension. Though content area teachers view content area reading strategies as an add-on that will detract from the content, it is the very strategies that help the learners comprehend their content reading. Consequently, teaching content along with the content area reading strategies helps learners improve their reading and their comprehension.

Since grade four learners shift from learning to read to interpreting the texts, it was important to zoom into the language that they need to be able to comprehend expository texts. As such, teachers should take note and be able to distinguish between everyday English and academic English. Academic English requires that advanced grammar, vocabulary and syntax development be used to master the language of learning and teaching. It is therefore significant that ELLs are taught these features as they do not automatically acquire them in communities. Fundamentally,

learners who are proficient in academic English are able to read academic texts critically, interpret, evaluate, synthesise the claims, and cite the reading. In content areas like mathematics, science, history, geography, etc. teachers need to teach academic vocabulary explicitly to develop the content knowledge. Reading comprehension skills are very important in mathematics reading.

3.3 Empirical investigation

3.3.1 Research paradigm

All scientific research is conducted from the specific perspective from which one's research material is viewed. At the commencement of a research project, the researcher needs to consider how she will learn and what she will learn through the course of the project (Firestone, 1987, De Vos *et al.*, 2011). This way of viewing or assumptions about the world is the research paradigm (De Vos *et al.*, 2011; Firestone, 1987) and is also referred to as "first principles" (Guba & Lincoln, 1994). The paradigms are generally divided into quantitative paradigms and qualitative paradigms (Johnson & Onwuegbuzie, 2004:14).

Quantitative paradigms support the assumptions that social observations should be treated as entities in the same way that scientists treat physical phenomena. The observer is also separate from that which is being observed. The researcher should thus remain emotionally detached and empirically justify the stated hypotheses. The knowledge claim of this paradigm is that reality can be observed and measured. The postpositivist paradigm is an example of a quantitative paradigm (Creswell, 2003:7; Johnson & Onwuegbuzie, 2004:14).

Qualitative paradigms support the assumption of multiple-constructed realities. Individuals want to understand the world they live in and they develop meanings of their experiences. These meanings are subjective and complex (Creswell, 2003:8). According to these paradigms, there can thus be no time- and context-free generalizations. The researcher as the observer is an inseparable part of that which is being observed as the subjective researcher is "the only source of reality" (Johnson & Onwuegbuzie, 2004:15). There are no hypotheses in qualitative paradigms. The researcher interprets findings based on visiting the context and gathering information

personally. Reality is not measured in this paradigm, but meaning is generated from interaction between people and their environment (Creswell, 2003:9).

The research problem of this study is of a multifaceted nature. A postpositivist paradigm will not render fitting first principles. The context of the study is grade 4 Setswana-speaking learners whose language of learning and teaching (LoLT) is English. It would be foolish to assume that this reality is objective and simple and that everything in this reality can be measured. A constructivist paradigm will not render fitting first principles either, as there are parts of this reality that can be measured, like the marks learners achieved for an assessment. This research study's first principles need to stem from a combination of a quantitative and a qualitative paradigm. This led to the adoption of a pragmatic paradigm for this study.

The central knowledge claim of the pragmatic paradigm is that the truth is what works best for understanding a particular research problem (Creswell, 2003:11). With regard to the element of ontology, pragmatism accepts singular and multiple realities (Creswell & Plano Clark, 2011:42). In a pragmatic paradigm, no method is specifically prescribed as the focus is not on the methods, but on the problem (Cherryholmes, 1992:13; Creswell, 2003:11). In this paradigm the researcher used all available approaches to understand the problem better. With regard to epistemology, pragmatism is characterised by practicality (Creswell & Plano Clark, 2011:42). The relationship between the researcher and that being researched was determined by what worked best and this governed the way data were collected in this study. Consequently, this paradigm offers the best choice of first principles for this study, as it proposes that there exists a middle ground between quantitative and qualitative paradigms.

3.3.2 Research approach

The research problem of this study is multifaceted. It involved the English reading literacy profiles (e.g. oral reading fluency, retell and reading comprehension) of Grade 4 learners whose Home Language is Setswana, their performance on a school-based mathematics assessment, as well as the Grade 4 teachers' and learners' perceptions of the reading related problems that might be affecting their Mathematics performance, an analysis of the mathematics end-of-term tests and examination papers as well as

the mathematics textbooks. Thus, neither a purely quantitative nor a purely qualitative research approach was fitting.

From a pragmatic viewpoint, it is possible to use components from both a quantitative and a qualitative research approach in this study. This is called a mixed method research approach (Creswell, 2003:18; Leech & Onwuegbuzie, 2009:266). The definition of a mixed method approach given by Creswell and Plano Clark (2011:5) relies on its core characteristics:

- Both quantitative (numeric) and qualitative data (text) are collected and analysed.
- The two forms of data are merged.
- The procedures are combined into a specific research design.

According to this approach, the research has a number of characteristics. Amongst others, the research is problem-centered and pluralistic (Creswell, 2003:18). These two characteristics were evident in this study:

- Firstly, the research problem was a starting point in the research design. The apparent reading challenges experienced by Grade 4 learners whose LoLT is not their Home language when learning mathematics. As the opinions and experiences of the participants were important in this study and there were numerical data to be collected, a mixed method approach was suitable.
- Secondly, the study is pluralistic as it accepts that there is no single answer for the research problem being studied. It also aimed to incorporate the views of different role players.

Personal experience is another criterion for selecting an approach (Creswell, 2003:23). The researcher was aware that the mixed method approach may take more time as both quantitative and qualitative data needed to be collected and analysed. The researcher was prepared to spend extra time on the mixed method approach as it gave her confidence that she was utilising the best elements of the quantitative and the qualitative approaches. The researcher also felt at ease with both the structure of the quantitative research and the flexibility of the qualitative research.

3.3.3 Research design

“A research design is a procedure for collecting, analysing, interpreting and reporting data in research studies” (Creswell & Plano Clark, 2011:53). Without a research design, the researcher would be unable to make the right choices about collecting data and interpreting the findings. The research problem of this study called for a mixed method approach grounded in the pragmatic paradigm.

There are a wide range of available classifications of type of mixed method designs. Creswell and Plano Clark (2011:56-59) tabularised over fifty designs according to the authors of the designs and the discipline. It became evident that there exist different formulations for mixed method designs, although the characteristics of many of the designs seem to be similar. Creswell is generally considered to be a leading author in the field of mixed method research. For the purpose of this study, the terminology of Creswell and Plano Clark (2011) is used when referring to the mixed method design.

The convergent parallel mixed method design was used in this research project. According to Creswell and Plano Clark (2011:77), this is the most well-known design. The choice of this design was based on the way that the quantitative and qualitative strands of the study related to each other, as proposed by Creswell and Plano Clark (2011:63). The typology of triangulation was the motivation for selecting a convergent parallel mixed method design. According to Greene *et al.* (1989:259), “triangulation seeks convergence, corroboration and correspondence of results from the different methods”. The convergent parallel design was initially called a triangulation design because quantitative and qualitative methods were used to get triangulated results (Creswell & Plano Clark, 2011:77; Rocco *et al.*, 2003:22,23). This design is definitely suitable as both quantitative and qualitative data were collected during the same phase of the research process and then merged for an overall interpretation.

Creswell and Plano Clark (20011:64-68) identify four procedural considerations that are important in all mixed method research designs, namely level of interaction between strands, the relative priority of the strands, timing of the strands, and the procedure for mixing the strands.

The level of interaction refers to the extent to which the quantitative strand and the qualitative strand are kept independent or interact with each other. In this study, there

was an independent level of interaction. The quantitative and qualitative data collections were kept separate. The researcher only mixed the results of the two strands when conclusions were drawn and interpretations were made at the end of the study.

The relative priority of the strands refers to the importance or weighting of the quantitative and qualitative methods for answering the research questions. The weighting of the qualitative and quantitative methods is equal in this study, as both components play an equally important role.

Timing indicates the temporal relationship between the qualitative and quantitative research components and describes the order in which the researcher collects, analyses and interprets the data sets. The timing can be concurrent, where the qualitative and quantitative data are collected at approximately the same time and analysis and interpretation do not happen until all data have been collected. This study made use of concurrent timing as the data were collected from grade 4 learners and teachers in a single term and not in different phases.

The fourth procedural consideration is how the quantitative and qualitative methods are mixed. Mixing indicates the procedure for combining the different data sets. Creswell and Plano Clark (2007:83, 84) identify three strategies for mixing quantitative and qualitative data, namely, merging, embedding and connecting the data sets. This study merged the two data sets as part of the interpretation phase after the presentation, analysis and interpretation of the individual data sets.

There are a number of convergent parallel design attributes relevant to this study (Creswell, 2003:62-67). Firstly, the purpose of the design is to obtain different, but complimentary data in the same study to best understand the research problem. In this study numerical data about the reading literacy profile and mathematics achievement were obtained. Descriptive/narrative data were gathered about teachers' and learners' perceptions of the possible reading related challenges learners may be experiencing in the mathematics class as well as a content analysis of the mathematics test papers and the mathematics textbooks. The data is thus different, but as all data are relevant to reading in the content area of mathematics, it is also complimentary. Secondly, the intent of the design is to make use of the strengths of

quantitative and qualitative methods, while at the same time trying to minimize the respective weaknesses of the two methods. Thirdly, the design provides for the implementation of quantitative and qualitative research methods during the same time frame and with equal weight. Fourthly, the design is specifically useful to expand the quantitative results with qualitative data, and finally, the two data sets were merged. This was accomplished by bringing together the quantitative and qualitative results during the interpretation phase of the research. The purpose of the convergent parallel design is to find valid and well-substantiated conclusions about the phenomenon, in this case the challenges faced by the Grade 4 Setswana-speaking learners' in English as LoLT used in mathematics.

A mixed methods research model for this study was developed as a conceptualisation of the research design and process. Figure 3.1 is a model of the study's convergent parallel mixed method research design.

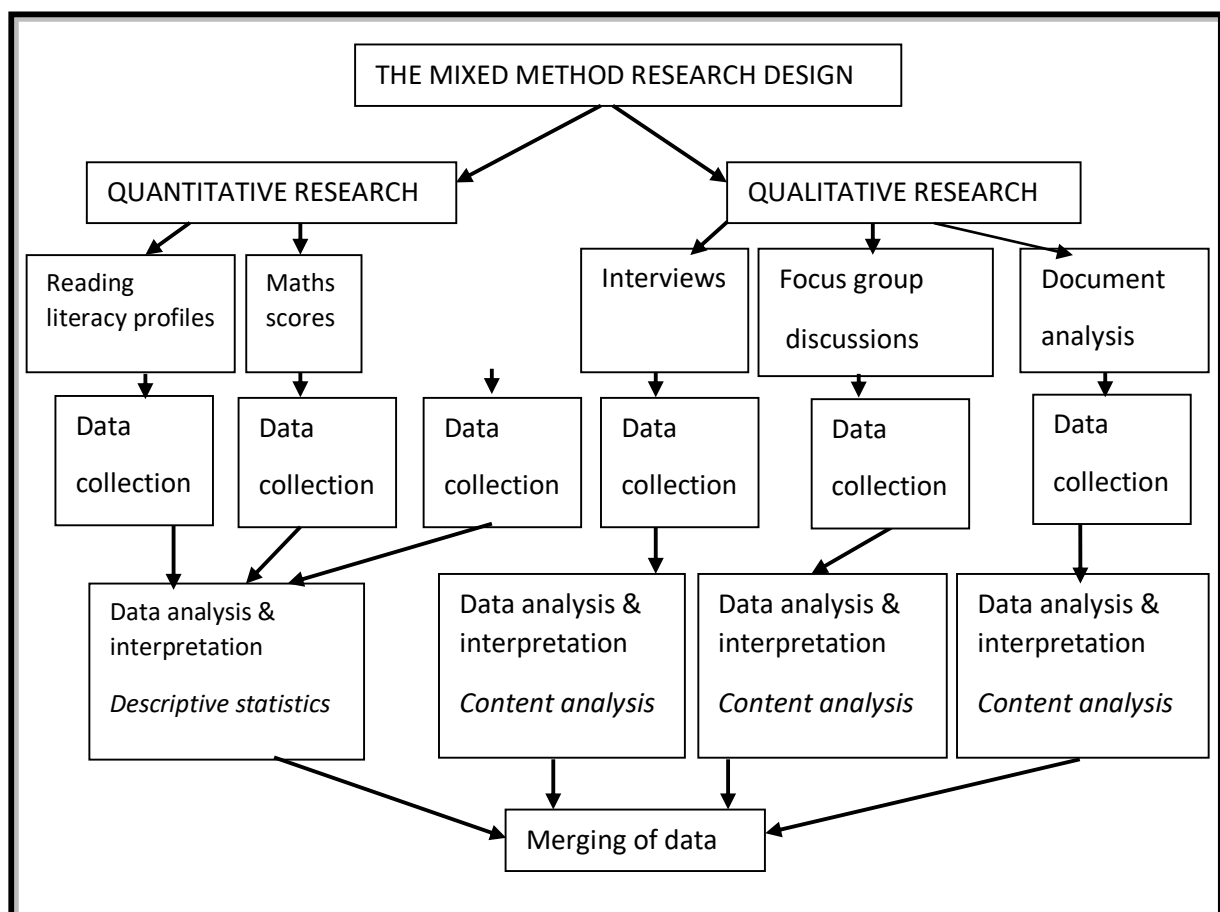


Figure 3. 1 The mixed methods research model

3.3.4 Sampling

The ideal population that a researcher may want to target may be too large to manage during the research period. Where the population characteristics are known and a sufficient sampling frame exists, then the researcher can draw a representative sample (May, 2011:101). Sampling refers to the selection of participants from the total population with which the research problem is concerned (Joubert *et al.*, 2016:39; De Vos *et al.*, 2011:223). The group of participants is much smaller than the population, but it is representative of the total population. In May's (2011:98) words, a good sample is a miniature version of the population.

Teddlie and Yu (2007:87) define mixed method sampling "as involving the selection of units of analysis for a mixed method study through both probability (quantitative) and purposive (qualitative) sampling strategies". According to these researchers, creativity and flexibility in the sampling design of mixed method research is important. For this research study, the researcher adhered to the suggestion of Teddlie and Yu (2007:98) and used a creative combination of purposive sampling and key informant sampling (non-probability sampling). According to May (2011), purposive sampling occurs when a selection is made according to a known characteristic as in the case of Tlhapi district schools that offers Grade 4 mathematics in English to Setswana Home language learners. Furthermore, with regard to key informants, I selected the Grade 4 teachers who teach the selected learners and who are also responsible for setting their mathematics assessments; in addition, the Grade 4 learners were selected – those whose LoLT is English while their HL is Setswana (cf. Table 3.1).

3.3.4.1 School characteristics

According to Silberman (1973:122), schools differ "according to the nature of the community, parents, the schools' own history, and tradition, the outlook of its teachers and administrators". However, for this study, the differences and similarities between schools are trivial. After the study topic was chosen, I decided that the study would sample urban learners because they are generally more advantaged and exposed to a print rich environment, there is transport access between home and school, and the socio-economic status of parents is very similar, etc. unlike the rural schools' learners. The study identified 13 primary schools that offered mathematics to grade 4 learners

whose HL is Setswana in a township in the Tlhapi District. In fact, in the planning stage, all 13 primary schools were identified but finally only four agreed to participate in the study. Of the four selected schools, one school dropped its participation after completion of the first assessments because a project of building extra classrooms at school began and there was a lot of disturbance related to noise and movement. At the time of the study, schools were not willing to participate because they were preparing for the Annual National Assessments (ANA) which resulted in a lot of timetable rescheduling. The single-stage purposive sampling procedure was therefore followed in this study.

The following are the characteristics of the three schools that participated in the study. There are 13 primary schools in a township in the Tlhapi District, of which 9 are located in the old area of the township, four are located in the new extended areas (usually referred to as extensions by residents). Out of nine schools in the old area of Ikageng, seven schools offered Setswana as Home Language, however only three schools agreed to participate in the study. All three schools are located in the predominantly Setswana speaking communities, with little visibility of the shacks. Distance between the schools had travelling implications which offered the researcher no other option but to sample the schools that were in the old location. Another reason for selecting and sampling from the old location was that the schools had the same establishment experiences and character in contrast to those that are located in extensions.

The teaching of the curriculum at all three schools is followed from the South African Department of Basic Education. The Provinces are tasked to implement the Curriculum and Assessment Policy Statement (CAPS) through Advisory services, which visit the schools and conduct implementation and empowerment workshops for the teachers of specific phases.

In all three schools, mathematics was taught by one teacher in each school. The desks were arranged in neat rows, facing the front of the classroom, with enough space in between for the teacher to walk back and forth. The setup in the classroom was that the same gender shared the desk, for instance a girl learner sat with another girl learner. Although two learners shared a desk, each learner had his/her own textbook. The classrooms consisted of the teacher's table, a chair, and the cabinet to store the books – learners' books that had to be graded and prescribed textbooks. There were

no charts on the side walls, only at the back, not even a calendar or any kind of poster that learners could glance at on a daily basis. In all these classes maths was offered for 30 minutes on Monday to Friday and English First Additional Language for 30 minutes on a daily basis.

The three schools were classified as quintile 1 schools, and they offered grades R to 7 to Setswana Home Language speakers. It is important to remember that the Grade 4 learners at all three schools, were in Grade 3 in the previous year, where their medium of instruction was their Home Language Setswana which changed to English as language of instruction in Grade 4. Some learners lived closer to the schools, some walked distances, while others whose parents could afford a taxi were transported to school by a taxi. School N differed from other two schools in that it was classified as a Full Service school. According to the Department of Basic Education, a Full Service school is a school that offers instruction to learners with special needs. Unlike the other two schools, school B received full support from the Department of Basic Education's mathematics subject specialist because it was identified as a pilot school for a mathematics laboratory where learners who struggled with maths could attend and have extra maths practice in the presence of the teacher. Table 3.1 gives an overview of the number of teachers and learners at each school.

Table 3. 1: Number of teachers and learners at each school

Name of school	Number of Grade 4 Math teachers	Grade 4 Math classes	Total number of Grade 4 Math learners
School B	1	3	80
School L	1	4	94
School N	1	3	88
Grand Total	3	9	262

3.3.4.2 Learner characteristics

Table 3.2 indicates the number of learners and their gender in each school.

Table 3. 2: Learner statistics

Name of school	Total number of Grade 4 Math Learners	Females	Males
School B	80	48	32
School L	94	61	33
School N	88	45	43

3.3.4.3 Teacher characteristics

One of the most difficult variables to control in classroom research is the teacher. Human beings and the situations that they find themselves in are too complex to be subjected to a too rigid research environment. The following information related to the teachers, namely, experience, qualification, gender, age, and Home Language and any other language that they were able to speak are presented in Table 3.3.

Table 3. 3: Teacher statistics

Name of school	Mathematics teachers	Gender	Age	Qualification	Math teaching experience	Teaching experience	HL
School B	1	M	62	UDE Grades 8-12	2 years	31	Setswana
School L	1	F	49	PTD Grades 4-6	4 years	22	Setswana
School N	1	M	48	SPTD Grades 7-9	1 year	25	Sesotho

One factor that came as a surprise was the language status of the teacher at school N, who was a Sesotho Home Language speaker and not Setswana, the language of the learners. The teacher claimed that in grade 4 learners needed more of English First Additional Language than their Setswana Home Language because they had changed to a new phase where LoLT is English.

With regard to the teachers' academic qualifications, the teacher at school N had a Senior Teachers' Diploma certificate. School B's teacher was in possession of a University Diploma in Education (Senior Certificate), while the teacher at school L had a Primary Teachers' Diploma and later acquired an Honours in Educational Psychology and Setswana, she taught math in grade 4 but most of her experience is with other grades in other subjects but not math.

3.3.5 Data collection methods

In this study a convergent parallel mixed method design was applied. As stated in section 3.3.3, this design makes use of both quantitative as well as qualitative methods for data collection. Each of the data collection methods are discussed in the following two sections.

3.3.5.1 Quantitative data collection methods

The following Dynamic Indicator of Basic Early Literacy Skills (DIBELS) Next assessments were administered, namely, Oral Reading Fluency (ORF), Retell and Reading Comprehension (Daze). These are assessments that are used to measure the acquisition of early literacy skills from Grade R through Grade six.

a) Oral Reading Fluency and Retell

DIBELSNext Oral Reading Fluency is an indicator of advanced phonics and word attack skills, accurate and fluent reading of connected text, and reading comprehension (cf. Table 3.4). Advanced phonics skills are an extension of basic phonics skills such as letter-sound correspondence and decoding of simple letter patterns. Advanced phonics includes skills such as:

- Common sounds related to combinations of letters;
- Understanding the way the position of the letter(s) in a syllable or word affects the sound, and
- Knowledge of affixes (Good, Kaminski, Cummings, Dufour-Martel, Petersen, Powell-Smith, Stollar, & Wallin, 2012).

Table 3. 4: Overview of DIBELS Oral Reading Fluency

Basic Early Literacy Skill	Advanced Phonics and Word Attack Skills Accurate and Fluent Reading of Connected Text Reading Comprehension
Administration Time	1 minute plus 1 minute maximum for Retell
Administration Schedule	Middle of Grade 1 through end of Grade 6
Score	• Median number of words correct per minute (Words Correct) • Median number of errors per minute (Errors) • Median number of correct words in the Retell • Median Quality of Response for the Retell
Wait Rule	On DORF, 3 seconds; On Retell, first hesitation 3 seconds
Discontinue Rule	If no words are read correctly in the first line, say Stop, record a score of 0, and do not administer Retell. If fewer than 10 words are read correctly on passage #1 during benchmark assessment, do not administer Retell or passages #2 and #3. If fewer than 40 words are read correctly on any passage, use professional judgment whether to administer Retell for that passage.

(Good, Kaminski, Cummings, Dufour-Martel, Petersen, Powell-Smith, Stollar, & Wallin, 2012:55)

Word attack skills are the approach to pronouncing and knowing the meaning of a word through the application of phonics, the use of context, and knowledge of morphology. Advanced phonics and word attack skills facilitate the accurate and automatic reading of connected text (National Reading Panel, 2000).

Accuracy and fluency with connected text, both critical components of skilled reading, allow meaning to be gained from text. To read a text easily and make sense of it, a large percentage of the words must be decoded effortlessly (Ehri, 1998). Reading fluency depends on well-developed word attack skills (National Reading Panel, 2000), efficient and automatic decoding of regular and irregular words, and the use of expression and phrasing while reading aloud. Oral reading fluency in connected text is more than the accurate reading of words in lists and is not speed-reading. Oral reading fluency can be described as the bridge between accurate, automatic, word-level decoding and reading comprehension.

b) Administration directions

There are two components to DIBELSNext Oral Reading Fluency namely, oral reading fluency and passage retell.

- For the oral reading fluency component, learners are given an unfamiliar, grade-level passage of text and asked to read for 1 minute. Errors such as substitutions, omissions, and hesitations for more than 3 seconds are marked while listening to the learner read aloud (cf. Figure 3.1). For benchmark assessment, learners are asked to read three different grade-level passages for 1 minute each. The score is the median number of words read correctly and the median number of errors across the three passages. Using the median score from three passages gives the best indicator of learner performance over a range of different texts and content.
- The passage retell component follows the reading of each passage, provided that the learner has read at least 40 words correct per minute on a given passage. Passage retell is intended to provide a comprehension check for the DIBELSNext Oral Reading Fluency assessment, and provides an indication that the learner is reading for meaning. With a prompted passage retell, the learner is instructed to read for meaning. Speed reading without attending to text comprehension is undesirable and will be readily apparent in the learner's retell.

During retell, the learner is asked to tell about what he/she has read. Passage retell provides a valuable indicator of reading comprehension. The assessor indicates the

number of words in the retell that are related to the passage by drawing through a box of numbers. Following a hesitation of 3 seconds, learners are prompted to tell as much as they can about the passage. If the learner hesitates again for 5 seconds or longer, or if the learner is clearly responding for 5 seconds in a way that is not relevant to the passage, the task is discontinued. The assessor must make a judgement about the relevance of the retell to the passage.

16 DIBELS® Oral Reading Fluency

Kinds of Hats

0	A hat sits on top of the head. There are many kinds of hats. Some	15
15	hats have special jobs, and some hats are just for fun.	26
26	A hard hat keeps the head safe. It is made out of plastic. House	40
40	builders wear this kind of hat. Things that fall cannot hurt their heads.	53
53	Firefighters also use a hard hat. Their hats have a wide brim on the back	68
68	to keep fire and heat away. You also wear a hard hat when you ride a	84
84	bike. That hat is called a helmet.	91
91	Many workers wear hats that show the job they do. Some of these	104
104	hats are made of cloth. Police officers wear a flat hat that is the same	119
119	color as their uniform. Chefs wear tall white hats when they cook.	131
131	People use different hats to match the weather. Wool hats fit closely	143
143	over the head. They keep the head and ears warm in the winter. Sun	157
157	hats and baseball caps have a wide brim or bill. These hats shade the	171
171	face and eyes from the sun in the summer.	180
180	Hats don't always have a job. Some are just for fun. Birthday party	193
193	hats are made of paper. They have bright colors and cute pictures.	205
205	Next time you walk in the neighborhood, go on a hat hunt. You will	219
219	be surprised at how many different hats you can find.	229

Total words: 73

Errors (include skipped words): – 15

Words correct: = 58

Figure 3. 2 Oral Reading Fluency

(Good, Kaminski, Cummins, Dufour-Martel, Petersen, Powell-Smith, Stollar, & Wallin, 2012:64).

The assessments were administered as laid down by the rules of DIBELS ORF administration in Dynamic Measurement Group, Inc. (2011) as shown in Figure 3.1 above. I personally administered the passage readings to all Grade 4 learners.

c) DAZE Reading Comprehension

Daze provides an indicator of silent reading comprehension. As an assessment of reading comprehension, Daze provides an indication of whether or not a learner understands what he or she has read (cf. Table 3.5). Daze assesses the learner's ability to construct meaning from text using word recognition skills, background information and prior knowledge, familiarity with linguistic properties such as syntax and morphology, and reasoning skills. The Daze is the standardized measuring for reading comprehension. Daze can be given to a whole class at the same time, to a small group of learners, or to an individual learner.

Table 3. 5: Overview of DIBELS Daze

Basic Early Literacy Skill	Reading comprehension
Administration Time	3 minutes
Administration Schedule	Beginning of Grade 3 to end of Grade 6
Score	Number of correct words in 3 minutes minus half the number of incorrect words

(Good, Kaminski, Cummings, Dufour-Martel, Petersen, Powell-Smith, Stollar, & Wallin, 2012:55)

d) Administration directions

Using standardized directions, the learners in the class are asked to read a passage and circle the words that make the most sense in the story. Three choices of missing words are given. The learner has to circle the word that makes the most sense. The

score is the number of correct responses, minus half the number of incorrect responses, which compensates for learners guessing. By design, approximately every seventh word in the Daze passages has been replaced by a box containing the correct word and two distractor words (cf. Figure 3.2).

The learner receives credit for selecting the words that best fit the omitted words in the reading passage. A scoring key is used for scoring, learners receive 1 point for each correct word that is circled. Put a slash through words that are incorrect. Incorrect responses include errors, boxes with more than one answer, and items left blank that are blank because they were skipped. The scores that are recorded are the number of correct and incorrect responses. An adjusted score, which compensates for guessing, is calculated based on the number of correct and incorrect responses. Daze is a 3-minute indicator of reading comprehension and is an easy measure to learn to administer and score. The measure can be group-administered for benchmark assessment, or individually administered for progress monitoring.

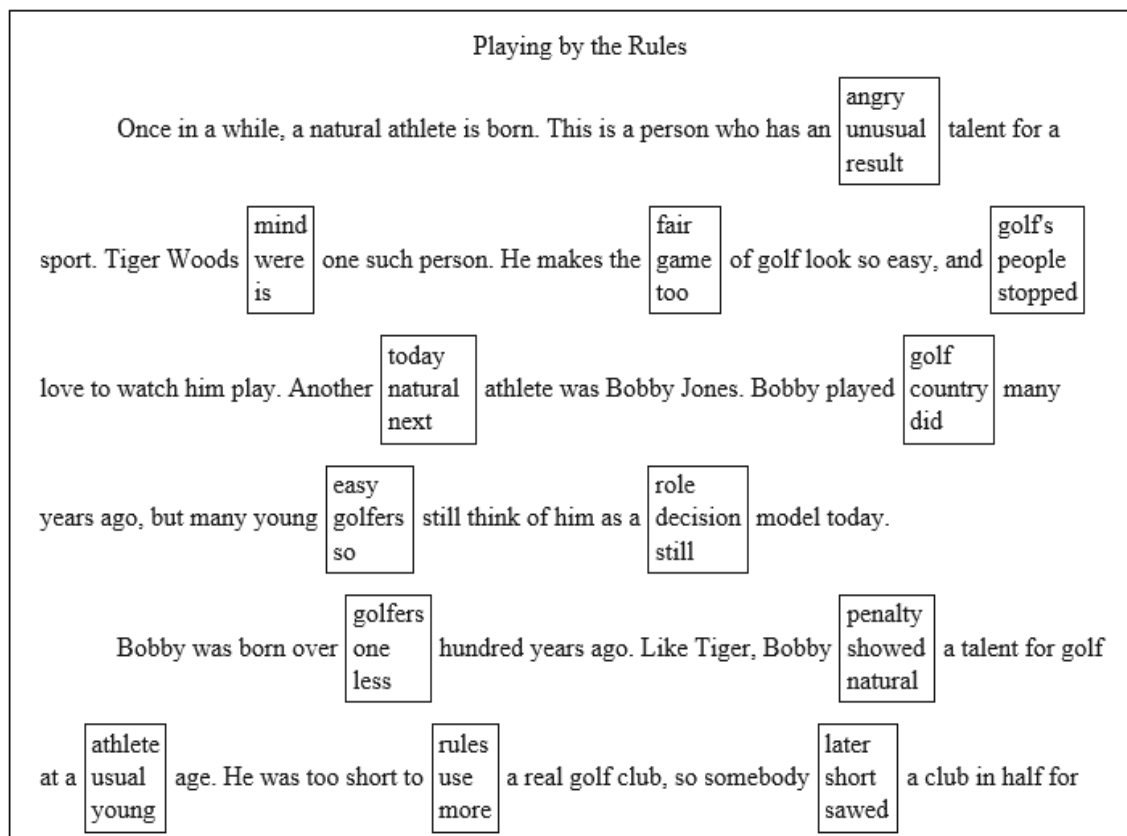


Figure 3. 3 DIBELS Daze

(Good, Kaminski, Cummings, Dufour-Martel, Petersen, Powell-Smith, Stollar, & Wallin, 2012:64)

e) Mathematics test

Research instruments are developed and used in order to capture or collect appropriate data. Data is appropriate if it provides evidence that helps to unravel the problem that the research study seeks to solve. In order to capture appropriate data, the instruments that are developed must suit the task for which they are meant. A mathematics test that was generated by the researcher using items from the selected teachers' school-based Math assessments was used.

Twenty three (23) multiple choice format items were developed for the test, with five predetermined answers where learners chose the correct answer. This means that there were no open-ended questions, though calculations had to be done to arrive at the correct answer. Question 1 was based on tally table. It was followed by questions 2 - 4 that had words and numerals. Question 5 was comprised of numerals, words and a number line. Questions 6, 7 and 10 were fractions questions, while questions 8 and 9 were number pattern questions. Questions 11 and 12 were word problem questions, the question 11 involved addition and subtraction and question 12 involved shapes respectively. Questions 13 – 17 were based on the map that was provided while questions 20-22 were based on the graph. Question 23 was based on a month's calendar (cf. Appendix F). The test papers were also used as the answering papers, meaning that learners answered on the test papers because possible answers were provided on the test paper.

f) Administration directions

The researcher personally administered the maths test at each school. As there was more than one class at each school, the math teachers would go to the other classes to keep the learners quiet, while the researcher administered the test in one class. The researcher and the teacher rotated until all classes had been administered the test. All schools and all classes received uniform instructions on how to complete the test. All learners were familiar with multiple choice questions as they had done such tests before.

3.3.5.2 Qualitative data collection methods

According to Johnson and Onwuegbuzi (2004:18), the inclusion of quantitative and qualitative methods in mixed method research “is likely to result in complementary strengths and non-overlapping weaknesses”. To apply these strengths in this study, the researcher included three qualitative research data collection methods to gain additional information on the challenges facing Grade 4 Setswana speaking learners who have to learn maths via English as LoLT. The researcher held semi-structured interviews, focus group interviews and also completed document analyses on the prescribed textbooks, and math test of term three of the academic year.

a) Semi-structured interviews

The interview is a managed verbal exchange (Ritchie & Lewis, 2003) and as such its effectiveness heavily depends on the communication skills of the interviewer (Clough & Nutbrown, 2007). These include the ability to clearly structure questions (Cohen *et al.*, 2007); listen attentively (Clough & Nutbrown, 2007); pause, probe or prompt appropriately (Ritchie & Lewis, 2003: 134); and encourage the interviewee to talk freely, “Make it easy for interviewees to respond” (Clough & Nutbrown, 2007: 134). Interpersonal skills such as the ability to establish rapport, perhaps with humour and humility, are also important (Opie, 2004). This last point draws attention to the relational aspect and trust which is needed between participants. For the purpose of this research, interviews were conducted according to a semi-structured interview schedule or in-depth questions as proposed by Greeff (2011: 151-152). This specifies predetermined questions and sequences for the interviewer (cf. Addendum A). Of course, the purpose of the interviews was to investigate the challenges that math teachers face and how they deal with those challenges when teaching mathematics in English to the Grade 4 Setswana speakers who were taught mathematics in Setswana in Grade 3. Further, the interviews were aimed at establishing how teachers reacted when learners do not understand academic English during the lessons and assessments.

b) Interview procedure

The interviews at different schools were conducted on different days and times. I recorded the data separately so that I could distinguish between the teachers`

responses of the three schools. I was allocated the times by the mathematics teacher of each school, which did not disturb the lessons and other activities of the school.

The recording of the interview data took place by means of note-taking and audio recording as recommended by, among others, Gall *et al.* (1996), Huberman and Miles (2002) and De Vos *et al.* (2011). The note-taking served as a back-up procedure if the audio recorder should malfunction. I asked permission to record their responses and that was accepted by them. Interviews with the teachers took place in the staff rooms.

There was also sensitivity to the specific situation of each respondent, because of the school-specific circumstances and work-related priorities. Interview skills are not simple motor skills, but involve a high order combination of observation, empathic sensitivity and intellectual judgement of the interview situation and person being interviewed (Denzin & Lincoln, 2005).

The initial task was to establish a friendly, secure and cooperative relationship with the interviewee by a word of thanks for being willing to partake in the research. The participants were assured of the confidentiality of their participation in the interview and the background of the research and related aims were explained to provide the interviewees with relevant and necessary information about the research. The format and sequence of questioning were also explained before the actual interview. The pace and time during the interview were continuously monitored (Best & Kahn, 2003; Breen, 2006). The preceding information and explanations were also included in the cover letter that was handed to each participant (cf. Addendum B). A copy of the interview schedule, with the contact detail of the researcher was provided to each interviewee for possible future enquiries.

c) Focus group interviews

Focus group interviews is “a way of collecting qualitative data, which – essentially- involves engaging a small number of people in an informal group discussion (or discussions), ‘focused’ around a particular topic or set of issues” (Wilkinson, 2004: 177). Focus group interviews are regarded as a research method that collects data through group interaction in which participants are encouraged to share perceptions, points of view, experiences and concerns in a non-threatening environment and without any pressure to reach consensus (Denzin & Lincoln, 2005; De Vos *et al.*,

2011). Focus groups allow the investigation of a multitude of perceptions in a defined area of interest and are fundamentally a way of listening to and learning from people to acquire ideas and insights (Breen, 2006).

Focus group interviews are less structured compared to semi-structured interviews. This is because of the difficulty in bringing structure in a group; however, rich data can emerge through interaction within the group, for example, sensitive issues that could have been missed in individual interviews, may be revealed. In a group, people develop and express ideas they would not have thought about on their own (Preece, Rogers & Sharp, 2002).

The purpose of the focus group interview in this study was to ensure cumulative and more elaborative data for a fuller, deeper understanding of the research topic according to the research purpose (Denzin & Lincoln, 2005; De Vos *et al.*, 2011; Breen, 2006). Also, to understand their perceptions and what they could indicate as their challenges in mathematics.

Krueger (1994: 17) has endorsed the use of very small focus groups, what he terms “mini-focus groups”, which include three or four (Krueger, 1994) participants, when participants have special experiences to discuss in the group. The approach during the above-mentioned focus group interview was at first a welcoming address followed by a brief overview of the purpose of the research. The focus group comprised of learners in one Grade 4 class at each of the three schools. The focus group in school B had 21 learners, while school L and N’s had 30 and 25 respectively. Caution was taken to ensure an interactive and participative atmosphere in which all participants had an opportunity to share their views (Denzin & Lincoln, 2005; Breen, 2006; Mertler, 2006).

d) Document analysis

Documents are defined by Merriam (2009: 139) as “a wide range of written, visual, digital, and physical material relevant to the study at hand”. Documents are important because they offer the researcher descriptive information that, unlike interviews or observations, is not altered by the presence of the researcher (Merriam, 2009). They also help the researcher discover meaning, and develop understanding and insights relevant to the research questions.

Document analysis is often used in combination with other qualitative research methods as a means of triangulation, “the combination of methodologies in the study of the same phenomenon” (Denzin, 1970: 291). Document analysis yields data — excerpts, quotations, or entire passages—that are then organised into major themes, categories, and case examples specifically through content analysis (Labuschagne, 2003). Merriam (1988: 118) pointed out that, “Documents of all types can help the researcher uncover meaning, develop understanding, and discover insights relevant to the research problem”.

Atkinson and Coffey (1997: 47) advise researchers to consider carefully whether and how documents can serve particular research purposes. As the authors emphasise:

We should not use documentary sources as surrogates for other kinds of data. We cannot, for instance, learn through records alone how an organization actually operates day-by-day. Equally, we cannot treat records—however ‘official’—as firm evidence of what they report. That strong reservation does not mean that we should ignore or downgrade documentary data. On the contrary, our recognition of their existence as social facts alerts us to the necessity to treat them very seriously indeed. We have to approach them for what they are and what they are used to accomplish.

e) *Mathematics test papers*

The test papers of the end of each academic *term*, including the June and November, examinations were collected from the math teachers of the three schools. These schools wrote similar June and November examinations papers that were also moderated. All tests were allocated 40 minutes of writing time. The term one paper consisted of 10 questions with allocation of a total of 40 marks. The term two paper was the June examination which consisted of a total of 40 marks with a time allocation of 1 hour 30 minutes. The paper consisted of a total of 11 questions. The term three paper consisted of six question with a total of 40 marks. The final term paper which was the final year examination paper, consisted of 14 questions with a total mark of 40, with a time allocation of 1 hour 30 minutes. All four tests stated that learners were not allowed to use a calculator. The language of the papers was English, even the instructions were not followed by Setswana for clarification.

f) Textbooks

In addition to the above mentioned documents, prescribed textbooks of the learners and the teachers' books were collected to analyse the mathematics language used in grade four and the type of questions and phrasing of problem questions. All three schools used the same workbook and different textbooks, except that the teacher of school L used extra textbooks which were not prescribed by the Department of Basic Education.

The following aspects were analysed:

- mathematical words that are related but confused by the learners because of their distinct meanings (e.g. fives and fifths);
- terms found only in mathematical contexts (e.g. denominator);
- mathematical words that are shared with English and have comparable meaning, but which their mathematical meaning is more precise (e.g. difference);
- words that have more than one mathematical meaning (e.g. round);
- words that are shared between mathematics and English, but they have different meanings in the two contexts (e.g. volume);
- words shared with other disciplines have different technical meanings in the two disciplines (e.g. divide);
- mathematical concepts are verbalised in more than one way (e.g. one-quarter vs one-fourth); and
- Prepositions with different meaning from the English prepositions (e.g. is, has)

3.4 Data collection procedure

Different types of data, quantitative and qualitative, were collected using different types of instruments that would help to answer the questions in the study. The researcher personally administered all the quantitative instruments at all three schools. Grade 4 teachers, however, helped with monitoring/invigilation during the oral reading fluency, reading comprehension, and maths. The reading comprehension test was administered first. Math was then tested a week after collecting the reading comprehension data. The oral reading fluency (ORF) was administered three weeks

after the math data collection because the schools were engaged with schools and education department activities, which could not be disturbed by the writing of my research tests. It took a full day to administer a single class. Below are the procedures that were followed during data collection:

On the first day of data collection, I started by testing the learners' reading comprehension. I started at school N in the morning before first break where there were three Grade 4 classes, after first break I went to test learners of school B and later in the day I tested the learners at school L. A few days before the tests were written I met with the math teachers to explain the procedure that I wished to follow in their classes during the administration of the tests, and requested them to help me with monitoring in the different classes.

I explained to the teachers that:

- I was going to speak with the learners to explain to them that they were going to write a short reading comprehension test and that they should do their best.
- I also indicated that learners should not ask the teachers questions, nor explain anything during the writing of the tests.
- Learners would be given opportunity to ask questions if they did not understand before the assessments were given out to them.
- I agreed with the teachers that the Math test duration would not be longer than 45 minutes.

In each class, I explained the following to the learners:

- I was going to give them a reading comprehension test.
- The test has a multiple choice format.
- They should read the passage and do the best they can.
- Before beginning, an example item was done with the learners to ensure that they understand the test instructions and what to do.
- It was also explained to the learners that the test results would not affect their school marks.

3.4.1 ORF

ORF assessments took longer than the other assessments because in testing each learner in each Grade 4 class, in each of the three schools, I had to listen to each learner read to me. I administered ORF as explained in section 3.3.5.1(i). School B allocated the computer room to administer the ORF while schools L and N allocated me one of the teachers' office. I used my cell phone clock to set the alarm for one minute of reading. When the learners finished reading and retelling they would call another learner from the class, according to the class list.

3.4.2 Maths

The procedure of administering the math test was similar to that of the reading comprehension test. In addition, learners were allowed to do the calculations on their test papers to compute the answers. There was lots of questions when learners wrote the math tests even when they were told that they were not allowed to ask questions. More questions were on the meaning of words in Setswana. I did not translate the words for them but requested them to try to figure out what the questions required them to do.

3.4.3 Teacher interviews

Teacher interviews were conducted after administration of quantitative data collection. Interviews were held with individual teachers at their respective schools to get their opinions about and understand the challenges they may experience in teaching math in Grade 4 in English. During the process of the interview, I allowed the teachers to elaborate. Where responses were not clear, I had to seek both clarification and elaboration (cf. May, 2011:134). After I explicitly encouraged the teachers to give descriptive statements and more elaboration, the nature of the interviews was more open and relaxed. Both the teachers at schools L and N were more spontaneous and elaborate than the teacher at school B. I also assured the interviewees that their participation and answers are valued. From the teacher from school B, I used probes where necessary, to encourage him to give his opinions (cf. chapter 4). This is presented in the following chapter focusing on the data presentation. Interviews were conducted in English and Setswana. Interviews took an hour.

3.4.4 Focus group interviews

The focus group interviews were conducted before the teacher interviews (Appendix G). One class of Grade 4 learners, out of three classes, from each of the three schools were interviewed in English with regards to the tests that they had written. Learners were told to be free to explain as much as they wished, and even use Setswana if they could not express themselves in English. There was a list of pre-determined questions and the interviews were more interactive. Interview questions were based on the learners' experiences/opinions related to the written math test. Also important to establish was their experience with being taught Math in English. It was quite difficult for the learners to express themselves in English. I had to allow them to use any language that they preferred so that they can feel free to express themselves. Participants then became more spontaneous. I also explicitly encouraged the focus group participants to talk to one another (May, 2011:142). The interviews lasted for 30 minutes.

3.4.5 Document analysis

The following documents were analysed:

- Mathematics tests of terms 1 and 3 generated by the teachers of each school
- June and November examinations
- Grade 4 mathematics workbooks and textbooks

The documents were obtained from the teachers. Information was checked from two quarterly math tests, and the June and November examinations. They were read in conjunction with the workbooks and textbooks to relate their use of English and the phrasing of the questions. In the quarterly tests the following information was noted:

- words that are shared by mathematics and everyday English, but have different meanings in the two contexts (e.g. data);
- words that have more than one mathematical meaning (e.g. round);
- words that are homonyms with everyday English (e.g. sum / some);
- English spelling and usage have many irregularities (e.g. four has u but forty does not);
- compound nouns (e.g. flow diagram); and

- words that are used interchangeably in mathematics and also have another meaning outside mathematics contexts (e.g. sign and symbol).

3.5 Trustworthiness

The aim of trustworthiness in a qualitative inquiry is to support the argument that the inquiry's findings are "worth paying attention to" (Lincoln & Guba, 1985). This is especially important when using inductive content analysis as categories are created from the raw data without a theory-based categorisation matrix.

According to Huberman and Miles (2002) and Tobin and Begley (2004), it is inappropriate to transfer terminology across paradigms. The authors suggest alternative ways to demonstrate reliability and validity outside the linguistic confines of a quantitative research paradigm. The trend that rather emphasises the use of *rigour* to assure reliability and validity in qualitative research was followed in this section of the research (Tobin & Begley, 2004; Twycross & Shields, 2005). Rigour refers to the demonstration of integrity and competence in qualitative research by adherence to detail and accuracy to assure authenticity and trustworthiness of the research process. As such the rigour of the qualitative section relates to the overall planning and implementation of the planned research design (cf. par. 4.2.2.3) conducted in a logical, systematic manner to ensure the authenticity and trustworthiness of procedures according to the following criteria (Roberts *et al.*, 2006:43; Freeman *et al.*, 2007:28-29):

- **Credibility:** Engagement with the data (recordings, notes and transcripts) was done intensively to demonstrate clear links between the data and interpretations. The use and indication of verbatim examples of participants' responses reflect for example the range and tone of the gathered responses. I made use of member checking to systematically solicit feedback about the data and conclusions from the people who were the participants in the study. In this study, the participants could review their interview text, provide feedback, correct inaccuracies, and/or clarify ambiguities in the text.
- **Dependability:** Care was taken to ensure that the research process was logical, traceable, and clearly documented in a reflexive manner by giving a detailed account of the research process.

- **Transferability:** This indicates the extent to which the findings can be applied in other contexts or with other participants (Babbie & Mouton, 2001). The strategies for achieving transferability comprises of thorough descriptions and purposive sampling (Babbie & Mouton, 2001). To ensure thorough descriptions, detailed descriptions of data are provided. Purposive sampling was applied within this study because of its propensity to maximise the variety of the information that can be obtained within a specific context (Babbie & Mouton, 2001).
- **Confirmability:** An audit process was implemented by working forward as well as backward through the research process to ensure that the data and interpretations of the findings were not figments of imagination, but clearly derived, sound and confirmed findings. The intention during the interpretation process was not to generalise findings to a population, but to identify generic accepted principles and trends related to the research topic. Confirmability, therefore, constitutes the degree to which my own biases are excluded from the finding (Babbie & Mouton, 2001). Accordingly, a confirmability audit trail was developed by leaving an adequate trail for following up the conclusions, interpretations and recommendations. To ensure that such a trail was adequate, six classes of data was reviewed. These include raw data, reduction and analysis products of data, reconstruction and synthesis products, and process notes.

The description of the research process of *what* was done, *how* it was done and *why* it was done as well as the implementation according to criteria for qualitative research ensured that the authenticity and trustworthiness of the research was increased. The stated criteria did not serve as a restrictive checklist for the qualitative research process, but were regarded as parameters to generate informational knowledge in accordance to the research aims (Freeman *et al.*, 2007). The legitimacy of the interviews was thus assured by a clear conceptualisation, a purposeful design of an interview schedule, as well as a set plan or protocol to conduct the interviews. The consistency of responses was checked by restating questions in different forms at various stages of the interview (Anderson, 1998; Best & Kahn, 2003).

3.6 Data analysis

This study made use of a mixed method research design. Thus, both quantitative and qualitative data were gathered and so both quantitative and qualitative data analyses were done in this study (see Figure 3.1):

3.6.1 Quantitative analysis

DIBELSnet is a reporting system for use with DIBELS assessments (i.e., Oral Reading Fluency and DAZE Reading Comprehension). The reports provided by DIBELSnet are designed to inform decisions about instruction at both the individual learner level and the system level (i.e., classroom, school and district). I captured the data (i.e., oral reading fluency and daze scores) into DibelsNet and the reporting system generates reports that were used to analyse the learners' oral reading fluency and reading comprehension abilities (cf. chapter 4).

3.6.2 Qualitative analysis

Qualitative content analysis has been defined as:

- a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns (Hsieh & Shannon, 2005:1278),
- empirical, methodological controlled analysis of texts within their context of communication, following content analytic rules and step by step models, without rash quantification (Mayring, 2000:2), and
- any qualitative data reduction and sense-making effort that takes a volume of qualitative material and attempts to identify core consistencies and meanings (Patton, 2002:453).

These three definitions illustrate that qualitative content analysis emphasizes an integrated view of speech/texts and their specific contexts. Qualitative content analysis goes beyond merely counting words or extracting objective content from texts to examine meanings, themes and patterns that may be manifest or latent in a particular text. It allows researchers to understand social reality in a subjective but scientific manner. Qualitative content analysis is mainly inductive, grounding the examination of

topics and themes, as well as the inferences drawn from them in the data. The qualitative data analysis of this research (responses from the semi-structured interviews, focus group interviews, and the analysis of the documents) was done according to a qualitative content analysis process.

The following steps were followed in this study:

Step 1: Prepare the data

Qualitative content analysis can be used to analyze various types of data, but generally the data need to be transformed into written text before analysis can start. If the data come from existing texts, the choice of the content must be justified by what you want to know (e.g., documents in this study) (Patton, 2002). When transcribing interviews, the following questions arise: (1) should all the questions of the interviewer or only the main questions from the interview guide be transcribed; (2) should the verbalizations be transcribed literally or only in a summary; and (3) should observations during the interview (e.g., sounds, pauses, and other audible behaviours) be transcribed or not? (Schilling, 2006). In this study all questions of the interviewer were transcribed and the verbalizations were transcribed literally. Nonverbal communication was not transcribed during the semi-structured interviews.

Step 2: Define the unit of analysis

The unit of analysis refers to the basic unit of text to be classified during content analysis. Messages have to be unitized before they can be coded, and differences in the unit definition can affect coding decisions as well as the comparability of outcomes with other similar studies (De Wever *et al.*, 2006). Therefore, defining the coding unit is one of your most fundamental and important decisions (Weber, 1990). Qualitative content analysis usually uses individual themes as the unit for analysis, rather than the physical linguistic units (e.g., word, sentence, or paragraph) most often used in quantitative content analysis. An instance of a theme might be expressed in a single word, a phrase, a sentence, a paragraph, or an entire document. When using theme as the coding unit, you are primarily looking for the expressions of an idea (Minichiello *et al.*, 1990). Thus, you might assign a code to a text chunk of any size, as long as that chunk represents a single theme or issue of relevance to your research

question(s). Themes (e.g., academic language) were used as the unit of analysis in this study.

Step 3: Develop categories and a coding scheme

Codes are names or labels assigned to specific units or segments of related meaning identified within the transcripts (Neuman, 1997; Henning *et al.*, 2004). The **coding process** for the transcripts consisted of three coding steps as described by Neuman (1997) and Thietart (2007), namely: open coding, axial coding and selective coding.

- *Open coding* involved the identification and naming of segments of meaning from the transcripts in relation to the research topic. The focus of open coding was on wording, phrasing, context, consistency, frequency, extensiveness and specificity of comments. The segments of meaning from the transcripts were clearly marked (highlighted) and labelled in a descriptive manner.
- *Axial coding* was done by reviewing and examining the initial codes that were identified during the previous procedure. Categories and patterns were identified during this step and organised in terms of causality, context and coherence.
- *Selective coding* as final coding procedure involved the selective scanning of all the codes that were identified for comparison, contrast and linkage to the research topic as well as for a central theme or “key linkage” that might occur.

The codes were eventually **evaluated** for relevance to the research purpose. Related codes were then listed in **categories** according to the research purpose and theoretical framework from the literature study.

Step 4: Test your coding scheme on a sample of text

I used a fairly standardized process in my analysis, so I wanted to develop and validate my coding scheme early in the process. The best test of the clarity and consistency of my category definitions was to code a sample of my data. After the sample was coded, I checked the coding consistency through an assessment of inter-coder agreement. I

used a qualitative research specialist for this purpose. Coding sample text, checking coding consistency, and revising coding rules is an iterative process and continued until sufficient coding consistency was achieved (Weber, 1990). There was a high degree of consistency in the coding process between the researcher and the qualitative research specialist.

Step 5: Code all the text

When consistency in coding was achieved, the coding rules could be applied to the entire corpus of text. During the coding process, it was necessary to check the coding repeatedly, to prevent “drifting into an idiosyncratic sense of what the codes mean” (Schilling, 2006). Because coding proceeded while new data continued to be collected, new themes and concepts emerged and were added to the coding manual.

Step 6: Assess your coding consistency

After coding the entire data set, I rechecked the consistency of my coding. It is not safe to assume that, if a sample was coded in a consistent and reliable manner, the coding of the whole corpus of text is also consistent. Human coders are subject to fatigue and are likely to make more mistakes as the coding proceeds. New codes may have been added since the original consistency check. Also, the coders’ understanding of the categories and coding rules may change subtly over time, which may lead to greater inconsistency (Miles & Huberman, 1994; Weber, 1990).

Step 7: Draw conclusions from the coded data

This step involved making sense of the themes or categories identified, and their properties. At this stage, I made inferences and presented my reconstructions of meanings derived from the data. I explored the properties and dimensions of categories, identifying relationships between categories, uncovered patterns, and tested categories against the full range of data (Bradley, 1993).

The outlined process enabled a systematic and logic step-by-step approach for the analysis of the qualitative data and allowed the researcher to go beyond mere descriptive, comparative and explanatory ends to discover the rationale and motivation for responses (Thiétart, 2007). The qualitative analysis process was approached like

a spiral or circular process and not as a fixed linear action. The content analysis approach implied that the various steps of analysis were regarded as procedural guidelines and not as rigid steps like that of a recipe (De Vos *et al.*, 2011).

3.7 Ethical considerations

The history of research abuses led to the creation of ethics policies focusing on the protection of human subjects from exploitation or exposure to unacceptable levels of risk through their participation in research. Three basic principles are set forth in the Belmont Report to provide an analytical framework toward the resolution of ethical problems that develop with research involving human subjects: (a) respect for persons, (b) beneficence, and (c) justice. The principles provide a framework within which to think about risks to human subjects participating in research; in addition, they “provide a basis on which specific rules may be formulated, criticized, and interpreted” (National Commission, 1979: 3).

Respect for persons represents flip sides of the same idea: that individuals are autonomous persons, capable and entitled to personal decision making in terms of participating or not in the research process, conversely, if their autonomy is diminished, they are persons in need of protection in terms of their possible participation in the research process (National Commission, 1979).

In terms of respecting potential research participants, the researcher is obliged to be forthcoming in terms of imparting the information necessary whereby the potential participant can consent to participate based on being apprised of relevant information; part of the relevant information is a complete description of what the participant might expect if agreeing to be involved in the research. This has typically involved a spelling-out of the procedures of the research – focus groups, semi-structured interviews, anything that the participant will be asked to do as part of the research. The idea is that the potential participant is fully informed as to what to expect in the research process.

The principle of justice in research speaks to the fair distribution of the burdens and benefits of research in the selection and recruitment of participants (Mastoianni & Kahn, 2001). The principle of beneficence speaks to the maximising of benefits and the minimising of risks in the research process. According to the Belmont Report,

researchers are to adhere to two general rules: (a) do no harm, and (b) maximise the possible benefits and minimise possible harms (National Commission, 1979: 6). Essentially, “we must actively attempt not only to avoid harms, but to benefit those studied, to augment, not merely respect, their autonomy” (Cassell, 1982: 27). The researcher dealt with the ethical issues in the following way:

a) Permission, assent and consent

Permission to conduct the research within the Tlhapi District was obtained from the area manager. Permission to conduct the research at the three schools was obtained from the School Management Team. The letters granting permission have not been included in the study to ensure the anonymity of the district and the schools.

The researcher informed the participants of the purpose, nature, data collection methods, and extent of the research prior to commencement. Further, the researcher explained to them their typical roles. In line with this, the researcher obtained parental permission, the learners’ written assent and the teachers’ consent (cf. Appendixes).

The researcher applied for and obtained ethical clearance from the Ethics Committee of the North-West University, Potchefstroom.

Number: NWU-00067-12-A2

Approval date: 2012/08/07

Expiry date: 2017/08/06 (cf. Appendix C)

b) Protection from harm

In this research study the researcher guaranteed that no participants were put in a situation where they might be harmed as a result of their participation, physical or psychological. Participants should not be subjected to unusual stress or embarrassment (Trochim, 2000).

c) Honesty and trust

Adhering strictly to all the ethical guidelines serves as standards about the honesty and trustworthiness of the data collected (semi-structured interviews, focus group

interviews, document analysis, and DIBELSNext assessments) and the accompanying data analysis.

d) Privacy, confidentiality, and anonymity

In this study the researcher ensured that the confidentiality and anonymity of the participants would be maintained through the removal of any identifying characteristics before widespread dissemination of information. The researcher made it clear that the participants' names would not be used for any other purposes, nor would information be shared that reveals their identity in any way. The researcher used pseudowords to identify the schools and a district.

e) Voluntary participation

Despite all the above mentioned precautions, it was made clear to the participants that the research was only for academic purposes and their participation in it was absolutely voluntary. No one was forced to participate. The participants have the right to withdraw from the research at any time.

3.8 The role of the researcher

This study is grounded in the pragmatic paradigm and followed a mixed method approach. The role of the mixed method researcher was to acquire knowledge about both quantitative as well as qualitative research methods. The researcher also had the responsibility to mix the methods appropriately. The researcher had to allocate additional funds and time frames to complete a mixed method study successfully, as it is often more expensive and time consuming than either a quantitative or a qualitative study (Johnson & Onwuegbuzie, 2004:21).

While conducting this mixed method study, the researcher used quantitative methods. These methods like the quantitative assessments required the researcher to play an objective role (Maree, 2007:80). The role of the researcher was inevitably to find a balance between the objectiveness of the quantitative methods and the subjectiveness of the qualitative methods.

Johnson and Onwuegbuzie (2004:21) state that in a mixed method study, the researcher has to identify the weaknesses of a method and overcome it by the

strengths of another by being able to successfully use multiple methods. The researcher was constantly aware of this role and endeavoured to use the different methods in such a way that they would provide stronger evidence for a conclusion. The role of the mixed-method researcher can be adequately summarised by the words of Greene and Caracelli (1997:7): "...to understand more fully, to generate deeper and broader insights, to develop important knowledge claims that respect a wider range of interests and perspectives".

3.9 Summary

This chapter introduced the research methodology and methods for the study. A mixed method design was adopted to investigate the key issues in relation to this investigation, followed by a detailed description of the implementation of research methods. This description included information about aims of the study, participant selection, data collection and data analysis procedures for this study. The ethical considerations for this study have also been outlined in this chapter.

CHAPTER 4: DATA PRESENTATION AND DISCUSSION

4.1 Introduction

This chapter presents and interprets the results of the quantitative data analysis, followed by the presentation and interpretation of qualitative data analysis. The results are presented in such a way as to address the research questions posed in chapter 1:

- What the reading literacy profile of Setswana-speaking Grade 4 learners whose LoLT is English looks like in terms of oral reading fluency, retell and reading comprehension as well as their composite basic early reading literacy score.
- What an analysis of Grade 4 learners' performance on a teacher-developed mathematics paper indicates.
- What an analysis of Grade 4 Maths language (e.g. vocabulary) in teacher-developed assessments and textbooks reveals.
- The teachers' and learners' perceptions of mathematical language problem areas.
- Develop an instructional support framework that helps content area teachers integrate reading literacy within their subjects taking cognisance of the LoLT as well as the mother tongue of the learners.

4.2 Quantitative results

4.2.1 Reading literacy profiles of Setswana-speaking Grade 4 learners whose LoLT is English

Teachers have the opportunity through early assessment and identification of literacy skill problem areas to provide needed interventions to children at risk for reading difficulties (Shaywitz, 2003). The earlier interventions can be implemented the greater is the chance that low reading trajectories can be modified to result in positive reading achievement (Good, Simmons, & Smith, 1998; Shaywitz, 2003). Research indicates that the earlier learners at risk for reading failure are identified, the greater the chances of decreasing the effects of the failure and getting them back on track (Hintze, Ryan, & Stoner, 2003; Strickland, 2002).

An analysis of the reading profiles of the Grade 4 classes (Medium of Instruction – English) in the three selected schools (cf. Table 4.1) indicates that with regard to the composite score, 99% of the learners scored below the benchmark set for readers at the end of Grade 3. It is, therefore, clear that these Grade 4 learners were not reading at a Grade 4 level. With regard to the Grade 4 learners' oral reading fluency, the results indicated that more than 90% of the learners were reading well below the benchmark set for Grade 3 learners. It should also be noted that the standard deviations in all three schools are fairly big, which indicates that there is a very big variation among the learners in the class. For example, some learners may be reading fairly fluently, whereas others are not even able to decode the basic words in the text. The results of the oral reading fluency accuracy indicates that the majority of the learners in school N and school L (e.g., 90%) are not able to read accurately, and therefore have problems with regard to decoding; this will have a very big impact on their ability to read for comprehension. In school B, 11% of the learners are reading at or above benchmark, and 11% of the learners are reading just below benchmark. This indicates that at least 11% of the learners can decode fairly accurately at a Grade 3 level. The retell component indicates a major cause for concern as 100% of the learners in all three schools had trouble retelling the basic main ideas of the story. The reasons for this can be attributed to various factors such as lack of automatic and accurate decoding skills, lack of sufficient vocabulary, lack of basic oral language proficiency in English, etc. The daze score refers to the learners' reading comprehension and the results indicate that in two of the schools more than 90% of the learners are comprehending well below benchmark, while in school N, there are at least 5% of the learners comprehending at or above the benchmark set for Grade 3, and 13% of the learners at comprehending just below benchmark. Overall, the results indicate that the Grade 4 learners in Schools N, L and B have not mastered the basic reading skills to be able to cope with academic reading required in Grade 4. The majority of the learners are reading below a Grade 3 benchmark level on the core skills of oral reading fluency and comprehension (cf. Table 4.2 & Table 4.3).

Table 4. 1: Reading profiles of Grade 4 learners in Schools L, N and B

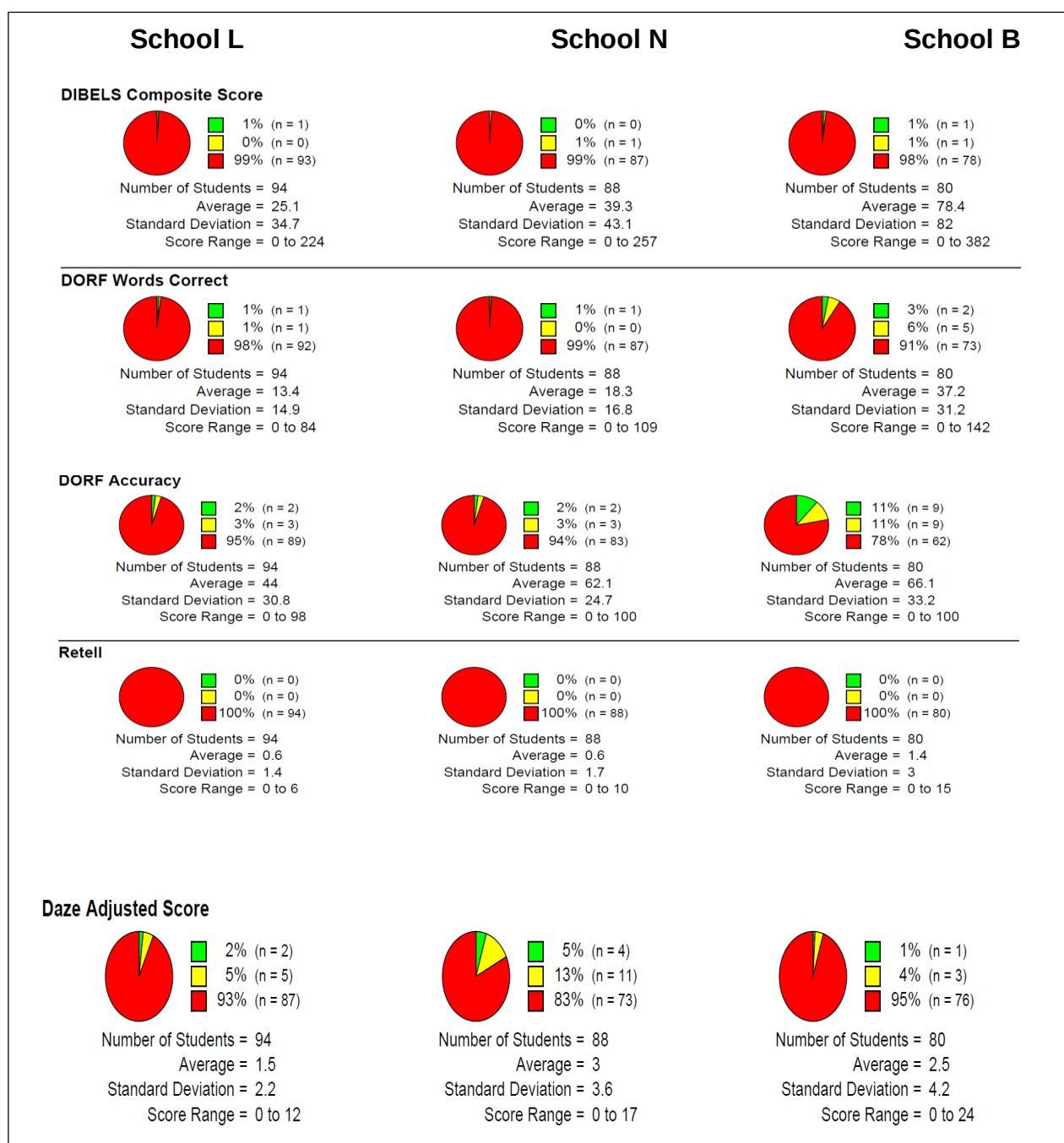


Table 4. 2: Grade 3 Benchmark Goals

Third Grade Benchmark Goals and Cut Points for Risk					
Measure	Score Level	Likely Need for Support	Beginning of Year	Middle of Year	End of Year
<i>DIBELS</i>	At or Above Benchmark	Likely to Need Core Support	220 +	285 +	330 +
Composite	Below Benchmark	Likely to Need Strategic Support	180 - 219	235 - 284	280 - 329
Score	Well Below Benchmark	Likely to Need Intensive Support	0 - 179	0 - 234	0 - 279
DORF	At or Above Benchmark	Likely to Need Core Support	70 +	86 +	100 +
Words	Below Benchmark	Likely to Need Strategic Support	55 - 69	68 - 85	80 - 99
Correct	Well Below Benchmark	Likely to Need Intensive Support	0 - 54	0 - 67	0 - 79
DORF	At or Above Benchmark	Likely to Need Core Support	95% +	96% +	97% +
Accuracy	Below Benchmark	Likely to Need Strategic Support	89% - 94%	92% - 95%	94% - 96%
	Well Below Benchmark	Likely to Need Intensive Support	0% - 88%	0% - 91%	0% - 93%
Retell	At or Above Benchmark	Likely to Need Core Support	20 +	26 +	30 +
	Below Benchmark	Likely to Need Strategic Support	10 - 19	18 - 25	20 - 29
	Well Below Benchmark	Likely to Need Intensive Support	0 - 9	0 - 17	0 - 19
Retell	At or Above Benchmark	Likely to Need Core Support	2 +	2 +	3 +
Quality of	Below Benchmark	Likely to Need Strategic Support	1	1	2
Response	Well Below Benchmark	Likely to Need Intensive Support			1
Daze	At or Above Benchmark	Likely to Need Core Support	8 +	11 +	19 +
Adjusted	Below Benchmark	Likely to Need Strategic Support	5 - 7	7 - 10	14 - 18
Score	Well Below Benchmark	Likely to Need Intensive Support	0 - 4	0 - 6	0 - 13
The benchmark goal is the number provided in the "At or Above Benchmark" row. The cut point for risk is the first number provided in the "Below Benchmark" row.					

(Good et al., 2012:135)

Table 4. 3: Grade 4 Benchmark Goals

Fourth Grade Benchmark Goals and Cut Points for Risk					
Measure	Score Level	Likely Need for Support	Beginning of Year	Middle of Year	End of Year
DIBELS Composite Score	At or Above Benchmark	Likely to Need Core Support	290 +	330 +	391 +
	Below Benchmark	Likely to Need Strategic Support	245 - 289	290 - 329	330 - 390
	Well Below Benchmark	Likely to Need Intensive Support	0 - 244	0 - 289	0 - 329
DORF Words Correct	At or Above Benchmark	Likely to Need Core Support	90 +	103 +	115 +
	Below Benchmark	Likely to Need Strategic Support	70 - 89	79 - 102	95 - 114
	Well Below Benchmark	Likely to Need Intensive Support	0 - 69	0 - 78	0 - 94
DORF Accuracy	At or Above Benchmark	Likely to Need Core Support	96% +	97% +	98% +
	Below Benchmark	Likely to Need Strategic Support	93% - 95%	94% - 96%	95% - 97%
	Well Below Benchmark	Likely to Need Intensive Support	0% - 92%	0% - 93%	0% - 94%
Retell	At or Above Benchmark	Likely to Need Core Support	27 +	30 +	33 +
	Below Benchmark	Likely to Need Strategic Support	14 - 26	20 - 29	24 - 32
	Well Below Benchmark	Likely to Need Intensive Support	0 - 13	0 - 19	0 - 23
Retell Quality of Response	At or Above Benchmark	Likely to Need Core Support	2 +	2 +	3 +
	Below Benchmark	Likely to Need Strategic Support	1	1	2
	Well Below Benchmark	Likely to Need Intensive Support			1
Daze Adjusted Score	At or Above Benchmark	Likely to Need Core Support	15 +	17 +	24 +
	Below Benchmark	Likely to Need Strategic Support	10 - 14	12 - 16	20 - 23
	Well Below Benchmark	Likely to Need Intensive Support	0 - 9	0 - 11	0 - 19
The benchmark goal is the number provided in the "At or Above Benchmark" row. The cut point for risk is the first number provided in the "Below Benchmark" row.					

(Good et al., 2012: 136).

4.2.2 Mathematics performance

This section presents the frequency table (cf. Table 4.4) that outlines the performance of Grade 4 learners` in mathematics followed by the discussion of their performance on each of the questions. Each question is captured verbatim from the questionnaire and coded by the letter Q together with a number of a question as it appears on the assessment, for example, Q1. In the discussion the questions have been grouped under the following Grade 4 mathematics content areas as mentioned in CAPS (2011:9), even though they are analysed individually:

- Numbers, Operations and Relationships
- Patterns, Functions and Algebra
- Space and Shape (Geometry)
- Measurement
- Data Handling

There was a total of 262 learners from three schools. A total of 112 learners had missing responses while some did not complete the assessment, therefore these responses were not taken into consideration.

Table 4. 4: A frequency table outlining Grade 4 learners Maths performance

Questions	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Question 1				
1	18	12.00	18	12.00
2	49	32.67	67	44.67
3	18	12.00	85	56.67
4	41	27.33	126	84.00
5	24	16.00	150	100.00
Question 2				
1	20	13.33	20	13.33
2	48	32.00	68	45.33
3	35	23.33	103	68.67
4	28	18.67	131	87.33
5	19	12.67	150	100.00
Question 3				
1	9	6.00	9	6.00
2	75	50.00	84	56.00
3	25	16.67	109	72.67
4	31	20.67	140	93.33
5	10	6.67	150	100.00
Question 4				
1	55	36.67	55	36.67
2	25	16.67	80	53.33
3	51	34.00	131	87.33
4	7	4.67	138	92.00
5	12	8.00	150	100.00
Question 5				
1	35	23.33	35	23.33
2	31	20.67	66	44.00
3	42	28.00	108	72.00
4	30	20.00	138	92.00
5	12	8.00	150	100.00
Question 6				
1	34	22.67	34	22.67
2	49	32.67	83	55.33
3	33	22.00	116	77.33
4	29	19.33	145	96.67
5	5	3.33	150	100.00
Question 7				
1	19	12.67	19	12.67
2	61	40.67	80	53.33
3	30	20.00	110	73.33
4	28	18.67	138	92.00
5	12	8.00	150	100.00
Question 8				

1	47	31.33	47	31.33
2	30	20.00	77	51.33
3	40	26.67	117	78.00
4	20	13.33	137	91.33
5	13	8.67	150	100.00
Question 9				
1	31	20.67	31	20.67
2	43	28.67	74	49.33
3	23	15.33	97	64.67
4	41	27.33	138	92.00
5	12	8.00	150	100.00
Question 10				
1	22	14.67	22	14.67
2	47	31.33	69	46.00
3	42	28.00	111	74.00
4	29	19.33	140	93.33
5	10	6.67	150	100.00
Question 11				
1	48	32.00	48	32.00
2	28	18.67	76	50.67
3	16	10.67	92	61.33
4	47	31.33	139	92.67
5	11	7.33	150	100.00
Question 12				
1	37	24.67	37	24.67
2	28	18.67	65	43.33
3	41	27.33	106	70.67
4	36	24.00	142	94.67
5	8	5.33	150	100.00
Question 13				
1	23	15.33	23	15.33
2	40	26.67	63	42.00
3	50	33.33	113	75.33
4	23	15.33	136	90.67
5	14	9.33	150	100.00
Question 14				
1	39	26.00	39	26.00
2	56	37.33	95	63.33
3	32	21.33	127	84.67
4	19	12.67	146	97.33
5	4	2.67	150	100.00
Question 15				
1	52	34.67	52	34.67
2	22	14.67	74	49.33
3	39	26.00	113	75.33
4	31	20.67	144	96.00
5	6	4.00	150	100.00
Question 16				
1	31	20.67	31	20
2	39	26.00	70	67
3	37	24.67	107	46.67
4	37	24.67	144	71.33
5	6	4.00	150	100.00

Question 17				
1	27	18.00	27	18.00
2	27	18.00	54	36.00
3	35	23.33	89	59.33
4	56	37.33	145	96.67
5	5	3.33	150	100.00
Question 18				
1	40	26.67	40	26.67
2	43	28.675	83	55.33
3	33	22.00	116	77.33
4	24	16.00	140	93.33
5	10	6.67	150	100.00
Question 19				
1	34	22.67	34	22.67
2	35	23.33	69	46.00
3	53	35.33	122	81.33
4	23	15.33	145	96.67
5	5	3.33	150	100.00
Question 20				
1	30	20.00	30	20.00
2	37	24.67	67	44.67
3	39	26.00	106	70.67
4	22	14.67	128	85.33
5	22	14.67	150	100.00
Question 21				
1	64	42.67	64	42.67
2	48	32.00	112	74.67
3	19	12.67	131	87.33
4	18	12.00	149	99.33
5	1	0.67	150	100.00
Question 22				
1	14	9.33	14	9.33
2	34	22.67	48	32.00
3	38	25.33	86	57.33
4	55	36.67	141	94.00
5	9	6.00	150	100.00
Question 23				
1	27	18.00	27	18.00
2	42	28.00	69	46.00
3	30	20.00	99	66.00
4	40	26.67	139	92.67
5	11	7.33	150	100.00

Questions that focused on the first content area of numbers, operations and relationships, were questions 4, 6, 7, 10, and 11, whereas questions 2, 3, 5, 8, and 9 are categorized under patterns, functions and algebra. There were only two questions asked from space and shape (geometry) focus area. From the measurement content areas questions 13, 14, 15, 16, 18, 19 and 23 were based on the map and calendar

that were provided. The data handling content area was covered by questions 1, 20, 21 and 22.

4.2.2.1 Numbers, Operations and Relations

Q4 - Round the number 2 471 to the nearest 100

An analysis of Q4 indicates that only 36.67% of the learners got the answer correct. The learners' responses were fairly spread out indicating that there was not a clear-cut answer for these learners. The term round, used in everyday English to refer to a circle, symbolized like zero, and also an adjective, could have been the cause for difficulty. The word round is used in both mathematical and everyday English.

Q6- You have 4 friends. Each of your friends gives you $\frac{1}{8}$ piece of one orange. How many oranges do you have?

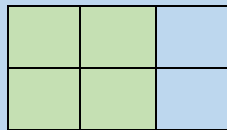
Only 22% of the learners got Q6 correct. The learners' responses were fairly spread out; indicating that the children were not consistent in their way of thinking about the problem, or language/vocabulary could have been a problem. The cause of difficulty in this common fraction expression could have been numerical presentation of a fraction together with a word piece ($\frac{1}{8}$ piece of one.) The meaning of the preposition *of* cannot be ignored as it is the word that indicates that the word problem is about division. The low percentage of learners who got the question correct means that teachers need to develop some strategies to support conceptual understanding of concepts that are used in the fractions section.

Q7 - Thapelo has been given R30,00 by his mother. On Monday Thapelo went to Bona café and found this price list on the wall. Coca-cola R7,50, Fish and chips R26,79, Chocolate R15,55. If Thapelo buys his friend one can of Coca-cola and chocolate, how much money is left for him?

Q7 is a subtraction word problem. Only 18.67% of the learners got this question correct, meaning that it was difficult for them. The difficulty with comprehending the question could have been the use of the conditional clause *if*. The low number of learners who got the answer correct indicates that there is a high risk of learner failure

in problems such as this. Of all the numbers, operations, and relationship questions in this assessment, this question received the lowest number of learners who got the answer correct. One would expect learners to make better sense of and not have difficulty with this question because it is about money which they talk about daily. But on the other hand, although they may understand each single word in the sentence does not mean that automatically they will understand the sentence.

Q10 - *In this diagram, 2 out of every 3 squares are shaded.*



Which diagram has 3 out of every 4 square shaded. [4 diagrams with possible answers were provided]. (cf Appendix F)

An analysis of this question indicates that 28.00% of the learners got the answer correct, implying that most of them had trouble with the question. The results show that there is inconsistency amongst these learners and this is reflected in their responses being fairly spread out. The two words *square* and *diagram* could have been the cause for difficulty because both words are specific to mathematics. The term square has more than one mathematical meaning, found in algebra and geometry. In algebra square means a number times itself while in geometry it is the name of the shape (Rubenstein, 2002:108; Thompson & Rubenstein, 2000:569). The words are only heard in the classroom, and as a result learners do not get the opportunity to verbalise and use them often. Monroe and Orme (2002:140) adds that “without understanding of the vocabulary that is used routinely in mathematics instruction, textbooks, and word problems, students are handicapped in their efforts to learn mathematics”.

Q11- *Lebo wanted to use her calculator to add 1 250 and 250, she entered 1 150 and 250 by mistake. Which of these could she do to correct the mistake? [Possible answers were provided, cf. Appendix F].*

An analysis of this question indicates that 31.33% of the learners got the answer correct. The cause for difficulty in this question could be syntax related. Setati (2002)

observes English Language Learners experience problems in learning the English for mathematics because they first have to learn English after which they can then learn the mathematics language in English.

4.2.2.1 *Patterns, Functions and Algebra*

The next math content area for Grade 4 according to CAPS is patterns, functions and algebra. This content area was covered by questions 2, 3, 5, 8, and 9 in the assessment.

Q2 - 243 is ...

- A. 3 times itself, 5 times,
- B. the product of 3 and 5,
- C. 3 times 5,
- D. 3 added 5 times.

Only 13% of the learners got this question correct. For Grade 4 the words *times* and *product* could be unfamiliar and challenging to comprehend. The question formulation is problematic as the “question” is left open-ended as indicated by It could be that learners were not sure what to do. The distractor also uses the words times, times itself, product and added. The question may point to teachers` uncertainty with Mathematical English usage. The problem could be with learners decoding of the number when put in words.

Q3 - *You were born in 2002. Write 2002 in words.*

An analysis of this question indicates that only 50% of the learners got the answer of this question correct.

Q5 - The values of A and B respectively on the number line are:

-----3050-----3100-----3150-----3200-----A-----3300-----3350-----3400-----B-----

Q8 - Complete the following number pattern

695; 790; 885; 980; 1 075; 1 170;;;

The above two questions are similar but use different concepts that imply addition. Only 20% of the learners got Q5 correct while Q8 has been correctly answered by 26.67% of the learners. An analysis of these two questions indicate that learners' responses were fairly spread out making it difficult to determine whether it was a mere mis-calculation or whether the learners were randomly guessing the answers. It is also possible that the words "values", "number line" and "number pattern" were causing confusion or they may not hear them often in class or they may have been explained in English without them comprehending.

Q9 - The daily start times for showing a movie are listed below. If the pattern continues, what is the starting time for the 4th show?

Show	Start time
1 st movie	2:00 p.m.
2 nd movie	3:30 p.m.
3 rd movie	5:00 p.m.
4 th movie	?

An analysis of this question indicates that only 28.67% of the learners got it correct. In Grade 4 the kind of patterns of sequences as shown above become more complex because the sequence is extended which demands that learners look for relationships or rules of patterns. Also, the term pattern could be difficult for them to comprehend when it is used in mathematics because they know pattern to be the shape of their clothes.

An analysis of this group of questions indicates serious problems for these learners. It is clear that teachers should be made aware of the importance of accurate question formulation as well as the necessity of answering that all explanations are understood – this may mean using Setswana to ensure that they comprehend.

4.2.2.3 Space and Shape (Geometry)

This is the third mathematics content area of Grade 4 according to CAPS. In the assessment there were two questions from this content area.

Q12 - Thabo, Mpho, Thapelo and Bonolo are all Grade 4 learners in Mr Sekate's class. Each one takes one shape and tell the class what dimension is their shape. Tell who has three dimensional (3-D) shapes?

An analysis of this 3-D shape question indicates that 24.67% of the learners got the answer correct. The learners' responses were fairly spread out; indicating that there was no clear preference for the learners. This question has three sentences that have to be decoded before learners can begin to determine what they are required to do. The questions also asks the learners to "identify" – tell who. The formulations of the question is confusing; there is too much emphasis on language "decoding".

Q17 Find what is in square C2.

This question has reference to the position of a building on a map which was provided on the assessment (cf. Appendix F). An analysis of the question indicates that 37.33% of learners got the correct answer. The use of the word square can be problematic. The question formulation for mathematics also needs attention. An analysis of the questions in this section indicates that learners have not mastered the content.

4.2.2.4 Measurement

Q13 – Q16 are based on a map that was provided while Q18 and Q19 are conversion questions, with Q23 based on a provided month calendar.

Q13 - 1 km equals 1000m. If Ntebo walks from her house to the stadium via the soccer playground via Bathoeng street, how far would he have walked?

An analysis of this question indicates that only 15.33% got the answer correct. This is an indication that the question was not easy for the learners because their responses were well spread out. Questions that make use of *if* are sometimes found to be difficulty for learners because they do not understand that when the problem mentions a conditional clause *if* in mathematics, it means that data is given, which should be followed by an instruction on what to do with that data. In addition, the word via is not a high frequency word and may have influenced the learners' comprehension.

Q14 - If Ntebo walks to the stadium either via soccer playground in Bathoeng or via Lesego Primary school, which distance is longer?

An analysis of this question indicates that only 39 out of 150 learners, 26.00% got the answer to this question correct. Given that the map was clear and allowed the learner easy interpretation, again the conditional clause *if* as well as the use of *either or* and *via* could have complicated the comprehension of the question.

Q15 - If Ntebo leaves her home at 06:00 a.m. to go to Nanogang Primary school and arrives at 07:00 a.m., how many minutes has she walked to school?

An analysis of this question indicates that only 34.67% of learners got this question correct. In Setswana there are no time abbreviations like in English, as a result learners could have failed to comprehend what the question asked of them.

Q16 - After school Ntebo must go to the stadium. She walks 60 minutes from school to the stadium. Convert the 60 minutes she takes to walk to the stadium in hours.

This question is nearly the same as Q15 above. An analysis shows that only 24.67% got it correct. The word *convert* may have been difficult to decode as well as that they may not be familiar with the term and what they are required to do.

Q18 - It takes Mpho 6 minutes to clean one classroom. She wants to know how many minutes it will take her to clean 6 classes at this rate. She should

- A. Add 6 and 6
- B. Multiply 6 by 6
- C. Divide 6 by 6
- D. Subtract 6 from 6
- E. None

An analysis of this question indicates that only 28.67% of the learners got it correct. It means that the question was difficult to most learners because their responses were well spread out; showing that there was no clear preference for these learners. The term *rate* is a new term to Grade 4 that needs to be defined and interpreted. The formulation of the question leading on to the distractors also presumes that learners know how to read this way. She adds 6 and 6, etc.

Q19 - (cf Appendix F) Which perimeter is the longest distance between the following?

An analysis of this question shows that it was better understood that other questions are were based on measurement. 35.33% of the learners got it correct meaning that less than half of the total of learners got it incorrect. The question includes the words perimeter (mathematical), distance (more familiar) and longest which requires analysis and interpretation before calculation can begin.

Q23 - *Learners of Tshupane Primary school are writing examinations on Tuesday, 2 October 2012. The school is closing for holidays exactly three weeks later. On what date will the school close? (cf. Appendix F)*

This question was correctly answered by 26.67% of the learners. Their responses varied and there was no consistent pattern.

4.2.2.5 Data Handling

Q1 - *Mr Moleme checked the grade 4 books a day after the school was opened and made this tally chart for the amount sold. How many more Setswana books than Mathematics books were sold?*

Q20 - *How many more learners have visited the library on Tuesday than Monday?*

Q21 - *Which day did the learners visit the library less than other days?*

An analysis of Q1 indicates that only 12.00% of the learners got it correct, for Q20 only 24.67% of the learners got it correct, and for Q21 only 12.67% got it correct. The mathematical concept *tally chart* could be a cause for difficulty because learners are not familiar with the term. Also, the words *how many more ... than* as well as the use of tense (i.e. were sold) which complicates the syntax could have been a cause for difficulty.

These concepts are difficult to explain to children whose home language is Setswana; if the concepts were explained in English without visual support, comprehension may have been compromised.

Q22 - If in the next four Thursdays the same number of learners visits the library, how many learners will have visited the library after four weeks?

An analysis of this question indicates that 36.67% of the learners got the answer correct. The use of the conditional clause, as well as the use of the future tense makes the reading of the items dense and most probably difficult to decode. The performance of the learners on the Maths assessment is a cause for concern. The learners did not master any of the Maths content areas. Given the fact that these learners were reading below Grade 3 level it is very likely that they were struggling to decode the test items in addition to being confronted with mathematical terminology they may not comprehend completely.

Cummins (2000) indicated that it takes five to eight years for a child to master the linguistic skills necessary for academic language in a second language. Learners who sat for the assessment receive instruction in the English language for a few hours a day, meaning that they are not exposed enough to it to master English, let alone the language of mathematics.

The results of PIRLS (2016:12) indicated that South African primary learners performed extremely poor in the literacy assessment of their HLs because they lacked academic proficiency. Sibanda's PhD study *"Investigating the nature of the linguistic challenges of the Department of Basic Education (DBE) 2013 Grade 4 Mathematics ANAs and learners' and teachers' experience of them"* (2015) indicated that teachers used code switching in their mathematics lessons because learners simply could not

understand even the simplest English words. According to Howie (2008, in Sibanda, 2015) the majority of South African learners, especially those in primary schools located in townships and rural areas, have only developed BICS and some CALP in their HLs and may not have developed BICS in the LoLT, let alone CALP

4.3 Qualitative analysis

4.3.1 Language/Vocabulary in teacher-developed mathematics assessments

The language, specifically, the vocabulary used in the teacher-developed assessments of term 1, the June examination, term 3 and the November examination of all three schools were analysed. Every assessment was analysed, but only those questions that had the mathematical vocabulary that could pose challenges to learners of Grade 4 when they read mathematics are reported on. Researchers (Gay, 2008; Rubenstein & Thompson, 2002; Rubenstein; Thompson & Rubenstein, 2000) have developed numerous categories of difficulty that point to language-based misconceptions, some of which I have used in this sub-section. Table 4.4 identifies some of the categories of difficulties that were identified in the assessments.

The questions are quoted verbatim from the papers and are coded with a TA to represent Teacher Assessments.

Table 4. 5: Grade 4 Teacher-developed Mathematics Assessments

Category of difficulty	Examples
Words shared by mathematics and everyday English, but have different meanings in the two contexts.	Data may refer mathematical information, also referring to airline.
Some words have more than one mathematical meaning.	Round refers to a circle, a zero-like shape versus to round as a number to the tenths and hundredths place.
Words that are homonyms with everyday English	sum / some ; symmetry / cemetery; hour / our; weight / wait; weigh / way; four / for
English spelling and usage have many irregularities	Four has u but forty does not.

Compound nouns	odd number; flow diagram; 2-dimensional; pie chart; bar graph; number pattern; picture number; expanded notation; number line; pictograph; millilitre
Words that are used interchangeably in mathematics and also have another meaning outside mathematics contexts	Sign and symbol Tell your mother to <i>sign</i> here.

4.3.2 Words are shared by mathematics and everyday English, but have different meanings in the two contexts

Besides the explanation of the definition of words and their related terms, there are words in mathematics that have multiple meanings (i.e., meaning in both mathematics and in everyday English.). Examples of such words that were used in Grade 4 teacher-developed assessments are **data**, **rounded off**, **key**, and **sign**. Knowing and understanding these words could be one of the factors that can advance the ability to read Maths comprehensively. Mathematics vocabulary that has multiple meanings may confuse understanding of the learners when the same vocabulary is used in their everyday interactions (MacGregor, 2002).

To illustrate, I use two of these words, **data** and **sign**. The word *data* may refer to mathematical information, ordinary information, or airtime for internet access. More often than not, the word *data* in mathematics is associated with a graph(s) or graphics through which clarity is generated through records or what is recorded. Also, in mathematics **data** means a collection of information or statistics in a form of words, symbols, pictures, shapes, or graphs created to be used in mathematical problems. In everyday English, the word *data* means the width of the band which allows the user to view, access, documents, sounds, and pictures on the internet that were created by other people. To the Grade 4 learners' social interactions, data means airtime that is used to access internet, and send and receive WhatsApp messages, videos, and play games. The confusion may arise when the learner hears the word *data* from social interactions and on the other hand has to apply it in mathematics. In a Grade 4 class, the mathematical data that is sometimes in a form of symbols, graphs, tables, or

problem statement, or even words, may aggravate the difficulty to comprehend the math. A question from the teachers-developed assessment:

(TA1) - Use the Tally in QUESTION 9 to fill in the pictograph below by adding a heading, labelling the vertical and horizontal axis, and filling in the

This question refers the learner to a prior question to access data from it in order to answer the current question. This means that data in the previous question has been given in a form of tallies. If the learner does not understand what the concept means, it will be difficult for her to comprehend the instruction. In this case, the data that is provided is the *different favourite fruits of classmates*. Therefore, the number of apples, peaches, and grapes should be depicted in the pictograph as they are given in tallies in the previous question's tally table. There is no word other than *data* in mathematics that can accurately capture what is required of the instruction of the above question. Consequently, the teacher should strategise to help learners recognize the nuanced differences of usage in mathematics.

In his study, Veel (1999, in Schleppergrell (2007:148) compared the student's use of mathematical language and teacher/textbook use of mathematical language and found a major gap between them in features that distinguish mathematics language from everyday language. Other examples that are used in Grade 4 that fit in this category are volume, area, and properties.

4.3.3 Some words have more than one mathematical meaning

Words such as **round** that learners know well may also be confusing when used in mathematics as they have a meaning different from that commonly known. For example

(TA2) - (T)he number 5 666 **rounded** off to the nearest 100 is ...

- (A) 5 700
- (B) 5 670
- (C) 6 000
- (D) 5 000

This question may not be easy to be solve by the Grade 4 learners as they know that the word round means a shape in a circle or zero form or “o”. Used with the word “off” may cause even more comprehension difficulty as they know the “of” with one “f”. Berenson (1997) in Adams (2003:788) advises that “when students are challenged by words with multiple meaning, it is helpful to make connections between children’s prior understandings of the word so that children can develop definitions from their own experience”.

In defining the words such as *round*, Molina (2012:47) says “some definitions explain rounding as reducing or increasing the digits in a number while trying to keep the value similar to the original. Such definitions are problematic in that the idea of reducing not necessarily applicable, and the idea of trying to keep a value similar is not the actual intent of rounding. We should never use the word being defined as part of the definition, yet one can find definitions that say *rounding* means to express as a *round* number. Using the word being defined in the definition itself renders the definition vague, confusing, and of little utility”.

Care should be taken when words are defined, as the definition itself may add complexity. Also, to avoid more difficulty in defining terminology like rounding, the *how-to-do-it* of it should not be included but only the idea of the concept. It can be good practice if teachers define words by using words with mathematical meaning. Molina (2012:47) further argues that “the definition of rounding should have embedded within it a connection to the idea of approximation as well as the critical component of accuracy, which is the covert link to the role of place value in the process of rounding”. He defines rounding off as “a method approximating a number to a specified degree of accuracy”. It is therefore important that teachers help the learners from lower grades to develop definitions of words in both mathematics and everyday language. Raiker (2002, in Schleppergrell, 2007:147) found that “the second through fourth grade students in her study had difficulty learning if the technical meaning of mathematical words such as division was not established”. Other examples that fit this category are **square** and **second**, which are mostly used in the learners’ textbooks and teachers’ manual.

4.3.4 Words that are homonyms with everyday English

An additional challenge in reading mathematics may also be caused by the use of homophones. Homophones are words with similar pronunciation but different meaning, origins, or spelling. The different spelling of these words may be a cause for confusion and difficulty. According to Ramsey (2013:6), when learners are introduced to these words in a mathematical context, they may misunderstand or misuse the word based on their prior knowledge. There are many examples of such words in Grade 4 Math classrooms, to mention but a few, there are **sum/some**, *hour/our*, *weight/wait/*, *weigh/whey*, *four/for*, *symmetry/cemetery*, etc. In mathematics, these are technical terms. The questions from teacher assessments read:

(TA3) - Write the **sum** as the single figure: $600 + 20 + 5000 + 9$.

(TA4) - Calculate each of the following **sums**. Show all your calculations.

$$543 + 159$$

$$134 \times 3$$

$$456 - 394.$$

In mathematics, the word *sum* may refer to the grand total or the total amount resulting from the addition of two or more numbers, amounts, or items, summation. Also, it may mean an amount of money, for instance in Thapelo owes the library a sum of R285. In everyday English, the word *some* can be applied as a determiner, pronoun, or adverb. Used as a determiner, it means a selected unspecified number of objects or unknown someone, as in, *the Grade 4s did some reading*. When reference is made to a small amount, unknown person or object it will be used as, for example, *the house was sold to some legal guru*. Used as an adverb, an example is, *the car stopped some 75m from where we were standing*. In a mathematics classroom these homophones take on a new meaning, whether said orally or written. TA4 may confuse the newcomer to English mathematics, the learner may find it difficult to understand if s/he has to add some numbers or not. To some learners, TA3 may mean that they have to write 6002050009. Adams (2003:789) maintains that homophones are words that “may interfere with comprehension of what students read, or understand when read to”.

Below is another question from teacher-developed assessments:

(TA5) - Draw the line of **symmetry** in the following shape.

The word *symmetry* is the homophone of **cemetery**. In everyday English, the meaning of cemetery is a place where dead people are buried, a graveyard. Since mathematics is one of those fields of study in which context is important for better understanding and sense making of the mathematical problem, if learners confuse the word with its homonymic partner the risk is that they can attach the incorrect meaning to the word which will result in lack of comprehension of what they read. In mathematics, symmetry means “an exact matching of a shape or a form on the opposite side of a line or around a centre” (Overbeek *et al.*, 2011:368). To the Motswana learner the problem may be worsened by the fact that Setswana does not have words written differently but sound the same. Unlike in English, Setswana has words with similar spelling and orthography but have a different meaning and pronunciation. According to Schleppergrell (2007:143), just knowing the technical vocabulary “is not enough, students also need to learn the language patterns associated with these words and how they construct concepts in mathematics”. Ramsey (2013:6) suggests that “explicitly addressing these misconceptions may help enhance students’ conceptual understanding”.

An interesting observation made when analysing the teacher developed assessments was that they very seldom used mathematical terminology in the assessments. This could be because they are aware that the learners may struggle. One negative consequence of this practice may be that when learners get provincial papers, the terminology will be foreign to them and once again negatively, affect their performance on Maths assessments.

4.3.5 English spelling and usage have many irregularities

It is not only the meaning of words that pose challenges to Grade 4 learners’ reading comprehension. Spelling can also cause some difficulty in understanding the meaning of certain words. English spelling and usage have many irregularities (Rubenstein, 2002:108) for instance, the word four is not spelt the same as forty, the same as five

and fifty. Setswana as an agglutinative language, has every letter of the word sounded, unlike English which may have some unsounded letters. Grade 4 learner learnt Setswana words which are different from English words. For example, in Setswana 4 is “nne”, 14 is lesomenne, then 40 is masomenne, there is always the adjective base of the number “nne”. An example from one of the learners’ textbooks is:

(TA6) - Write the following words as a number:

*Three hundred and **forty-five**.*

(TA7) - Copy and complete: **Five** thousand and seven rand and **fifty** cents.

(TA8) - 5 equal parts are **fifths** (each piece is $\frac{1}{5}$).

The Setswana learners may find it difficult to comprehend the question because of the different spellings of five and fifty in TA7. The case with the different spelling of words that have the same meaning is similarly experienced with nouns, verbs, and adjectives of the same words, for example wide and width, and high and height. These different spellings may affect comprehension. Strategies need to be identified on how learners who have background knowledge of Setswana can be taught in order that they can understand the numerical progression in English. The Sesotho languages provide for numerical consistency and logical progression of the number system as opposed to English which deviates from numerical progression by imposing number words that serve more as labels than number sense as is the case with the word like eleven, making a learner think of it as a new concept instead of being a logical progression from the number ten. Campbell and Xue (2001) in Zulu (2013) attest to a scientific evidence of the role of language in the number system.

4.3.6 Use of compound nouns

The use of compound nouns may also cause confusion for learners in reading mathematical problems, especially because the compound noun contains more than one word but yet refers to one object or subject. Compound nouns are formed by different parts of speech, for example, a noun and a verb, or a noun and an adjective or even a noun and another noun. For instance, some of the compound nouns that were identified in the teachers’ assessments are *word bank*, ***flow diagram***, *number*

line, number pattern, expanded notation, tally marks, tally chart, tally table, bar graph, pie chart and pictograph, millimeter, centimeter, parallelogram. These words may look and sound simple to understand but the reality is that to the Grade 4 learners they must be explained in simpler and more understandable words.

(TA9) - Name the following shapes. Use the **word bank** to help you.

(TA10) - Complete the **flow diagram**.

(TA11) - Look at the **pie chart** and answer questions that follow.

(TA12) - Grade 4 learners' favourite sports are listed below. Use the information to draw the **pictograph**.

The word bank in TA9, which means the bank of words, refers to a list of words that are provided to choose from. To the learner the word bank will surely immediately mean a place where money is saved, and with the two mixed it may be cause for confusion that will affect comprehension negatively. *Pictograph* shares its suffix with other words that have a completely different meaning, for example, bar graph. Overbeek *et al.* (2011:112) maintain that a flow diagram is “a diagram that shows the sequence in which something happens”. Actually, it “shows the flow of data and how the data is processed or changed until it gets to the other end”. To the Grade 4s there needs to be some kind of explicit instructional strategy to explain and demonstrate such compound nouns. In Grade 3 these words were in Setswana. Because Setswana and English do not have cognates, the English version of the words create a completely new reading challenge. Molina (2012:47) maintains that “[C]onceptual understanding in mathematics includes the ability to recognize the line between what a concept is and any how-to procedures involved with that concept”. TA12 demands the knowledge of the definition of the concept *pictograph* for the question to make sense and to be answered correctly. In itself, the concept has two words – “*picto-*” and “*-graph*”, it is a compound noun.

4.3.7 Words that are used interchangeably in mathematics and also have another meaning outside mathematics contexts

Another confusion may be caused by words that are used interchangeably within mathematics and also have another meaning outside mathematics. There is an exchange of the use of the words **sign** and **symbol** in mathematics assessment developed by the teachers. The word *sign* can be used as a verb or a noun. The everyday English meaning refers to writing one's name to identify oneself as the writer or sender, which is a verb. For instance, the statement *parents are requested to sign and return the school report*; the instruction is clear that parents should agree with the information on the report. In mathematics, however, the word *sign* refers to mathematical operators like $+$, $\div$, $-$, $\times$, $/$, $>$, $<$, $\approx$, $\neq$, and $=$, this list is not exhaustive. Each mathematical operator carries meaning and some kind of action is to be performed. Here is an example of the use of mathematical signs from the teachers-developed assessments:

(TA13) - Fill in addition **sign** (+) or subtraction **sign** (-) to make the following number sentence true: $275 \text{ ______ } 145 = 130$

(TA14) - What **sign** should replace the ______ to make the following number sentence true? $4 \times 8 = 43 \text{ ______ } 11$

- A. $\times$
- B. $-$
- C. $\div$
- D. $+$

Mathematical signs are more precise than words because they say clearly what operation must be performed. Therefore, it is important for the teachers to also explain the meaning of the mathematical symbols and the words that imply mathematical symbols.

An analysis of the teacher developed assessments indicates that teachers did not try to simplify the test items, linguistically, for the Setswana learners. The result is that these learners are unable to “decode” the language; pointing to a problem with the

language and not necessarily their ability to do the calculation or reason mathematically.

4.3.8 An Analysis of Grade 4 Mathematics Language (e.g. vocabulary) in Learner Textbooks and Workbooks

As textbooks and workbooks are the major learning resources that learners use on their own without the help of the teacher, be it at home or during assessment preparations, I found it fitting to also analyse the vocabulary used in these learning resources to add to the analyses of the teacher-developed assessments. Anderson-Inman and Horney (1998), maintain that every day in their classrooms, students encounter a text-centered instructional setting that creates unintended barriers to their learning. Textbooks are therefore there to “help learners move from every day, informal ways of constructing knowledge into the technically and academic ways that are necessary for disciplinary learning in all subjects” (Schleppegrell, 2007:140). Reading from the textbooks in the absence of the teacher means that the learners should be able to interact with every aspect of the book on their own, be it mathematical symbols, text structure, content design, pictures, graphs, or language. Schleppegrell (2007:147) maintains that the “explanations textbooks provide tend to be dense, so the teacher plays a key role in helping students learn to negotiate the symbols, diagrams, and the technical language”.

The textbooks and the two workbooks labeled as *Book 1 Term 1 & 2* and *Book 2 Term 3 & 4* used by the three schools are freely supplied to the schools by the South African Department of Basic Education (DBE). They are aligned with the Curriculum Assessment and Policy Statement (CAPS).

In this sub-section, some of the mathematical vocabulary difficulties as categorised by Rubenstein (2002) are analysed from the learners’ textbooks and workbooks. In addition to these categories of difficulty, I have looked at the mathematical terms that need to be defined in the textbooks to make it easier for the learners. Also, I found it fitting to look at other aspects that can cause difficulty in understanding mathematics in textbooks which Thomson and Rubenstein and Rubenstein and Thompson did not address, and these are mostly found in word problems. These are words such as conditional clauses and prepositions (cf. Table 4.6).

The examples of the various categories of difficulty are quoted verbatim from the textbooks and workbooks and are coded as TB to represent both the textbooks and the workbooks.

Table 4. 6: Vocabulary in Grade 4 Mathematics Textbooks and Learner Workbooks

Category of difficulty	Examples and symbols
Some mathematical words are related, but students may confuse their distinct meanings.	Fives and fifths Fives: {5, 5, 5, 5} Fifths : $\frac{2}{5}$ is read as 2 fifths (or 2 divided by 5 is $\frac{2}{5}$). Numerator and denominator $\frac{2}{5}$
Some mathematical terms are found only in mathematical contexts.	Denominator, parallelogram, quadrilateral, and decimal.
Some mathematical words are shared with everyday English and have comparable meaning, but the mathematical meaning is more precise	Difference as the answer to a subtraction problem versus difference as a general comparison.
Some words have more than one mathematical meaning.	Difference as comparison and difference as subtraction. Round as a circle v/s to round a number to the tenth place
Some words are shared between mathematics and everyday English, but they have different meanings in the two contexts.	Area; Volume; Properties
Some words shared with other disciplines have different technical meanings in the two disciplines.	Divide in mathematics means to separate into parts whereas the continental divide is a geographical term referring to a ridge that separates eastward- and westward-flowing waters.
Some mathematical concepts are verbalised in more than one way.	One-quarter v/s one-fourth. Two-fifths (or 2 divided by 5 is $\frac{2}{5}$).
Prepositions with different meaning from the English prepositions	At, to, in, on, up, of, for, off, from, out under, underneath, with, within, without.

Reading a combination of words, numerals and symbols	If I pay three R100 notes how much change do I get? [this is a multiplication equation]
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4.3.8.1 *Some mathematical words are related, but students may confuse their distinct meanings*

Some mathematical words are related, but learners may confuse their distinct meanings. The list of words that are provided in Table 4.6 are not exhaustive. According to Rubenstein (2002:108), words such as hundreds and hundredths and denominator and numerator are easily confused by learners at primary schools. Examples from learners' workbooks and textbooks include:

(TB1) - Write each of the following as a number:

- a. a third
- b. three tenths
- c. four sixteenths
- d. half of a half
- e. five eighths

If we look at the words **three** and **thirds**, for example, three refers to a numeral, a quantity or number of objects. Thirds is a fractional number because it means there is a one whole (not hole) that is divided into three equal parts. It means that in the fraction the denominator is three, read as thirds as there are three pieces that form one whole.

The words denominator and numerator are no exception in coming across to the learners as confusing because they are both used inseparably, one defines the other. When there is a numerator there must also be a denominator. These two words express the common fraction, the denominator is the bottom number, a divisor, while the numerator is the top number, and they are divided by a fraction line or a bar. Other examples of such words are area and perimeter. One example from the Teachers' Manuals reads:

(TB2) - The **denominator** should be the same when we add fractions. Example:

$$\frac{1}{4} + \frac{1}{4} = \frac{2}{4}$$

Write the following on the board: $\frac{1}{4} + \frac{2}{4} = \dots$

The learners pack out the sum using the fraction strips and then give the answer to the teacher, who writes it in the board. Do as many sums as necessary for the learners to see that when we add fractions, the **denominator** stays the same.

The concept development activity from this lesson was to:

(TB3) - Do a few more examples of adding fractions on the board but make sure all the sums have the same **denominator**.

The learners' workbook is their daily companion in and outside the classroom. The definitions of the two words are not provided in the learners' textbooks and workbooks. This implies that the learners book does not really support in learners in the understanding of mathematical terms. According to Jojo (2016:2607), "textbook related issues have been implicated as responsible for the dismal performance of learners in Mathematics". The numerator and the denominator can be presented in numeral form or in words, for example, as $\frac{1}{4}$, this is a quarter or one fourths or one divided by four. In words it is read as 1 is the numerator while 4 is the denominator. If the numerator and the denominator are divided by slash like in $\frac{1}{4}$, the learners can be confused because fraction line may be simpler for them to realise the relationship between the two numbers. The words of this category are usually learnt in pairs because they are mathematically related, as one implies the other. Learners may easily mix up the two words and even confuse them if these words are not clearly distinguished. Mixing them up would be a sign of learners not understanding them conceptually. Other examples of words in this category are hundreds and hundredths. Rubenstein (2007:205) advises that one strategy to reduce the confusion of the mathematical pairs that are often learnt together would be to teach one term and later

introduce the other term; therefore, teachers should avoid teaching the two terms together.

4.3.8.2 *Some mathematical terms are found only in mathematical contexts*

Mathematical terms that are found solely in mathematical contexts may be found to be difficult for learners to comprehend and master simply because they are not exposed to them outside the classroom. The difficulty of these words may be aggravated by the fact that they were either learnt in Setswana or are new concepts altogether to the Grade 4s. Amongst the examples of such words are denominator, numerator, quadrilateral, and parallelogram (Rubenstein, 2002:108). Quadrilateral and parallelogram are geometrical concepts. Quadrilateral is defined by Overbeek *et. al.* (2011:321) as a two-dimensional shape that has four straight sides and can have different forms. On the other hand, they define parallelogram as a four-sided, two-dimensional figure with both pairs of opposite sides parallel. A parallelogram has opposite sides that are parallel and equal in length and opposite angles are also equal. Geometry may be more difficult because it is the part of mathematics that has shapes, some of which the learner cannot associate with symbols and words. Jojo (2016:2607) maintains that in geometry the learner sees a drawing as an object first before processing it, which could possibly be one of the aspects that makes mathematical shapes difficult to comprehend. One example of the use of these words in the learners and the teachers books reads:

(TB4) - Fill in the missing number : $\frac{1}{2}$ is the same as $\frac{\quad}{4}$

(TB5) - Draw the following in the table - two **quadrilaterals**, two **pentagons**, two **heptagons**.

It is interesting to note that these very words that are not easily accessible in the learners' environment are also scarcely used in their textbook and the workbooks of Grade 4. The words *denominator* and *parallelogram* do not appear anywhere in the learners' workbooks, while numerator appears only once and quadrilateral appears three times, in an exercise question. The concepts are not defined or explained in the

textbooks or workbooks. It means that the learners only hear these terms from the teacher during the mathematics class; this may also only be sporadically. The textbooks and workbooks do not seem to be learner friendly in that the support given is minimal. Riordain and O'Donoghue (2011:48) maintain that use of specialist vocabulary can lead to misunderstanding and misinterpretation of mathematical tasks because terms such as parallelogram are only encountered in the classroom and not reinforced outside the classroom. Rubenstein (2007:203) says words that are "used solely in mathematics make some students believe that mathematics is a foreign language".

4.3.8.3 Some mathematical words are shared with everyday English and have comparable meanings, but the mathematical meaning is more precise

An example of such a term is **difference**. In everyday English, difference refers to comparison of two or more things whereas the mathematical definition is subtraction. The prescribed Grade 4 learners' textbook defines difference as "*the difference between two numbers (subtraction)*". Words such as these that learners hear outside the math classroom and during the math lesson should be conceptually understood in these contexts so that learners can use them correctly. If not, learners can experience struggle to decipher how the terms are distinctly different either the mathematical definition or the everyday use of the term. An example from a textbook:

(TB6) - $628 - 333$: calculate the **difference** between your estimates and the actual answers.

From the same textbook a question in the same section as TB6 reads:

(TB7) - Explain why your estimate in Question 1 is different from Gary's answer.

The use of these two words without conceptual understanding has potential for confusion to learners which may contribute to poor performance in math achievement. Other terms for the Grade 4 textbooks and workbooks that fit in this category are *right*, *expression*, *function*, and *factor*.

In a section of the workbook where subtraction is dealt with, there is a question

(TB8) - What is the **difference** between 4 738 m and 8 735 m?

This is a word that when well understood by learners will not be difficult to solve the word problems that need the operations of subtracting like in TB8. According to Rubenstein (2002:108), some mathematical words are shared with English and have comparable meanings, but the mathematical meaning is more precise. In Grade 3 learners were taught either *tlosa*, *ntsha* or *pharologanyo*. The first two words mean minus or subtract while *pharologanyo* means the difference in TB8. As maintained by Riordain and O'Donoghue (2011:45) teachers need to encourage learners to recognize and distinguish between 'mathematical' English and everyday English because the two may be a source of confusion and they lead to errors in performance.

4.3.8.4 Some words have more than one mathematical meaning

In mathematics, while some words may cause confusion for different reasons, some words have more than one mathematical meaning (Rubenstein, 2002:108) which may also contribute to the challenge of comprehending a mathematical problem. These are words such as *round* and *square*, to mention but a few. For instance, a sum can be rounded off to the nearest number, say a 10, 100, or 1000. Also, round means a circle or a shape in a zero form. The teacher's manual defines rounding off as:

(TB9) - to change a number to the nearest whole number or the nearest number ending in zero.

From the teachers' manual the following is an instruction to the teacher to perform in class as a concept development exercise:

(TB10) Draw the following on the board.
 Examples 1.
 Revise **rounding** off to the nearest 10 of 2-digit numbers.
 86 **rounded** off to the nearest 10 is 90. Between which two tens will 80 be?
 [a number line is provided to answer this question]

The following is an example from the learner workbook is:

- (TB11) **Round** off to the nearest 1 000. Circle the number which you look at when deciding whether to round up or down to the nearest 1 000. Complete the following
- a. 3 400 is between and and would be rounded to
 - b. 1 900 is between and and would be rounded to

Nowhere in the workbook is the concept *round off* explained for learners to read for themselves. This means that the learners depend on the teachers verbal explanation during the lesson. This may be one of those words that seems simple but is actually complex to be understood by the Grades 4 learners because they did them in Setswana in the previous grade. This question has three words which may confuse the learner – round off, round up, and round down. The teacher needs to employ strategies that will help learners to associate these three concepts with the Setswana concepts that means the same that they have learnt in Grade 3.

4.3.8.5 Some words are shared between mathematics and everyday English, but they have different meanings in the two contexts.

Examples of words that fall into this category are found in Grade 4 are **volume**, **properties**, **area**, and **face** amongst others. These words are used in mathematics and also have meaning in everyday contexts and interactions (Adams, 2003:787). The following TB comes from the learners` textbook:

(TB12) - What is the **volume** of each piece of furniture? Give your answer in number of rectangular blocks.

(TB13) - A pyramid has 5 **faces**. One **face** is a square. Four **faces** are triangles

(TB14) - **Properties** of 3-D objects.

(TB15) - We can find the **area** of a shape. Count how many squares the shape covers on a square grid. For example, the rectangle in ... has an **area** of 18 blocks on the grid.

In learners textbook word bank, the word **volume** is defined as “the amount of space taken up by object (We can measure volume in number of cubes that fill the object” (Hassan *et al.*, 2012:298). The everyday meaning of **volume** is the level of noise of electronic equipment. The words that fall in to this category can easily confuse learners` understanding of mathematics, as a result teachers need to make sure that they know the words that learners use to make sense of their mathematics. They should also develop strategies to understand the mathematical terms by working from the everyday terms to make it comprehensible for learners to understand the terms, especially at a Grade 4 development level. Rubenstein (2007:203) maintains that it is important to recognise that words have relationships to other words that provide some reason for their having been invented or selected to represent certain mathematical ideas. In a related sense, the word *face* meaning a person`s body part, is already present in the learners` vocabulary but not in the meaning that they know its mathematical concept. In mathematics, a prism is a 3-D shape with two congruent parallel polygon faces (called bases) (Rubenstein, 2007:203). Terms such as these easily confuse Grade 4 learners because the word face is known to refer to the person`s face. In mathematics the word refers to the flat surface of a 3-D object.

4.3.8.6 Some words are shared with other disciplines have different technical meanings in the two contexts

The word **divide** is used in both mathematics and science. In mathematics it means to separate into parts but the Continental Divide is a geographical term referring to a ridge that separates eastward- and westward-flowing waters (Rubenstein & Thompson, 2002:108). Divide in Grade 4 is one of the popular operations. The vocabulary lag in mathematical operations may affect comprehension negatively. It is therefore paramount that teachers help learners develop ways and means to understand concepts so as to avoid challenges in understanding mathematics. For example, the following TB stated

(TB16) - *Draw three rectangles. Divide each of them into eights. Colour in these fractions on each rectangle.*

(TB17) - *When you divide something into two equal parts, each part is one half of the whole. We write one half as $\frac{1}{2}$. This shows one part out of two equal parts.*

The word is used as a verb but can also be used as a noun (division). The TBs do not define this term, surely taking it for granted that learners know the word but forgetting that they learnt it in their HLs. It is important to define mathematical operations words and indicate how they should be used in the mathematical context.

4.3.8.7 *Mathematical concepts that are verbalised in more than one way*

In most cases, the challenge with fractions to primary school learners is visibly high (Siegler & Alibali, 2005) possibly because in fraction arithmetic there are some mathematical concepts that are verbalised in more than one way (Rubenstein, 2002:108). For instance, one-quarter is sometimes verbalised as one-fourth, one-quarter as one-fourth, and two fifths as 2 divided by 5 is $\frac{2}{5}$. From the learners' textbooks, the following is an example:

(TB18) - **One-fifth** is one whole divided into five equal parts: $\frac{1}{5} = 1 \div 5$.

This equation is read as one-fifth equals one divided by five. In this instance the learner should be able to associate the words one-fifth and one divided by, and a whole divided into five equal parts. The confusion may come as a result of the teacher's use of concepts when s/he refers to one divided by five then s/he says one-fifth, while in the next lesson s/he may refer to it as one whole divided into five equal parts. This means that teachers need to be conscious of the terms they use in the Grade 4 class. In addition, words such as *one, ones, and first; two, twos and second; and three, threes, and third, thirds* need to be explicitly distinguished and explained in terms that learners will correctly and conceptually understand them. These words may confuse learners in a mathematics class because one means the numeral and it is a noun while second is a plural form of the first and the third one is an adjective.

4.3.8.8 *Prepositions with different meanings in mathematics*

In her research article, *Cracking the vocabulary code in mathematics in the Foundation Phase*, Nel (2012) focused on small but yet important words that have the power to change the meaning in mathematics as compared to everyday English. Prepositions and conjunctions such as *is, are, were, of, off, are, has, have, if*, and then, cannot be

ignored in this work as they are words, in their small nature, that have the power to change meaning in mathematical word problems. For instance, the examples below are from the learners' textbooks as evidence of the point made above.

(TB19) - *The cost of a new bicycle **is** R3 546. The bicycle in the store **is** scratched so the price has been reduced to R3 295. By how much has the price been reduced.*

(TB20) - *If there **are** 30 mealies in each row, how many mealies in each of the following rows:*

rows	1	2	3	4	5	6	7	8	9
mealies	30								

(TB21) - *A train was carrying bags **of** mealies. At the first station they **off** loaded 354 bags and at the second station 587 bags. There **were** still 627 bags left on the train. How many bags were loaded onto the train at the start of the journey?*

TB19 has a phrase and two intransitive verbs. The use of “*is*” in a phrase has different meanings from that one that is used in the first transitive verb. The “*is*” of the phrase has mathematical impact because it is given the quantitative qualities. Actually, its use in this phrase means “equals to”. Mathematically, this phrase should be written *new bicycle = R3 546*, in short *nb = R3 546*, meaning that “*is*” stands for “*equals to*”. On the other hand, the “*is*” of the first transitive verb describes the value of the bicycle, it is more qualitative than quantitative. This phrase is actually not valuable in describing the mathematical facts in the phrase. Basically, this transitive verb that has *is* - *The bicycle in the store is scratched* - does not contribute mathematically to be able to solve the problem. The most important impact on mathematical meaning is the phrase and the second transitive verb - *The cost of a new bicycle is R3 546. ...the price has been reduced to R3 295* – with the word ‘reduce’ meaning decreased, subtraction. The *is* in a *new bicycle is R3 546* does not merely serve the grammatical purpose to make the sentence complete or so, but it is used to give semantic content to the mathematical problem. This therefore means that teachers and learners should look

more at on the impact on mathematical meaning that the given information causes, that which help to solve the equation.

With reference to TB20, **are** is used in the same way as the **is** of question TB19. There is a mathematical impact that “are” provides because it equates one row with quantity or value, simply meaning 1 row equals to 30. Mathematically it can be written as $r = 30$, r standing for rows. Again, this is proof enough to encourage teachers and learners to look for a mathematical information in word problems. It should be clarified that Small words such as these can easily confuse learners and fail to comprehend but which at the same time help to establish the logical relationships and link smaller units within a text.

The words “of” and “off” in TB21 are clearly different in their spelling, the meaning is also different, but the Grade 4 learners may fail to comprehend important mathematical value of each words. This example is not similar to the example in TA2 because their different meanings of “offs”. Actually, the “of” is a preposition for possession, it adds no mathematical value to the given information. On the other hand, the “off”, in this context has subtraction connotation. It means there is a certain amount on the train and from the amount 354 were taken out (subtracted) another 587 was taken out again (subtraction). If s stands for station, this word problem can be written as $s_1 = 354$ and $s_2 = 587$. This word problem continues to put more emphasis on the importance of looking for mathematical values to the problem.

TB22 below has the small words “has” and “have” that have meanings that differ from the ordinary English meanings. The “has” of the predicate is more of an equal sign than a possession preposition. Mathematically it can be written as $b = 2\,432$, and can be verbalized as book equals 2 432. The second “has” in this context implies subtraction. Therefore the “have” has the mathematical value of equals to. Consequently, the equation can be written as $b = 2\,432$; read = 1 116, therefore left = ? and it can be verbalized as book equals to 2 432 – has read 1 116 = have left.

(TB22) - “Zanele is reading a book that **has** 2 432 pages. She **has** already read 1 116 pages.

How many pages does she **have** left to read?”.

Words such as these can easily cause confusion to the Grade 4 learner, which can easily result in incomprehensibility in reading the problem. These words do contribute in finding the values that are quantitative (the first *has* and *have*) and those that are qualitative (the second *has*).

4.3.8.9 Reading a combination of words, numerals and symbols

Schleppergrell (2007:142) states that “language provides the contextual information about the situation, the mathematics symbolism describes the pattern of relationships between the entities”. TB23 below illustrates the use of R as a symbol of the value of money, a number and words. The learner will be forced to translate words in numbers to be able to determine the relationship of the entities and also to answer the question correctly. What must happen here is that R100 must be converted to R300, to arrive at this stage, it means the operation of multiplication must be undertaken. Here the learner needs the skill to convert words into numbers. Important to note also is that the word “pay” here means subtraction because immediately when one pays one spends, one minuses from the amount that one has. Teachers should help the learners to formulate word problems such as these in mathematical terms so that it becomes easier for them to contextualize, conceptualise and finally operationalize the problem. Jojo (2016:2608) maintains that the “current practices in the primary grades promote little conceptual understanding of geometric concepts. They do not allow learners to build mental constructions connecting their visual expressions with concept meaning”. In the example below the learners need the skill to conceptualise the terms used in the problem and try to interpret the words mathematically to be formulated as follows:

(TB23) - If I pay with **three R100** notes how much change do I get? if I had R500.

$$\begin{aligned} \text{I} &= \text{R}500 \\ \text{Pay} &= 3 \times \text{R}100 = \text{R}300 \\ \text{I} - \text{Pay} &= \text{R}500 - \text{R}300 \\ \text{I} &= \text{R}200 \\ \text{Left} &= \text{R}200 \end{aligned}$$

The learners may find it confusing and not understand the question because of the use of both words, symbols and the numbers in one statement. The word *three*

together with R100 may not make sense to the Grade 4 learner to understand that this is a multiplication expression because there is no word that refers to multiplying. For the learners to be able to read the mathematical expression that is presented in words, teachers need to teach them strategies to translate the expressions to numbers and symbols so that it becomes easier for them to understand what they read and need to do. Below TB24, I have translated the question in numbers to arrive at the correct answer. Another example from the learner textbooks that is similar to the above one is

(TB24) - Mom has two R100 notes, five R2 coins, nine R5 coins and four 20c coins in her purse. How much money does she have?

The above examples may be even more difficult for Grade 4 learners to comprehend because there is a combination of words, numbers and symbols. Also, the two mathematical operations that should be performed may be another serious challenge. There needs to be multiplication and subtraction and addition which are not shown in symbol forms like $\times$ and $-$ and $+$. Naturally, symbols make it easier to read the problem and understand it than words or a combination of words (e.g., *nine R5 coins*). Lack of conceptual understanding of the above mentioned words may interfere with mathematical reading because “multiplicity of representations of words in everyday language and within the mathematical register can create significant interference causing learners to struggle to assign appropriate meanings to words in unfamiliar contexts” (Nel, 2012:19).

4.3.9 Teachers` and learners` perceptions of mathematics language-related difficulties

The interviews with the teachers from all three schools (N=3) were semi-structured. The purpose was to allow teachers the opportunity to express the difficulties that they experienced in teaching English mathematics and to enrich the perspectives on English mathematics challenges that they experience in their mathematics instruction. The teachers were interviewed individually at their respective schools and in interviews that lasted an hour each. All three teachers shared similar experiences and perceptions.

In this subsection, data is presented in broad themes that emerged from a thematic analysis of teacher responses, namely:

- Teachers general teaching experience as well as their experience in teaching mathematics to Grade 4 learners in English.
- Challenges experienced by teachers in teaching mathematics.
- What teachers think could be the cause of challenges in teaching mathematics in English.
- How, and if, teachers teach vocabulary and comprehension in the mathematics classroom.
- How teachers accommodate struggling learners in their mathematics classes
- The kind of support that teachers receive from the Department of Education with regard to difficulties experienced in teaching mathematics to learners whose English proficiency is low.

I have coded the teachers' utterances by use of SL, SN and SB, standing for school L, school N and school B, respectively and the number that goes with them means the number of that utterance by the teacher of that school.

4.3.9.1 The challenges that teachers experienced in teaching Math in English in Grade 4

The data of this subsection emanated from the three Grade 4 teachers (SB, SL, and SN) from the three schools. The three teachers' learners were Setswana speakers who were taught mathematics in English, their FAL. It was explained in the methodology chapter that the purpose of interviewing the teachers was to investigate the challenges that teachers experience in teaching mathematics in English and how they reacted when learners did not understand academic English during the lessons and assessments. SB had 28 years teaching experience, SL aged 49 had 22 years of teaching experience while SN aged 48 had behind him 25 years of teaching experience.

A) Teacher training background of the teachers

Before I asked the challenges that teachers experienced in teaching mathematics in English in Grade 4, I wanted to understand what their qualifications were and what the

teachers' training entailed; whether they were taught how to teach mathematics in English. The purpose of asking this question was to determine whether teachers knew the teaching methods and strategies that they could apply in teaching mathematics in English to Setswana speaking learners. The following analysis emerged from these interviews.

Researcher: *What is your teaching qualification?*

- SB1 *Ke editse UDE. UDE ke University Diploma in Education*
- [I have done UDE. UDE is University Diploma in Education.]
- SL1 *Ke kereile PTD ya me ka 1992-1994 ...Ke gona ko ne ke major ka Math le Biology. ... Honours in Educational Psychology, BA major in Psychology and Setswana ...*
- [I got my PTD (Primary Teachers' Diploma) in 1992-1994 ... that is where I majored in Math and Biology. ...Honours in Educational Psychology, BA major in Psychology and Setswana].
- SN1 *.... nna ke entse SPTD, ga ka etsa J, so SPTD it was from Standard 5 akere, ene e le distandard ka nako eo ... it was from Standard 5 up to 7.*
- [... I did SPTD (Senior Primary Teachers Diploma, I did not do J, so SPTD it was Standard 5 isn't, and it was Standards at that time ... it was from Standard 5 up to 7.]

All three teachers were qualified except that teachers SB and SN had qualifications that were relevant for Senior Phase and Senior Primary, respectively. SL's improved qualification was not based on mathematics though she majored in Mathematics in her training. Grade 4 is an extremely important grade, because it is here that learners transition from home language as medium of instruction to English as medium of instruction.

Researcher: *Are your learners Setswana Home Language speakers?*

- SB2 *Ee ke Batswana botlhe, eehh botlhe Setswana ke Home Language ya bona, ke Batswana, ba tla ba tswa Grade 3 ba rutilwe disubject tsotlhe tsa Grade ka Setswana.*

[Yes, all of them are Batswana, ehhh to all of them Setswana is their Home Language, they come here from Grade 3 they were taught all the subjects in Setswana in Grade 3.]

SL2 *Ke mix, Grade 3 ba e dirile ka Setswana. Sekolo sa rona ke sa Setswana. Ehhh... ba ba tswa mo Setswaneng ba botlhe mo Grade 4*

[It is mix, they did Grade 3 in Setswana. Our school is a Setswana school. Ehhh ... all of ones come from Setswana]

SN2 *Ke Batswana botlhe, ke gore botlhe ba se tlhaloganya.*

[They are all Batswana, it means they all understand Setswana].

The purpose of this question was to confirm if the learners who took the assessments were all Setswana speakers who were taught math in English, who actually came from Grade 3 in the previous year. These are learners who are still developing language proficiency in their home language, Setswana. There is plethora of research that indicates that Grade 3 learners in South Africa do not have good L1 reading skills (Howie, 2003). This status quo answers to the poor performance as shown by the results in reading tests of the quantitative data analysis above. Cummins (2000:190) maintains that the linguistic and literacy related knowledge and skills that an individual has learned in his or her L1 will be brought to bear on the learning of academic knowledge and skills in L2. Cummins further adds that these learners have a far more difficult task to acquire concepts in English (Cummins, 2000:190), because learners do not have the common underlying proficiency of concepts and linguistic knowledge that makes linguistic transfer possible. Teachers should therefore realise the significant role that explicit instruction should play in the mathematics classroom, specifically when teaching the academic register of mathematics.

Researcher: *Have you been trained to teach mathematics in English in Grade 4?*

SB3 *Haai!, we only had the module that was called method. We were taught methods in general. There was no training on how to teach children when they come from Grade 3 when they come to Grade 4. And nna ke ne ke dira UDE, ke ele ya Senior Phase ya today.*

[Haai!, we only had the module that was called method. We were taught methods in general. There was no training on how to teach children when they come from Grade 3 when they come to Grade 4. And myself I did UDE, that one of the current Senior Phase].

SL3 waitse ko college go ne go rutiwa fela dimethods, ne go se na gore ba re bolelela gore mos ko college ne go sena gore wa itse gore bana ba tswa koo ka language e nngwe ba tla mo, ne go se na dilo tseo, hhhmmm, ne re rutiwa fela dimethods, e seng go teacher bana.

[... you know at the college only the methods were taught, we were not told, at college there was no way that we knew that learners came from somewhere they came with another language, there was no such, hhhmmm, we were only taught the methods, not how to teach children.]

SN like SB, indicated that during his teacher training they were taught methods in the Senior Primary Teacher's Diploma (standard 5 – 7), currently called senior Phase (Grade 7-9).

SN3 no there was no such ... ehh... mme Dlavane, kore basically it was fela the issue e ya gore o rutiwa disubject didactics, ka nako eo ne o rutiwa subject didactics, subject barriers how to teach ga go na selo se se yalo. ... I did my further diploma e be ke etsa remedial education, so eehh, you know one have a bit of eehh tolerance ehh ..

[no there was no such ...eehh . Mrs Dlavane, I mean basically it was only the issue of being taught the subject didactics at that time, at that time we were taught subject didactics, subject barriers how teach there was no such. I did my further diploma, then I did remedial education, so eehh, you know one has a bit of eehh tolerance eeh].

From the comments made by teachers SB and SN it would seem as if they may not be entirely qualified, or rather they have not been properly equipped to teach Grade 4 mathematics in English. This is supported by their non-response to the question that I asked them later where I asked how they accommodate struggling learners in their math classes.

B) Teaching experience in teaching English mathematics to Grade 4s

The purpose of this question was to determine if teachers were experienced in teaching mathematics in English in Grade 4 which would mean that in the years that they have taught math they would possibly have strategies that they used to deal with the difficulties that occurred in the teaching of mathematics to Setswana learners via the medium of English.

Researcher: *How long have you been teaching and how long have you been teaching Grade 4 mathematics, to be more specific?*

SB4 *Ke na le mengwana e le 31 ke ruta, but ke ne ke ruta Grade tse ko dimo, Grade 4 ke gona ke ne ke e ruta last year. Ke ne ke ruta Grade 6 le 7.*

[I have 31 years of teaching experience, but I used to teach higher grades, I started last year to teach Grade 4. I taught Grades 6 and 7].

Researcher: *Can you perhaps share with me why you left the senior classes for Grade 4?*

SB5 *You know mam, bana ba ba ko tlase ba ga ba sokodise jaaka ba ko dimo, ba monate gampe. Mathata mo Grade e ke yona issue ya puo fela.*

[You know mam, these learners at lower classes they do not give problems like those in higher grades, they are very nice. The only problem in this grade is that of language].

SL4 *Teaching experience 22 years. Ke kile ka ruta Grade 4 pele, e be ke e tlogela, ke boetse gape ngwaga o.*

[Teaching experience of 22 years. I once taught Grade 4 before, I am now back this year]

SN4 *20 ...I had a break ya 2 years, uuhh, so its about 24-25. Wa bona, fana in my first year ke berekile ko Sesothong neh, first year ya ka ga ke qala*

go ruta, my first year then ka ba HOD ko Setswaneng, so I was HOD for 6 years ko Setswaneng, then from there ka ya ko ko Khuma, then ka ya ko ee it was an English medium. I taught Senior Phase and this year I teach Grade 4.

[20 ... I had break ya 2 years, uuhhh so its about 24-25. you see, here, in my first year I worked at Sesotho school neh, my first year when I started to teach, my first year, then I became an HOD at Setswana school, so I was HOD for 6 years at Setswana school, then from there I went to at Khuma, then I went to ... ee it was an English medium. / taught Senior Phase and this year I teach Grade 4].

Teacher SN sounded more positive and courageous than teachers SB and SL who expressed their anxiety with teaching mathematics in Grade 4 to learners who do not understand the language of instruction. The teachers indicated that they started teaching Grade 4 mathematics again in 2017.

C) Challenges in teaching mathematics in English in Grade 4

Within this theme (i.e., challenges), a number of sub-themes were identified:

- Mathematical terms that are found only in mathematics contexts
- Words are shared between mathematics and everyday English but have different meanings in the two contexts
- Words have more than one mathematical meaning
- Words in the assessments that teachers indicated would be difficult for the learners?

Researcher: *Do you experience any challenges in teaching mathematics in English in Grade 4. If so, can you elaborate on that.*

An important challenge that teachers experienced was the “slowness” of Grade 4 learners in understanding the new math concepts and the amount of time that they had to spend on repetition when they teach a new term. The teachers biggest outcry was related to the teaching of specific mathematical words that the learners did not

understand. The specific words that teachers mentioned as the most challenging to their learners were *digits, place value, denominator, numerator, square, the names of the shapes in English, fractions, tallies, reading numbers of 4 digits*. They all mentioned that their learners struggled to read and that this negatively affected their performance on written assessments.

SB responded that teaching digits is a huge challenge because learners have knowledge of digits in Setswana but not in English.

SB6 *Thatathata the big problem ke ke ke o kare bana ba ka tla ba rutilwe di **digits**, ba di rutilwe ka Setswana, eeh, jaanong ba tla ba di rutilwe ka Setswana and wena o di ruta ka English, so ha ke tlo gore forty-four, ga ba itse that number, what is that number, ke tshwanetse gore someamanenne, that is the problem le **bodishapes**, ba tla ba di bitsa ka Setswana, bodikhutlonne, o mo raa o re **rectangle**, ga ba go utlwe.*

(A lot, a big problem is I wish these learners would come knowing digits, they know them in Setswana, eeh, now they come here been taught in Setswana and on the other hand you teach them in English, so when I say forty-four they do not know that number, what is that number, I have to say *someamanenne* (forty-four), that is the problem .. and the shapes, they come here naming them is Setswana, rectangles, you say to them rectangle, they do not hear].

The teacher from school L was not specific but was more general when she pointed out that:

SL5 *... ba very slow to understand a concept, o tshwanetse o e boeletse ka Setswana ko re ga o bua ka English they don't understand, most of the time re dirisa Setswana, most of the time re dirisa Setswana, just to link English le Setswana. They don't understand concepts, because of language barrier for example when we teach **place value**, for tens, units and hundreds they don't understand, we have to translate.*

[... they are very slow to understand a concept, you have to repeat it in Setswana, you know when you speak English they do not understand, most of the time we use Setswana, most of the time we use Setswana,

just to link English and Setswana. They do not understand concepts, because of language barrier for example when we teach place value, for tens, units and hundreds they don't understand, we have to translate].

SN5 *Now ga re bua ka **square** ... remember ba ntse ba etsa Setswana ... eeh eeh ... e be nna issue ya gore language, basically ba etsa English fela ka ko Foundation Phase as a language, but ba etsa dipalo, they are not doing mathematics, ba etsa dipalo, so it affects like you said, original terminology because it is almost non-existent in terms of the language.*

[Now when we talk about the square ... remember they have been taught in Setswana ... eeh eeh it becomes the issue of language, basically they only do English as a subject in the Foundation Phase, but they do numeracy, they do not do mathematics, they do numeracy, so it affects like you said original terminology because it is non-existent in terms of the language.]

The above words that were identified by the teachers are math technical vocabulary which cannot be avoided nor made simpler for the sake of learners' cognition in mathematics register. It is clear from the teachers' comments that they are in dire need of strategies to support bridging the gap from Setswana to everyday English to Mathematical English.

Teachers also indicated that teaching the **word problems** and **number sentences** is a challenge to them which also affects the learning of math by the learners.

SB7 *... ke teng ko go nang le mathata teng. ... yone e batla gore o e dramatise.*

[... that is exactly where there is a problem ... it needs to be dramatised].

SL6 *... that 2 plus 3 o e kentse in a sentence yooh! mam it's another thing.*

[... that 2 plus 3 when you put it in a sentence, yooh! mam, it's another thing].

SN6 *... wa bona le a serious challenges in terms of the sums, bana ba rona ba na le a serious challenges in terms of word sums because to change a word sums into a number sentence for them it's very difficult like your*

first question you will see gore eeh, more than, gore this are tallies and how many books tsa Setswana were sold more than English neh, it's easy for them to say 23-17 they will give you the right, answer but immediately you phrase in a form of a word sum it becomes difficult for them to translate a word sum into a number sentence.

[... you see and a serious challenge in terms of the sums, our children have serious challenges in terms of word sums because to change a word sum into a number sentence for them it's very difficult like your first question you will see that eeh, more than, that these are tallies and how many books of Setswana were sold more than English neh, it's easy for them to say 23-17, they will give you the right answer, but immediately you phrase in a form of a word sum it becomes difficult for them to translate a word sum into a number sentence]

Though the teachers make efforts to help their learners to understand mathematics concepts, their cry is that in teaching these concepts in a new language consumes a lot of time because they have to engage in a lot of repetition and more practical examples; this affects the pace at which the curriculum is taught and adds to the pressure on the teachers. It is not clear whether the additional explanations are having any effect on the performance of the learners.

SL7 *Repetition, moo o e dira gore o ome, that is the thing e etsang gore process e be telle cause it takes time, o ka se rute jaaka o ruta disubject tse dingwe. ... that one alone e ja nako ya rona thata ka gore always o tshwanetse o boele o nne so practical ka their real life situations ke gore ba kgone go understand this, ga o ntse o explaina jalo nako ya tsamaya.*

[Repetition, there you do it until you are dry, that is the thing that makes the process longer because it takes time, you cannot teach the way you teach other subjects; that one alone takes a lot of our time because always you have to go back and be practical about their real life situations, so that they can understand this, when you are busy explaining that time goes].

I also tried to understand the difficulties that they experienced in teaching mathematics as identified in the research conducted by Rubenstein (2002). Though the teachers acknowledge the importance of knowing the language of instruction for the learners to understand concepts in any content area classroom they all acknowledge the fact that with mathematics it is a different ball game because of the reasons they give below. They accept that communicating mathematically is a complex task for even the most mathematically advanced learner. This implies that teachers should consider teaching mathematical vocabulary explicitly. This is what the teachers had to say about their teaching of mathematics vocabulary to the Grade 4s.

D) Mathematical terms that are found only in mathematical contexts

SB8 *... bona ga se question ya terminology ke language itself, ga ba e itse. Everything is new.*

[... with them it is not the question of terminology it is language itself, they do not know it. Everything is new].

I asked SB the question which mathematical words are difficult or those that he thinks are difficult for his learners but he kept on referring back to the general problem of language.

SL8 *There are various areas, for instance, ka June they were asked 2-D shapes neh, ne ba filwe triangles, they can't remember **rectangle**, and the other one I think it was **pentagon**.*

[There are various areas, for instance, in June they were asked 2-D shapes neh, they were given triangles, they can't remember **rectangle**, and the other one I think it was **pentagon**].

SN7 *... kana difraction wa utlwa gore its new term for them, a fraction, kwana ba sa e bitsa ...gore **numerator**, **denominator**, tshwanetse o ba rute ... if you check it is difficult even for them right now neh, particularly if you check bana ba rona neh when it comes to decimal fractions ...*

[... by the way fractions, you can hear that it's a new term for them, a fraction, the other side (referring to Grade 3) they call it ... that

numerator, denominator, you have to teach them ... if you check it is difficult even for them right now neh, particularly if you check our children neh when it comes to decimal fractions ...].

The words that are found only in mathematical contexts are difficult to find outside the classroom. This implies that learners do not find the opportunity to learn these words in their interactions at home and in their social life. Hence, SN says that:

SN8 *... ke hore it depends on the general vocabulary ... it is a challenge in terms of for them to understand but neh understanding hore ba etsa that vocabulary kae, mo sekolong fela. It will have 2 periods it has that 3 periods ha a tswa a fitlha ko gae go fedile, go fedile o tlaa e bona hape the following day ha a tla mo skolong.*

[... it means it depends on the general vocabulary ... it is a challenge in because for them to understand but neh understanding that they do that vocabulary where, at school only. It will have 2 periods, it has that 3 periods when s/he leaves and arrives at home that all, that's all s/he will see it again the following day when s/he comes to school].

Having infrequent opportunities to use specialized mathematical vocabulary in non-mathematical contexts make it more difficult for the teachers and also for the learning by learners. But teachers must make efforts, as suggested by Rubenstein and Thompson (2002:111) that because “one of the few places students have to talk mathematics is in our classrooms, we as educators must give attention to mathematical language learning”. Continuing to ignore the vital role that direct instruction of mathematical vocabulary has on learner achievement will continue to disadvantage learners in ultimately mastering the language of math, in turn, math content and conceptual and procedural skill in solving problems.

E) Some words are shared between mathematics and everyday English but they have different meanings in the two contexts

The teachers' responses clearly indicated that the maths specific meaning of words was causing problems for the learners and that as teachers they found it difficult to help them easily distinguish between these meanings. The teachers very often

assumed that the learners would just know the difference. These words include amongst others: *volume, data, function, difference, area, round, and properties.*

SN has this to say about these words:

SN9 *Ha ba sa itse ba botse because sometimes I would take it for granted hore ba itse **data** handling neeh, they know what data is, so ke mang a sa itseng. ... we take it for granted but I have told them hore whatever ha ke tlo introducer something hore we are dealing with data handling ... if they don't know I explain, I don't get into a concept before explaining the term because for them to understand the term its I think hore it makes it easier for them. I make examples ... it starts there, so I try to explain ka practical concepts. ...like ke bua gore bo data handling neh, that vocab you must be little bit carefully because bona ba itsebela ha o kenya mo founung for them that is data but for them to say hore data in this sense is information so e batla e ba a bit tricky for them, so almost hen, wa tseba vocabulary ya ma Grade 4 to teach Grade 4 mme mma Dlavane its challenging I'll be honest with you, it's very challenging in terms of yona issue ya vocabulary, remember hore bat la bas a itsebele niks. eeh so there is a lot of vocabulary that you must do*

[If they do not know they must ask because sometimes I would take it for granted that they know what is data handling neh, they know what data handling is, so who does not know. ... we take it for granted, I have told them that whatever I will introduce something that we are dealing with data handling if they don't know I explain, I don't get into a concept before explaining the term because for them to understand the term its I think here it makes it easier for them. I make examples ... it starts there, so I try to explain ka practical concepts ... like I am saying that things like data handling neh that vocabulary you must be little bit carefully because they know only the data that you loud on the phone, for them that is data but for them to say that data in this sense is information, so it sound a bit tricky for them, so almost hen, you know vocabulary of the Grade 4s, to teach Grade 4, mme mma Dlavane it's challenging I'll be honest with you, it's very challenging in terms of this

very issue of vocabulary, remember that they come here knowing nothing eeh so there is a lot of vocabulary that you must do.]

Specialised mathematics vocabulary may cause learners to grapple with the content of mathematics and in turn result in poor performance on written assessments.

F) Some words have more than one mathematical meaning

In mathematics the word *difference* may mean comparing two or more things and it may also mean subtraction. This is rightly shared by SN when he says:

SN10 *Uuh, wa tseba bana ba rona ha o re ke etse example what is the difference between 7 and 2, the difference of 7 and 2 it becomes a challenge neh remember hore difference is the answer that you get when you subtract but if o re 7 but if o re now the difference between 7 and 2 or sum between 7 and 2 e ba, e ba depending on how you approach it. May be ko re sometimes re ba too lenient le rona in terms of vocabulary, we don't use much of it in Grade 4*

[Uuh you know our children if you say I must make an example, what is the difference between 7 and 2, the difference of 7 and 2, it becomes a challenge neh, remember that difference is the answer that you get when you subtract but if you say 7 but if you say now the difference between 7 and 2 or sum between 7 and 2 becomes this one, it is depending on how you approach it. May be it is because even us sometimes we become too lenient in terms of vocabulary, we don't use much of it in Grade 4].

Such words can confuse learners when they have to comprehend what they read. Teachers need to apply strategies that will familiarize learners with words such as these once they (teachers) become aware of this problem.

G) Words teachers indicated would be difficult for the learners

I gave the teachers the assessment before learners answered the papers. When I asked them which words/terms/concepts they thought would be difficult for the Grade

4 learners, SB mentioned the difficulty with naming the numbers in English. For example, he said:

SB9 *Thatathata o kare bana ba ka tla ba rutilwe didigits... so ha ke tlo go re 44 ga ba itse that number ... tshwanetse ke re masome a manenne. ...dishapes ba di bua ka Setswana mmmhhh... bodikhutlonne, o re wa mo raa o re eeee man ke rectangle, ga a go utlwe.*

[... so when I say 44 they do not know that number ... I must say masome a manenne. ... they name the shapes in Setswana mmmhhh ... bodikhutlonne, even when you tell him/her that eeee man this is a rectangle, s/he does not hear you]

SL9 *They don't understand concepts because of language barrier for example. When we teach place value, for tens, units and hundreds they don't understand, we have to translate tens to metso ... ga o ba ruta diplace value ba itse e le masome, makgolo, metso then wena you come and say hundreds, tens and units, ba struggler go understand the difference but immediately ga o re ka Setswana ...*

[They don't understand concepts because of language barrier for example. When we teach place value, for tens, units and hundreds they don't understand, we have to translate tens to metso ... when you teach them the place values, they know them to be masome, makgolo, metso then you come and say hundreds, tens and units, they struggle to understand the difference but immediately when you can say Setswana ...].

SN11 *O tlhalosa a concept you must, ke gore for them to link it to the Grade 3 tshwanets o boele ko Grade 3 o re a kere ko Grade 3 this is a place value, mona re e bitsa e setse e le ka language e nngwe, e ne e le place value or tlhakanya ka mo we are adding, subtract ka kwa re ne re ntsha*

[You explain a concept, you must, for them to link Grade 3 you must go back to Grade 3 and say you remember at Grade 3 this is a place value,

here we call it ... it now in another *language*, it was a *place value* or *tlhakanya* here we are adding, subtract that side we were *ntsha*

SN made a very important point that the use of incorrect words by teachers can contribute to learners' difficulty in reading mathematics. He said:

SN12 ... when it comes to decimal fractions and what, even batho ba bagolo ntse ba re, ga ba re zero comma two three, ba re zero comma twenty-three, so you, o tshwanetse o ba tlhalosetse gore it is not 23, if you go to the place value table neh, wa bona gore the 2 does not fall under the tens, e fola under di what we call now, the hundreds, so it can't be 23. But you know le le rona batho ba bagolo sometimes we are being, ga re bua le bona, we still use that wrong thing gore zero comma twenty-three, neh, which makes it difficult because pre-knowledge ya ngwana ha a tlile ka yona e re zero comma twenty-three hore o mo tlwaetse hore it's zero comma two three it's a challenge because o tla a tlwaetse.

[... when it comes to decimal fractions and what, even adults they still say, they don't say zero comma two three (0,23), they say zero comma twenty-three(0,23), so you , you have to explain to them that it is not 23, if you go to the place value table neh, you can see that the 2 does not fall under the tens, it falls under the what we call now, the hundreds, so it can't be 23. But you know even us adults sometimes we are being, when we speak with them, we still use that wrong thing that zero comma twenty-three, neh, which makes it difficult because the pre-knowledge of a child if s/he has come with it, it says zero comma twenty-three, for you to let her/him get used to say it's zero comma two three it's a challenge because s/he is used to it].

This means that mathematical terminologies which are not spoken or explained correctly and accurately can cause difficulty in understanding when learners have to read the questions and do the calculations. Hence, Gay (2008:218) says teachers must have mastery of mathematical vocabulary and use words correctly as they teach.

H) How teachers teach vocabulary and comprehension in Grade 4 mathematics

Researcher: *How do you teach, if you teach it at all, vocabulary and comprehension in Grade 4 mathematics?*

Though two teachers seemed puzzled when I talked about teaching mathematics vocabulary, SN's approach was clear, but teachers SB and SL did not really indicate any explicit focus on the teaching of mathematical vocabulary to the learners. It is clear that teachers should be made aware of the importance of an explicit focus on language challenges that grade 4 learners could face, and how they can assist the learners to overcome these barriers. From the overall discussion with the three teachers, it seemed that repetition was their strategy of choice. The teachers stated the following:

SB10 *Usually in the morning re etsa di like di timetable, ba di goa gantsi, ba di opela, Ee ga ke dire mafoko a math.*

[Usually in the morning we do timetables, they say them loud and sing them. Yes, we do not do math words].

This way of teaching mathematics focuses more on procedural skills than on conceptual skills because learners repeatedly say the words that they may not even understand. It does no justice to learners because they spend time acquiring isolated skills through repeated practice and rote repetition (Stigler & Hiebert, 1999:10-11 in Ramsey, 2013:2). They further maintain that conceptual understanding is key because knowledge of vocabulary is one of the solutions that leads to less time spent on "killing and drilling procedural skills".

SL9 *Practical is very important mo go bona magrade 4. ... with math you can only use examples honestly, if we are talking about the fractions you have to gore o di drawe gore ba bone gore ke reng, ... with capacity ke tshwanetse ke tle ka metsi ke ba bontshe gore ooh ka nnete 500ml tse di kana di mpha litre tse di kana, wa bona, a iponne ka matlho gore ooh ka nnete, if you just write when you are doing mathematics it's tough.*

[practical is very important to them the Grade 4s ... with math you can only use examples honestly, if we are talking about the fractions you have to draw them so that they can see what I am saying, ... with capacity I must bring water and show them that ooh truly so many 500ml gives so many liters, s/he can see, so that they see with their own eyes that ooh really. If you just write when you are doing mathematics, it's tough].

SN13 *O tlhalose a concept, you must, ke gore for them to link it to the Grade 3 o tshwanetse o boele ko Grade 3 o re a kere ko Grade 3 this is a place value, mona re e bitsa ... you go there so that ba bone the link gore ooh this thing ke ntho e ntse re e itse from Grade 3 ... so you link. so I try to explain ka practical concepts*

[You must explain a concept, you must, it means for them to link it to the Grade 3 you must go back to Grade 3, and say remember in Grade 3 this is a place value, here we call it you go there so that they can see the link so that ooh this thing they still know from Grade 3 .. so you link so you link. ... so I try to explain ka practical concepts.]

SN indicated that he taught his learners that they must not answer any question when they do not know the meaning of a word in that question, they must ask him the meaning of words that they did not understand. He mentioned that before he solved the math problem with the learners, he made sure that they understood every word, number or symbol in the problem. He would explain the English meaning, then apply the term to the English or Setswana class context, after which he would then move to describing and explaining the concept in mathematical terms and use it in a problem. The teacher referred to data handling as an example. Because he knew that the learners knew the data as airtime that is loaded on the phone, he would use an example like this:

(SN14) *Mamago o palame taxi neh kapo wena o palame taxi, o utlwa batho ba bua ka mamago gore hey mma Dlavane this and that, ke mamago ka nako eo, o dutse moo, ho buiwa ka mamago, how do you, ke eng ntho eo, ke information, how do you handle it, ...*

[Your mother is in a taxi neh or you are in a taxi, then you hear people talk about your mother that hey mma Dlavane this and that, at that time she is you mother, you are sitting there, they talk about your mother, how do you, what is that, that is information, how do you handle it, ...]

Basically, the teacher uses prior knowledge of the learners and those incidences that they can easily relate with. In using their prior knowledge, learners comprehend the mathematics problems much better.

SN also explained that to allow learners to comprehend, he sometimes indicated that for every word problem he would use the most relevant examples using the learners, their parents or friends so that they can easily make sense of the concept in mathematics. He would let one or two learners or three stand in front of the class and ask each one how old they are. Then he would ask who is older and who is smaller, after which he would then use the mathematical word problem language.

(SN15) *How many years does Thabo have more than Palesa? or how many years does Palesa have less than Thabo?*

To get them to a level where they can easily understand the mathematical concepts, it is a teacher's responsibility to guide learners through understanding the language of mathematics. Public Sector Manager magazine (2018:20-21) reported that Mishael Matonhodze was crowned the best mathematics teacher in South Africa. In her interview with the editor of the magazine she explained that she tried her "best to link mathematics to their everyday experiences and interactions, using examples that they can relate to and making them appreciate mathematics as an essential part of life in general." She further added that she "cannot emphasise enough the importance of a strong foundation of concepts because if it does not exist, then you have nothing to build on".

1) How teachers accommodate struggling readers

Learners who cannot understand English will definitely have a difficult time to not only understand the teachers' explanations, but also have trouble reading the questions. When I asked the teachers how they accommodate their struggling learners, these are some of their responses:

Researcher: *How do you accommodate struggling learners in your math lesson?*

SB11 *Ke dirisa di... re na le math lab mo skolong, so ke na le go tsaya bonero go dira like physically, a e tshware, 4 ke e, a e handle ka matsogo a gagwe, gore this is a 4, ee.*

[I use the ... we have math lab at school, so I sometimes take them to go and do physically, they must touch it, here is 4, they should handle it with their hands to say this is 4, yes.]

SL10 *example on top of example ... repetition.*

SN16 *to teach Grade 4 it's challenging, there is a lot of vocabulary that you must do, practical examples di a thusa because simply denominator horewhat is denominator, denominator ke eng wa utlwa tshwanetse o strate fatshe!*

[to teach Grade 4 it's challenging, there is a lot of vocabulary that you must do, practical examples di a thusa because simply denominator hore what is denominator, denominator ke eng wa utlwa tshwanetse o strate fatshe!]

The teachers' responses clearly indicate that repetition in terms of explanations and offering them additional opportunities to practice seems to be the key strategies employed by the teachers. From the results on the teacher developed assessments and the learners' reading literacy profiles it is clear that alternative strategies should be employed and that the impact on learners' learning should be monitored. Whole group practice or chorusing enables individual learners to fall between the cracks. Learners are typically good at trying to save face in front of their peers and their teachers.

J) What language do you use to teach during your mathematics instruction in Grade 4?

Grade 4 learners come with Setswana mathematics terminology from Grade 3. All three teachers experience this as the major cause of difficulty for lack of comprehension by the learners because they do not understand English; this is also

supported by the learners reading literacy results in this study (cf. section 4.2). The teachers acknowledged the fact that during the first and second terms of the year, they used Setswana as medium of instruction in their math lessons, with little English. The two teachers expressed their frustration with regard to teaching mathematics in the first term of Grade 4 because learners' prior knowledge of concepts is "wiped out" by them being required to use English as medium of instruction.

Researcher: *Which language do you use during your math classes?*

SN17 *Ke se berekisa a lot, a lot, ga ke batle ke re ke berekisa English throughout, ka se berekisa, kore although first term I use a lot, second term to fourth term ba setse ba tlwaetse vocabulary, ke try, ke reducer hmm..*

[I use it a lot, I do not want to say I use English throughout, I use it (Setswana), meaning although first term I use a lot, second and fourth term they are already used to vocabulary, I try, I reduce hmmm...]

Using Setswana for instruction is of course a way of helping learners to grasp the content and understand the mathematics vocabulary. This therefore implies that "learning takes place at the interface of two languages", Setswana and English. The idea is to support and promote learning. The challenge though, arises when learners have to write their assessments. Their assessments are in English. This situation may be one of the reasons for low performance in mathematics, namely decoding the language of the question (i.e., fluency). Another challenge of going English solo would certainly be limiting learners' opportunity to participate in learning mathematics content and participating in mathematical discourse.

SL11 *... gwa ba disadvantage go ba ruta ka Setswana whereas question paper e tla ka English, ee, ba ga itse le go bala.*

[... it disadvantages them to teach them in Setswana whereas the question paper comes in English, ee, they can't even read].

SB12 *Ke dirisa both languages, ga ba sa tlhaloganye, ga go na le mo ba sa tlhaloganyeng teng ka English ke dirisa Setswana, e seng thata, mo di*

terminology strictly English. Ga ke tlhalosa ke gona ke dirisang Setswana.

[I use both languages, if they do not understand, if there is somewhere where they do not understand in English I use Setswana, not much, with terminologies strictly English. I use Setswana when I explain].

It is clear that teachers use code switching a lot. It appears that SB uses English to to explain math concepts while the instructions are in Setswana. The other two teachers, SL and SN, state that they used Setswana a lot. In their case, code switching seemed to replace English which as SL rightly states – this may be to the disadvantage of the learners because they have to complete their assessments in English, where no support is provided in Setswana.

K) The learners' reading and writing skills in written assessments

Teachers indicated that learners in Grade 4 are slow both in writing and reading. Actually, they stated that learners cannot read. These statements are supported by the results presented in section 4.2. They say so because when learners write a test and the test is explained orally either in Setswana or English, they do well. SN suggested that if the Grade 4 math examination was oral they would pass with flying colours. The teachers stated the following:

SB13 *.... because le ha o ba file question paper like I said kore ba tsena mo mathateng, le ha question ba e itse, ba e tlhaloganya, ba itse, ba ne ba ka e tshwara but because e beilwe ka English so ga ba itse gore go etsagala eng, le reading tota ga e yo. ... ka molomo ba ka phasa ... eeh ... and le diclasswork ba di tshwara because nna as a teachers ka ba tlhalosetsa, ke re la gopola maloba e rile re etsa this thing ke gona ba tshwarang but ge nna nka suta e le exam, go invigilate somebody else, tsho!*

[... because even when you have given them a question paper like I said, I mean they experience problems, even when they know the question, and understand it, and know it, they would get it correct but because it is put in English, so they do not know what could be happening, even

reading is not there they cannot read. verbally they can pass ... eeh .. and they pass even the class works because myself as their teacher I explain to the, I say do you remember that yesterday we did this thing, that is when they remember, but I can shift when it is exam time, when it is another teacher invigilating, blackout!]

SL12 *... oral ba excella, in oral, you know why, because they can't read so when you teach and ask ba go understand but when you put that mo pampering, ga ba itse go e bala. ... ga o e typer it's a different story because mo class workeng you tend to explain you read the question le bona and then you explain the question but then ka question paper you just give them the question paper gore ba nne independent but ke mo bothata bo tswang teng.*

[... in oral they excel, in oral, you know why, because they can't read, so when you teach and ask they understand you but when you put that on paper, they do not know who to read it ... when you type it, it's a different story because in the classwork you tend to explain, you read the question with them and then you explain the question but then with a question paper, you just give them the question paper so that they can be independent but this is where the problem comes.]

According to Schleppergrell (2007:156), “if mathematics concepts are not introduced and explained in oral language that moves from the ordinary language that students already understand to the more technical language that they need to develop for full understanding of the concepts, students learning suffers” and they will continue to have difficulty in written assessments. In addition, if their math is to be “communicated appropriately, both written and orally, students need an exceptionally deep conceptual understanding of mathematical vocabulary for solid foundation in the higher, more accelerating math classes at the secondary level” Ramsey, 2013:4).

From the interviews with the teachers it is clear that they are very aware of the barrier that English as medium of instruction creates for the Grade 4 learners, given the fact that their reading literacy in English is not even at a Grade 3 level. Their oral retell fluency also indicates that they have trouble retelling main ideas in English.

L) The support that teachers get from the Department of Basic Education

The Department of Basic Education is aware of the difficulties of transition of language from Grade 3 to Grade 4. Teachers from schools L and N lost hope with regard to receiving support from the DBE except school B which was used as a pilot school for what they called “math lab”. This is what teachers had to say about the support:

Researcher: *Department of Education e le support jang ka teaching math mo Grade 4 ka English?*

SB14 *yes ... uhmmm... usually the education specialist ya rona e na le go re romella di ... eehh ... ke reng? Types of methods gore you must try when coming to fractions, for example try this method but ga e le gore o dirile ona there is another way gape, e nngwe e o ka e dirisang and o re checka time and again Ee, Mr Thabo (pseudo name) wa re attender, Mr Thabo o tlaa go attend ga wena o mo tshwenya, so rona re dula re mo tshwenya.*

[yes ... uhmmm ... usually our the education specialist sometimes send us the Eehh ... what must I say? Types of methods that you must try when coming to fractions, for example try this method but if you have done this one there is another one again, another one that you can use and he checks us time and again ... Ee Mr Thabo attends us, Mr Thabo will attend you if you bother him, so us we bother him]

SL13 *Heeeiii ba re thusa ka eng? ... ka gone ko dikolong ntse a sa ye ke mmoditse two weeks back gore before you used to come o tla go checka gore go ya yang nou yana ga a satla mo dikolong problem ke eng a bo a ntheela something sa pilot schools mara ba concentratile thata ko Grade 9 ... he is overloaded... and o dula a seyo mo Potch ka gore o ne a nthaya a re le nouyana o tswa PE.*

[Heeeiii they help us with what? ... because he has not be going to schools, I asked him two weeks back that you used to come to check us

to ask it was going with but now he does not come to schools anymore, what is the problem, he said something about pilot schools but they are concentrating in Grade 9 ... he is overloaded... and he is always out of Potch because he was saying to me he just arrived then from PE].

SN18 *Can I be honest with you, wa bona ke kgwedi mang e ha ke so attende any PSF meeting ya math, we haven't been called for anything hore re a bitsiwa or ha re bitsiwe ... uuhh... I'm just being honest neh, nothing so the only thing maybe bkareng ba re support ka yona Department of Education ke dibuka, ke di report tse ba di batlang fela hore na DBE books le di sebedisistse that just concientise us hore this what we have to do, basically support ya resource materials yaaahh ke tsona tse nakreng itse there but in terms of eehhh I'm not sure but I don't think in service training ntse e le teng akere inservice training normally ne e le teng pele so ha di sa le yo dintho tseo.*

[Can I be honest with you, can you see what month this is, I have not attended math PSF meeting yet math, we haven't been called for anything to say we are called or we are not called ... uuhh... I'm just being honest neh, nothing, so the only thing maybe that I can say they support us with are the books of the Department of Education, the reports that they want to say whether you have used the DBE books, just to conscientise us that this what we have to do, basically support of resource materials yaaahh they are the ones that I can say it is there but in terms of eehhh... I'm not sure but I don't think inservice training is still there inservice training normally used to be there so they are not there anymore].

Teachers in Grade 4 need more support than any other because a number of complex transition challenges that affect them and the learners and the school in general. In her study of the transition from Setswana Grade 3 to English Grade 4 in Botswana, Mokibelo found that the critical and sensitive transition period from Setswana medium of instruction to English medium of instruction is taken for granted and that teachers should have the necessary delivery skills and support to enable them to go through that critical period with less anxiety (Mokibelo, 2016:665).

In summary, the analysis of the teacher interview data highlighted the following issues:

- They are torn between teaching learners who are not proficient in the language of instruction (i.e., English), explaining complexities of mathematical vocabulary, and the strategies they should be using to assist the learners with the “difficult” vocabulary;
- Learners are “slow” (i.e., take a lot of time and a lot of repetition) in understanding the concepts;
- Learners write very slowly;
- They had difficulty explaining some of the technical mathematical vocabulary in Setswana;
- Learners know the two symbols of mathematical operations (+ and -) very well, but when the symbols are put in words, they have to learn a “foreign language”.
- Teachers need urgent support.

4.4 Learners` perceptions about Math assessments and related language challenges

The purpose of interviewing the learners was to determine firsthand what the learners themselves perceived to be difficult about the maths assessment. In this subsection I coded the learners from each school as S standing for the school, then the letter for the name of the school, i.e. B or L or N, and lastly, L standing for learners and the number for the number of occasions of their utterances. (e.g., SBL4 will mean School B learners, utterance number 4).

A) Which questions were difficult for you?

Nearly all the learners in each of the focus groups per school indicated that the assessment was difficult. The general response was that “we did not know the words in the questions”.

Some of the learner responses included:

SLL1 *Mafoko a na le thata. Re ne re itse dipalo fela.*

[The words were difficult. We knew the numbers only].

I also requested those learners who did not find the entire assessment to be difficult to put up their hands. Only a few in each class put up their hands to indicate that not the whole paper was difficult. At school L only 9 out of 29 learners put up their hands. When asked whether they could explain some of the maths vocabulary, the answers included:

Researcher: What is a tally chart? [question was posed in English and then Setswana]

SLL2 *Ditally ke dithupana tse re di balang.*

[Tallies are sticks that we count]

From the other school learners also indicated that the paper was difficult because:

SBL1 *Ga re tlhaloganye English, re batla test ka Setswana. Meneer ena o re bolella yona ka Setswana le ga a e kwadile mo chalkbotong ka English.*

[We do not understand English, we want the test in Setswana. Mr. tell us in Setswana even when he has written it on the chalkboard].

The learner responses resonate with research conducted by Chall and Jacobs (2003) who reported that the grades 4 through to 7 learners had greatest difficulty in defining more abstract, academic, and less common words and that these learners were more than two years behind grade level norm expectations. Lack of vocabulary knowledge obviously negatively impacts learners' performance in the content areas.

B) What made the questions difficult?

This follow-up question was aimed at understanding if there was any specific term(s) that made the question difficult.

SNL1 *Re tlhaloganya test ga titšhere a re baletse yona, re be re bua ka yona a re tlhalosetsa yona.*

[We understand the test when the teacher has read it to us, and talk about it and explain it to us].

This is the group that indicated their wish to be taught math in Setswana like in Grade 3 because they did not understand most of the words. From the learners comments it also seems as if their Grade 3 teachers read all the maths questions to them.

SNL2 *Ko Grade 3 re ne re phasa dipalo maar mo Grade 4 ra di feila. Re batla titšhere Kagiso (pseudo name) a re rute dipalo ka Setswana gore re di tthaloganya*

[In Grade 3 we used to pass math but in Grade 4 we fail it. We want the teacher *Kagiso* to teach us math in Setswana so that we can understand it].

SLL3 Ga ne re rutilwe dipalo ka Setswana re ne re tlaa phasa dipalo tsena.

If we were taught mathematics in Setswana we would have passed this test.

In general, all the learners complained about the language and that they could not read any of the words and that they didn't understand them. From my "reading between the lines" as mentioned previously, it does seem as if teachers in the foundation phase read the questions to their learners – also in Setswana. This may also explain why they found the whole "reading" exercise related to doing maths very taxing and frustrating. As is maintained by Dunston and Tyminski, (2013:40, in Ramsey, 2013:3), "many students view the language of mathematics as being a foreign language".

C) What do you do when you do not understand the question?

The majority of the learners seem to use the teacher as their first and only strategy when they are not sure what to do. It is clear that these learners are not familiar with strategies and how to figure out when things don't make sense. The total reliance on the teacher for explanations in Setswana and for a lot of repetition may also lead to learned "helplessness" on the part of the learners.

SBL2 *Ga re nke re botsa dipotso ka gore titšhere o tthalosa dilo kaofela. Maar ga re sa tthaloganye wa re tthalosetsa.*

[We never ask questions because the teacher explains everything. But when we do not understand, he explains to us.]

SLL5 *Mistress Mpho (pseudo name) wa re tlhalosetsa.*

[Mistress Mpho explains to us]

SNL3 *Re batla titšhere a bue Setswana le rona gore re kgone go tlhaloganya dipalo. Ga a bua English ga re mo utlwe.*

[We want the teacher to speak Setswana with us so that we can understand mathematics]

D) Which words were specifically difficult for you?

From all three schools these are the words/phrases that the learners themselves mentioned: *tally; product; 3 times itself; a day after the school was opened; round the number; values; kilometre and metre (the map shows km but when the question is asked it says m); 3 out of every square; dimension; 3 dimensional; convert; at this rate; perimeter; cm; less than; and the next four Thursdays.*

The focus group sessions with the learners indicated that the use of English in the Maths classroom was a major obstacle. The learners also highlighted the words that the literature review pointed out as being problematic. It was also clear that the “use of the teacher” was the go-to strategy used by the majority of the learners. It was also clear that their motivation was exceptionally low because some of the learners indicated that if they didn’t know they just left out the question – this is supported by the fact that a large percentage of the learners’ data could not be used in their maths performance analysis because of incomplete assessments. It also became clear that guessing was used very frequently by a lot of the learners. From the responses it was also clear that language in the maths classroom needed to be addressed as a matter of great urgency.

Ramsey (2013:3) reiterates that there is a clear need for learners to possess a rich understanding of mathematical vocabulary. The challenge though in Grade 4 is that, as is maintained by Chall and Jacobs (2003), texts begin to contain new words and concepts beyond the learners’ own language and their knowledge of the world, the words and concepts in such texts are beyond the everyday experience of the children. Teachers should apply strategies that will help learners to learn some of the new words

on their own or have a strategy to deal with difficult words and concepts as well as explicitly teach them vocabulary.

4.5 Summary

This chapter presented and analysed the findings from quantitative and qualitative data. The quantitative data presented the reading literacy profiles and mathematics performance of the learners. The results indicated that the grade 4 learners were reading below a grade 3 level, which means that they are not able to read fluently and accurately; they have trouble decoding basic English language words in text format. The results, therefore, imply that these learners will also have trouble decoding and reading for meaning sentences in mathematical assessment papers. A frequency analysis of the learners' performance on a maths assessment indicated that approximately 80% of the learners were experiencing problems in all mathematical focus areas covered in the Grade 4 curriculum. Ramirez (1992) indicated that learning English language skills by ELLs requires six or more years of special instructional support.

The qualitative analyses focused on a document analysis of teacher developed mathematics assessments and textbooks as well as learner workbooks and teacher manuals. In addition semi-structured interviews and focus groups were held with the teachers and learners, respectively. It emerged from the qualitative analysis that mathematical words may cause confusion in comprehending the math questions because of a number of factors such as sharing the terms with English, unfamiliar mathematics words, words with more than one meaning, homonyms, the irregularity of English spelling, compound nouns, and words that are used interchangeably in math. The study shows that the interaction between mathematics and English vocabulary is real. In addition, the analysis of learner textbooks, workbooks and teachers' manuals also shows that the math resources use "difficult words" (as identified by both teachers and learners) such as words that are taught in pairs which causes confusion in understanding the meaning of such distinct words, mathematics terms that are found only in mathematical contexts, words that are shared between everyday English and mathematics but have different meanings in both contexts, math words that are used in other disciplines, math concepts that are verbalized in more than one way, and finally prepositions in word problems.

The analysis of teacher interviews supports the quantitative data analysis in this study. It emerged from the teachers' interviews that learners' English proficiency is low to non-existent. The learners prefer being taught in Setswana. The teachers indicated that the learners could not do the assessments because they could not read the questions. Schleppergrell (2007:146) maintains that the "technical vocabulary and grammatical structuring associated with it make the oral and written language challenging in its own right". Jamison (2000) and Usisskin (1982) (in Jojo, 2016:2607) distinguish between three ways in which the use of language in Mathematics differs from the language of ordinary speech, that there is no present, past or future in Mathematics, a concept "is", it has no emotional content and it has no ambiguity. Hence it is a challenge for the both teachers and learners to translate the mathematical semiotic resources and maintain the technical register in a mathematics class.

The results of this study clearly show the impact of learners' language background on their math performance. Data from the study were consistent with previous research suggesting that English vocabulary in maths may affect comprehension and that average and low-achieving learners may be at a relatively greater disadvantage in answering mathematics items with technical mathematics vocabulary. The results indicate that Grade 4 learners prefer to use their HL to the LoLT in order to better understand mathematics. The results also suggest that teachers are aware of the language problem, but that they are in need of instructional support in terms of how to address the language barrier affecting maths performance by Grade 4 learners. The findings from this study echoes Cummins' statement that low language proficiency restricts the readers' ability to understand and interact in L2 text (Cummins, 2000).

CHAPTER 5: CONCLUSION

5.1 Introduction

The present mixed method study set out to determine the reading literacy profile of Setswana-speaking Grade 4 learners whose LoLT is English as well as their performance on a teacher developed mathematics assessment. I was also interested in finding out what challenges and/or problem areas learners identified with regard to Grade 4 Maths language (e.g., vocabulary) in teacher-developed assessments, learner workbooks and textbooks. In addition, I sought to understand the teachers' and learners' perceptions of mathematical language problem areas in order to develop an instructional support framework that will help content area teachers integrate reading literacy within their subjects taking cognisance of the LoLT as well as the mother tongue of the learners. The ever rising and continuing underperformance of Grade 4 learners in mathematics gave impetus to this study, and lead to the formulation of the following research questions:

- What does the reading literacy profile of Setswana-speaking Grade 4 learners whose LoLT is English look like in terms of oral reading fluency, retell and reading comprehension as well as their composite basic early reading literacy score?
- What does an analysis of Grade 4 learners' performance on a collated teacher-developed mathematics paper indicate?
- What does an analysis of Grade 4 Maths language (e.g. vocabulary) in teacher-developed assessments, learner workbooks and textbooks reveal?
- What are teachers' and learners' perceptions of mathematical language problem areas?

The purpose of this chapter is to give a summary of the results of the study, to outline the limitations of the study, to present the vocabulary instructional support framework that emanated from the literature review as well as the empirical component of the study, to discuss recommendations of the study for various stakeholders, and lastly, to present a succinct conclusion to the study.

5.2 Summary of Findings

The summary of the findings is presented according to the research questions that guided the study.

5.2.1 Reading Literacy Profiles of Setswana-speaking Grade 4 learners whose LoLT is English

The results of the study indicate that the Grade 4 learners are reading below Grade 3 level. The majority of the learners' oral reading fluency, their retell, reading comprehension as well as their composite basic early reading literacy scores were well below benchmark. These results are similar to the recent PIRLS (2016) results that indicated that 78% of the Grade 4 learners could not read for meaning in any language. The results are also reminiscent of the 2010 ANA results (DBE, 2011) that indicated that the Grade 3s, across the nine provinces of the country, performed extremely poorly in the reading comprehension tests they took in their HLs. This is cause for concern because if learners cannot comprehend in Grade 3, the probability that the problem is carried over to grade 4 is high; resulting in what is called the grade 4 slump. The pattern of results over time also indicates that the problem with regard to reading literacy in South Africa is not improving.

Sibanda (2017:3) posits that CALP is characterised by “the high cognitive demand that language imposes upon the learners and the extent to which it allows for discussion of abstract concepts not captured in the here and now”. He further clarifies the fact that the academic aspect of CALP denotes its use of language that goes beyond the everyday into the academic and technical. In this instance, the South African Grade 4s have not acquired the basic level of CALP and it cannot be assumed that most African language speaking learners (Setswana in this study) would have developed BICS in English by the time they get to Grade 4. Prinsloo (2007) maintains that learners are set up for failure by using HL (Setswana) in Grades R-3 and transition to English in Grade 4.

With more than 90% of learners failing to read for comprehension, it is clear that Grade 3 has not catered for these learners because all have not mastered basic reading skills to be able to cope with academic performance in Grade 4. Cummins (2000) posits that BICS takes two to three years to develop while CALP required five to seven years, but

important to remember is that this refers to the acquisition of HL and not to FAL. This means that for FAL more time will be required for learners to become proficient in English by the end of Grade 3. It means that African languages learners require more time to learn basic reading literacy skills such as decoding, fluency, etc. in order to read to learn in the content areas. Another challenge is that English and African languages are non-cognates because African languages with their phonetic spelling allows for grapheme-phoneme correspondence in reading (Sibanda, 2017:4). African languages learners who learn English find it harder to read English words because of the opaque orthography.

5.2.2 Grade 4 learners` performance on a collated teacher-developed mathematics paper

Mathematics involves various “types of texts” within a single text, viz words, mathematical symbols, graphs, maps, etc. A combination of these can cause anxiety to the learners who do not understand the language in which the text is written, resulting in them not fully comprehending the text. The results in this study indicated that between 70% and 80% of the learners in all three schools had trouble on all the content area domains being covered in the Grade 4 curriculum. The responses also seemed to indicate the many learners were guessing the answers, because they did not understand the questions (supported by learner responses during the focus groups). This may be a reason why there was a big range in performance (i.e., all distractors being marked by a certain percentage of the learners).

5.2.3 Grade 4 Math language (e.g., vocabulary) in teacher-developed assessments, workbooks and textbooks

Overall, the results indicated that the language use in teacher-developed assessments was very general and non-technical; teachers tended to avoid, if possible, the “correct” mathematical terminology. In the workbooks and textbooks the words were majorly technical and maths specific with multiple meanings not being defined. These are words that cause confusion to English language learners. Textbooks and the teacher are the only resources and sources for learners in and outside the classroom. Words such as denominator, fraction, quadrilateral, difference, and round are used in the learner textbook but no definition or explanation of the words are provided. It is

important that these words must be explained in the learning resources because learners are given homework and they have to prepare for assessments when no teacher is around. Given the fact that these learners are also having trouble with basic reading literacy skills such as fluency is an indication that the reading of mathematical texts will pose a serious challenge to these learners. Of the three textbooks that were analysed, two of them did not contain explanations of technical mathematics words, but at least the word bank used in the third textbook defined the following words once or twice in the whole textbook: *tally table, volume, number sentence, sum, flow diagram, digit, difference, pictograph, data, pie chart, bar graph, polygon, quadrilateral, triangle, rectangle, pentagon, hexagon, cube, line symmetry, fraction strip, factor, perimeter, area, capacity, and grid*. These words may form part of the learners' terminology booklets that teachers use as a strategy to help them define and explain their own words.

The results indicated that the language use in the assessments, the workbooks as well as the textbooks were not accessible to English language learners. It is also clear that because of the density of mathematical language, learners had problems comprehending definitions as well as English words used as nouns, verbs and or adjectives that affect the spelling of the particular word. For instance, words such as *high* and *height* refer to the same thing but have different spelling. This study has found that to English Language Learners these words may be confusing because Setswana does not have such words.

Various categories of language-related problem areas identified in the research also manifested in the analysis of the assessments, workbooks and textbooks, namely words shared by mathematics and everyday English, but have different meanings in the two contexts, some words have more than one mathematical meaning, words that are homonyms with everyday English, English spelling and usage have many irregularities, compound nouns, words that are used interchangeably in mathematics and also have another meaning outside mathematics contexts. The implication is that because Setswana does not have cognates with English, these words cannot, or are very difficult to, be explained from the language background of learners.

5.2.4 Perceptions of teachers and learners on language problem areas

Teachers' and learners' perceptions are strongly supported by evidence that emerged from both the quantitative profiles as well as the qualitative analysis of the assessments, textbooks and workbooks. It emerges that the challenges facing teachers are pedagogical (content teaching and teaching strategies) and learner based. It appeared that the slow pace in writing and comprehending mathematical concepts tapped teachers' energy and resulted in them employing repetition ad infinitum as a strategy in their classes. The teachers indicated that they suspected that the teachers in the foundation phase, specifically grade 3 made use of orally explaining all mathematics to the learners; the consequence is that the grade 4 learners have trouble decoding the English language on the mathematics assessments – the learners indicated that they wanted the teachers to read and explain the questions to them. The learners clearly indicated that they wanted their teachers to use Setswana to explain to them as their teachers did in their grade 3 classes. The language problem areas are very similar to those identified during the assessment, textbook and workbook analyses. For example, words that had a different meaning in the mathematical context to that which they are used to (i.e., volume, etc.).

The results also indicated that because of the lag in their English reading literacy skills, their ability to communicate their thoughts and thinking processes in English was severely constrained; most of the learners resorted to explaining in Setswana. This is also an indication that their oral language ability in English may negatively affect their maths performance. It is difficult to comprehend how frustrating this must be for the learners; they can't read and engage in an assessment because of a language barrier. Learners found the whole "reading exercise" related to doing mathematics very taxing and frustrating and this could be the reason why it appeared that some learners may have guessed the answers.

This idea brings into question the validity of the tests that are given to English language learners in their L2 (English). Are teachers assessing the learners understanding of the math concept, or are they assessing learners' grasp of the academic register of mathematics? A landmark Supreme Court Case in the United States of *Lau vs. Nichols* (1974) found that all learners, despite their first language, should be provided the opportunity for a meaningful rigorous education. To make

sure that this happens, English language learners need direct academic vocabulary instruction in mathematics (Marzano, 2004; Zwiers, 2012). According to Marzano (2004), increasing learners' academic vocabulary will improve test scores.

5.2.5 Teachers' limited experience in teaching mathematics in English

Though it has emerged that teachers in the study were qualified, the disadvantage is that they were qualified to teach higher grades, and not specifically intermediate phase. The implication is that these teachers would not be familiar with the repertoire of strategies that they could use to assist the English language learners in their maths classes, and also how to effectively draw from their home language, namely Setswana. The Grade 4 learners need teachers who understand the numeracy that was taught in Setswana in the Foundation Phase and the English mathematics that has to be taught in Grade 4, including strategies on how to deal with reading literacy related challenges as well as common teaching challenges related to "pacing". Also, "[T]eaching children so that they are successful in mathematics requires that educators plan for not only short-term success but long-term success" (Powel *et al.*, 2016:16).

5.3 Limitations of the study

The researcher would like to acknowledge the following limitations:

- The study was completed in one district in a specific province.
- Disruptions at various schools and also preparation for assessments necessitated a number of schools from withdrawing from the study. It is a possible that because of these ANA preparations learners may have been in more of a "panic mode" than usual when writing mathematics.
- The selection of a collated teacher developed assessment was predetermined in order to obtain a picture of how learners performed on maths assessments drawn up by their teachers. These assessments are reported on to parents and are used for progression purposes. In order to get a more "accurate" picture of maths performance reliable and valid maths assessments could have been used.

- It is possible that observations of teachers giving mathematics lessons may have provided a more accurate picture of what was transpiring in the classroom in terms of how the learners and teachers “managed” the English mathematical language issues and how these affected mathematical performance.
- The inclusion of a limited number of teachers may also have skewed the perceived difficulty of coping with the mathematical issues.
- The research results clearly indicated that English as Language of Learning and Teaching was experienced as a challenge by learners and teachers alike. The implementation of dynamic bilingual or multilingual teaching strategies such as “translanguaging”, a teaching strategy built on the importance of mother-tongue education, was not considered as an option in this study, and should be considered in future research.

5.4 Content Area Vocabulary Instruction Framework

Academic vocabulary development is critical to the success of all learners, particularly English language learners. The framework presents teachers with a road map that can be used to facilitate English language learners journey from informal language to more formal vocabulary, specifically focused on content area learning, namely mathematics. Vocabulary experts (e.g., Beck, McKeown, & Kucan, 2002; Graves, 2009; Stahl & Nagy, 2006) have highlighted the importance of learners receiving systematic, well-orchestrated vocabulary instruction across subject areas throughout the school year. Study findings show that on the whole, English language learners know fewer English vocabulary words than mother tongue speakers of English, “but in addition, know less about the meaning of these words” (August, Carlo, Dressler & Snow, 2005: 51). Thus, a disparity exists between mother tongue speakers and English language learners with regard to both the breadth and the depth of vocabulary knowledge. The purpose of the framework is to make teachers aware that they need to take their learners on a journey along a winding path by starting with their informal language and systematically taking them to formal mathematical vocabulary. The framework provides a structure for creating rich, meaningful vocabulary interactions essential for English language learner development in the maths content area. (cf. Figure 5.1)

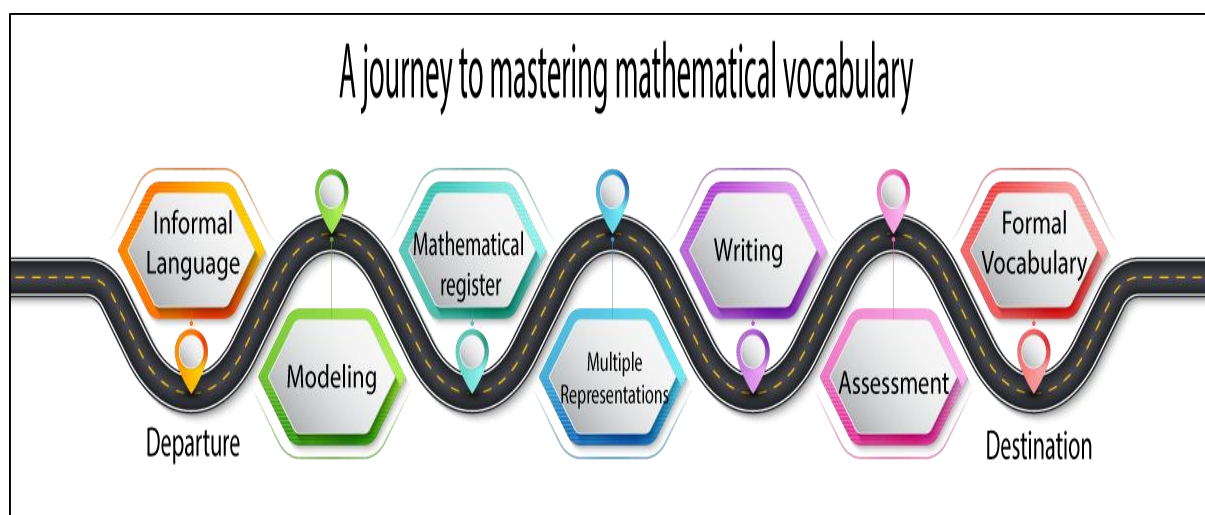


Figure 5. 1: Vocabulary Instruction Framework

5.4.1 Departure: Informal language

Development of mathematical language should move from smoothly shifting from informal language of mathematical thinking to communication using technical mathematical language. This development all starts with the teacher acknowledging that learners come to school with language. Establishment and recognition of words of learners that may already exist can help as a starting point for teachers to teach mathematical vocabulary. According to Johnston (2010:3) children`s prior experience with the material and social world provides the early bases for interpreting the language they hear, implying that learners will need the language they accumulated since they were born up to Grade 3. Because only a limited number of words can be directly taught, it is critical to choose those that will be the most broadly useful and the most applicable to content learning. Teachers should be aware of the vocabulary they use in the classroom, specifically as it relates to maths, for example:

Table 5. 1: Maths vocabulary

Informal	Setswana Informal	Mathematical	Setswana Mathematical
Split	phatlola	divide	Arola
Take away	tsaya	subtract	Tlosa
More	ntsi	greater	Ntsi
Less	Nnye/nnyane	fewer	Fokotsa
Total	palogotlhole	sum	Pologotlhe
Same	tshwana	equal	tshwana

At the start it is important that teachers define and explain words in English language learner friendly terms; this may mean making use of Setswana to explain to the learners.

5.4.2 Modeling

The teacher should use the targeted vocabulary within a meaningful context, often “revoicing” the learner’s informal language with the formal mathematical terminology:

Learner: I split 14 and got 7

Teacher: So you mean 7 is half of 14

During this part of the journey it is important to model which strategy(ies) is/are the most appropriate for teaching the maths vocabulary words. Selected strategies should enrich and enliven words for the learners. For example, dramatization is ideal for action words, and demonstration is well suited for process words. Another useful strategy is to draw from what learners already know about a word to help unlock its meaning. Modeling helps in providing additional information about the concept or the word.

An example to **reinforce and extend vocabulary knowledge and concepts**:

- This can be used to teach learners the difference between 3 digits and 4 or more digits.
- Learners work individually. When they finish the task they can then work in groups.
- Learners exchange ideas and justify responses.
- Each member should understand the reason for each answer. They should explain it.
- If there is a learner who does not agree with the rest, s/he should be given the opportunity to ask questions. The question is directed to the learners not the teacher.
- Allow learners to use words in discussing answers.

5.4.3 Mathematical register/discourse

The purpose of this stage of the framework is to allow learners to encounter mathematical words and the mathematics register, hear and use them. Learners in a mathematics class must be engaged, both verbally and physically. Setati (2005:449) maintains that during conceptual discourse “learners articulate, share, discuss, reflect upon and refine their understanding of the mathematics that is the focus of mathematics”. It is important that the teacher use the language of mathematics in both Setswana and English to help learners develop the means to acquire new concepts. In addition, learners should use the new terms in a range of contexts before those new words become part of their working vocabulary. For instance, the teacher plans, develops and poses questions that elicit learner conversation about mathematical ideas as they arise within the course of the lesson.

Learners need to be engaged in meaningful mathematical communication, because “mathematical discourse is primarily understood as a tool for mathematical thinking” (Barwell, 2016:332). Though learners struggle to understand English and the conceptual web that English weaves around African languages speakers (Mati, 2004:1) teachers should not rely a lot on informal conversations, they should work at making the mathematical register and discourse accessible to the learners.

From the findings of the study it was noted that English may be a challenge to both teachers and learners. Halai and Muzaffar (2016:66) state that in such situations English in practice is used to merely name the mathematical concepts. In addition, interactions that show no knowledge of English in mathematics lessons showed that the classroom talk was mainly in the realm of procedural discourse of mathematics because they engaged in ‘safe talk’ which was a strategy to escape from the difficulties of engaging in meaning communication in a second language. Learners should be given the opportunity to explain their thinking in words.

Monroe and Orme (2002) have it that because learners are expected to know hundreds of mathematical words, teachers must expose learners to clear, concise and uniformly used language. In addition, teachers themselves must use mathematical language, a denominator should not be called a bottom number. The bottom number

is only the position of the denominator and the top number is the position of the numerator. (Powel *et al.*, 2016:10). Using the wrong mathematical language may suggest that the numerator and the denominator are separate and independent numbers. This explanation does not help learners to understand the correct language of mathematics which may have negative effect on understanding the concepts. With reference to teaching numbers and operations, Powel *et al.* (2016:11) further suggest that in teaching digits, teachers should not ask ‘what number is in the tens place in the number 243’, rather, they should ask ‘what digit is in the tens place?’ alternatively ‘what is the value of the digit 4 in the tens place?’ When the correct mathematical language is used it will reinforce the conceptual understanding of place value and emphasizes that 4 is part of the number 243 with a value of 40. They state that one way to support children and promote progressive understanding of mathematics is to use precise and accurate language.

The teacher creates activities and poses questions that require learners to talk about mathematical ideas as they arise within the course of the lesson. The initial introduction of new vocabulary for explicit instruction can be accomplished using a see/hear/say/write method, which includes the following steps:

1. Present the word in written form for all students to see.
2. Point to the word and say, “this word is circumference.”
3. Invite students to read the word with you. “Say it with me.”
4. Have students read the word chorally. “Now say it together.”
5. Have students say the word to a partner. “Turn to your partner and take turns saying the word.”
6. Have students write the word on the front of a reference card, saying the word quietly as they write it. “Now, write the word here (teacher points to her card) on the front of your reference card.” (Nisbet & Tindall, 2015: 77)

5.4.4 Multiple representations

Word knowledge is built incrementally, and it takes multiple exposures for a learner to understand a word and its meaning (Stahl & Nagy, 2006). The teachers should use various visual representations such as graphic organizers and displays to reinforce targeted vocabulary. A number of studies demonstrated that using physical and visual

representations to facilitate conceptual understanding helps children master and maintain mathematical competence (Fuchs & Fuchs, 2001). It is recommended that a variety of representations in forms of pictures, symbols, graphs, maps or words can be used to reinforce targeted vocabulary mathematics. Teachers can also make use of a Setswana glossary to support their teaching practice (cf. Table 5.6). Examples of visual representations are included below:

K-W-L		
The basic K-W-L uses three columns in which to write down information that we Know (background knowledge), Want to know (establishing purpose and asking questions), and have Learned (main idea). In addition to teaching students to connect to background knowledge, this activity also can develop habits of summarizing, questioning, predicting, inferring, and figuring out word meanings.		
K What I know	W What I want to find out	L What I learned

Figure 5. 2: Example of KWL
(Michigan Council of Teachers of Mathematics, 2018)

K What I know	W What I want to find out	L What I learned
Fibonacci's Sequence 1, 1, 2, 3, 5, 8, 13, 21 ... Fibonacci's Rabbits Multiplying populations	How do bees fit in the Fibonacci pattern? What is the connection between the Fibonacci's sequence and the Golden ratio? Is there a formula for the Fibonacci number sequence? What do pineapples and pinecones have to do with Fibonacci?	

Figure 5. 3: Example of Fibonacci's Sequence
(Michigan Council of Teachers of Mathematics, 2018)

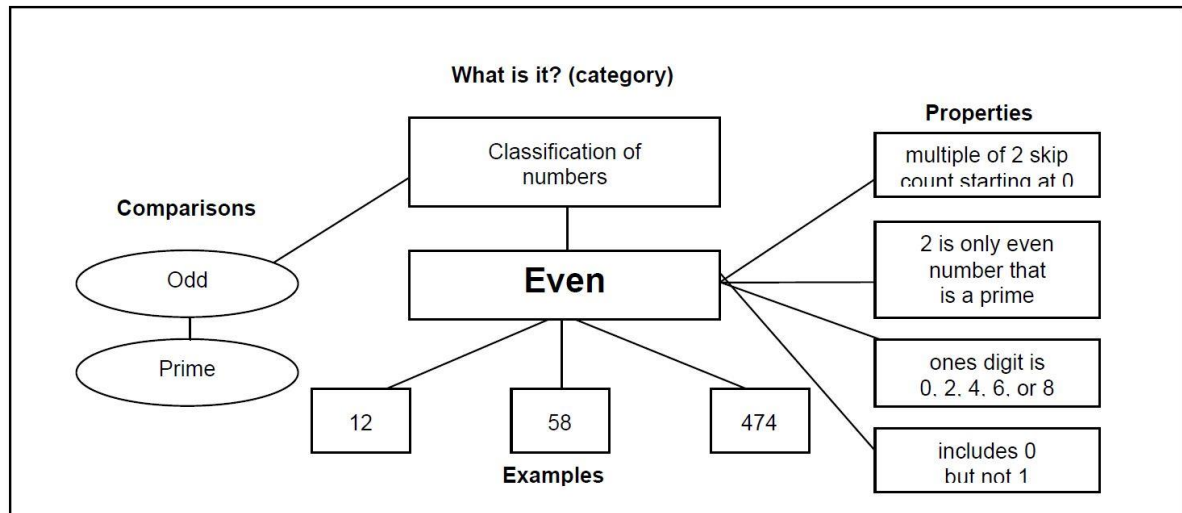


Figure 5. 4: Semantic Mapping

(Michigan Council of Teachers of Mathematics, 2018)

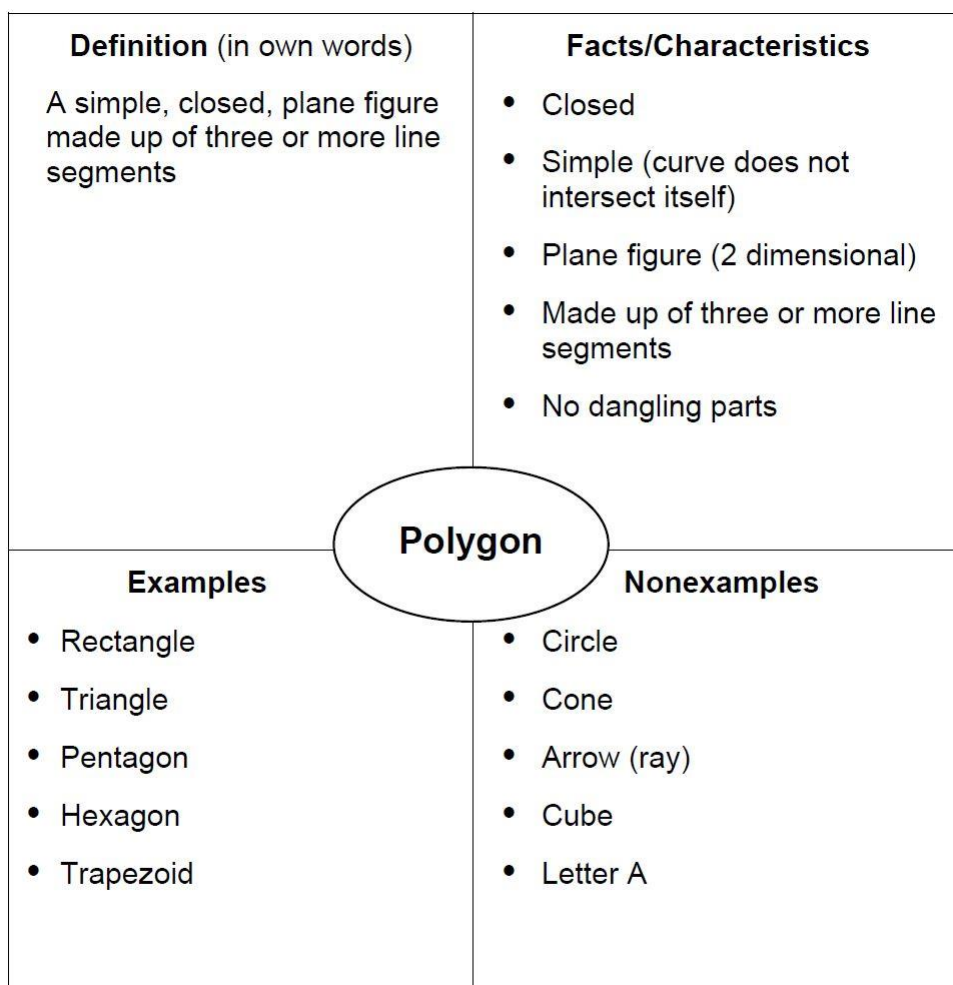


Figure 5. 5: Frayer Model

(Michigan Council of Teachers of Mathematics, 2018)

Table 5. 2: Mathematical terms for the Grade 4

English Mathematical Terms	Setswana Mathematical Terms
Numbers, Operations and Relationships	
Add	Kopanya/ tlhakanya
Addition	Kopanyo/tlhakanyo
Altogether	Gotlhe
Arrange	Rulaganya
Break down	kgaoganya
Bigger than	Kgolo go/tona go
Calculate	Balela
Circle (v)	Rala sediko
Common fraction	Palophatlogale
Convert	fetolela
Count	Bala
Denominator	Lerei
Digits	Dipalo / mono
Divide	Arola
Division	Karolo
Draw	Taka
Equally	Ka go lekana
Equals to	Lekana le
Even number	Palotekatekano/palomaleka
Few	Nnye
fifth	Nngwetlhanong
Fraction	Palophatlo
Halve	Seripagare/halofo
Many	Ntsi
Multiples of	Katisanetswa
Multiplication	Katiso
Multiply	Atisa
Numerator	Lebadi
Odd numbers	palomafeta
Place value	Boleng kemedi
Plus	tlhakanya
Quarter/fourths	Nngwenneng/ kwatara
Round off	atametsa/garela
Smaller than	Nnyane go
Subtract / minus	tlosa/ntsha
Subtraction	tloso
Sum	palogotlhe
Thirds	nngwetharong
Total	palogotlhe
Two-thirds	peditharong
Value	Bolengpalo
Patterns, Functions and Algebra	
Flow diagram	Papetlakaello
Number line	Molapalo
Number sentence	Polelopalo
Numeric pattern	Palothulaganyo
Number sequence	Tatelanopalo
Geometric pattern	pateronejometiri
Space and Shape	

Cylinder	Selennere
Hexagon	Khutlothataro
pentagon	Khutlothano
Polygon	Khutlontsi
pyramid	Phiramidi
Quadrilateral	Sekhutlonne
Quadrilateral prism	Pirisimi ya sekhutlonne
Rectangle	khutlonnetsepa
Rectangular prism	Pirisimi ya khutlonnetsepa
Sphere	kgelokwe
Square (n)	sekwere
Three dimensional	Popegotlhakoretharo
Triangle	khutlotharo
Two dimensional	Popegotlhakorepedi
Measurement	
Centimeter	Sentimetara
Millimeter	Milimetara
Meter	Metara
Kilometer	Kilometara
Conversion	Phetolelo
Capacity	mothamo
Volume	Mothamo/bolumu
Convert	Fetola
Perimeter	Perimeta
Cubic unit	
Data Handling	
Bar graph	Kerafonoko/kerafomika
Data handling	Tsholo ya tshedimosetso
Graph	Kerafo
Mass	Boima
Pictograph	Setshwantshokao
Pie chart	Tšhate ya phae
Tally marks	matshwaonyalano

Adapted from Department of Arts and Culture, 2013 and Setshedi []

Because visual representations might provide additional information to learners, teachers should use as many representational means of the concept as possible. If the word can be represented in different representations, the teacher may use all available representations which will even better reinforce understanding of the term.

5.4.5 Writing

Research done in the area of written communication in mathematics argues that writing improves understanding (Woodward, Olson, 2005). The kind of writing (transactional or expressive), the reason for the writing (for the teacher, for the student, or for both), and the task (problem solving, explaining, or note taking) are all themes that emerge in the literature. Albert (2000: 109) noted that “the act of writing serves as

a mode for students to reflect on their thinking". This type of communication gives the students an avenue to convey ideas, feelings, and experiences that can lead to developing their critical thinking, sound reasoning, and problem-solving. "Perhaps the greatest promise of writing in mathematics is that it will forge connections with students who typically drift or run rapidly away from mathematics. Writing offers a means for students to relate mathematical ideas to their own lives" (Baxter, Woodward, and Olson, 2005:132). The teacher of the classroom, in their study, found reading her students' journals and responding was a way for her to privately encourage her students. Journal writing was also a way for the student to communicate his or her thoughts to the teacher privately. This teacher saw journal writing as another way to assess and modify her teaching. She could adjust her pacing, explanations, and activities to accommodate the understanding or lack of understanding of her learners.

Just because students write in the mathematics classroom does not mean their writing is formal or contains appropriate math language and correctly used terms. It is up to the teachers to construct different settings for the writing to take place. The teachers should model appropriate writing, offer feedback, and a chance to revise writing to guide the students in expectations in written communication. "It is important to avoid a premature rush to impose formal mathematical language" (NCTM, 2000: 63). As students begin to write about their mathematical understanding, they begin to use familiar words. This can be built upon as they make a connection to the more formal mathematical language. The learners can use targeted vocabulary to reflect on and organize their thoughts around related mathematical ideas, for example, by using journals. Strengthening learners' mathematical writing is a complex activity, teachers need to think and rethink and appropriately structure the writing activities that s/he wishes to engage learners in and set up the goals for each activity and most importantly target the vocabulary that is difficult for the learners. Therefore, targeted vocabulary should be used to reflect on and organize learners' thoughts around related mathematical ideas, e.g. journals and or justification of solution, etc. Actually, learners should be encouraged to discuss, even to explain their ideas after which they must write them down. Doing this will benefit learners during written assessments.

5.4.6 Assessment

The *Standards for Educational and Psychological Testing* state that for “all test takers, any test that employs language is, in part, a measure of their language skills” (American Educational Research Association [AERA], American Psychological Association [APA], & National Council on Measurement in Education [NCME], 1999: 91). Thus, if certain learners have not yet sufficiently acquired language skills, they may not be able to adequately demonstrate their knowledge in a content-based assessment. Studies have suggested that English language learners have more difficulty responding to test items that are linguistically complex (Abedi & Lord, 2001). Learners may have trouble interpreting vocabulary, or misinterpret words literally (Duran, 1989; Garcia, 1991). They may also perform less well on tests because they read more slowly (Mestre, 1988).

The linguistic complexity of test items, as a source of construct-irrelevant variance, may affect the construct validity of assessments (Abedi, 2006). The *Standards for Educational and Psychological Testing* noted: “Test use with individuals who have not sufficiently acquired the language of the test may introduce construct-irrelevant components to the testing process...Therefore it is important to consider language background in developing, selecting, and administering tests and in interpreting test performance.” (AERA, APA, & NCME, 1999: 91). Studies have shown that reducing the unnecessary linguistic complexity of test items helps improve the performance of English language learners without compromising the validity of the assessment (Abedi & Lord, 2001; Abedi, Lord, Hofstetter, & Baker, 2000; Kiplinger, Haug, & Abedi, 2000; Maihoff, 2002). Reducing unnecessary linguistic complexity is a form of testing accommodation, also referred to as linguistic modification.

Assessments that are linguistically modified may facilitate learners’ negotiation of language barriers. This may be accomplished by shortening sentences, removing unnecessary expository material, using familiar or frequently used words, using grammar considered more easily understood (such as present tense) and using concrete rather than abstract formats (Abedi, Lord, & Plummer, 1997). Research has suggested that language factors that are unrelated to the construct being measured could affect the validity of assessments, particularly for English language learners (Abedi, 2002).

Testing accommodations, or simply accommodations, are meant to assist English language learners in order to “level the playing field”. Learners’ performance in content-based assessments, such as mathematics and science, can be confounded by language, which is considered irrelevant to the construct. In other words, a test should gauge their knowledge of the content, not their language ability. Accommodations can help ELL learners demonstrate their content knowledge by reducing the confounding of language. Accommodations are not intended to give ELL learners an unfair advantage over learners not receiving accommodated assessments (Abedi, Courtney, & Leon, 2003).

Accommodations can either refer to specific modifications to the test itself, or modifications to the test procedure. For example, modifications to an assessment that teachers may consider include:

- modification of linguistic complexity
- embedding glossaries into the test for non-content vocabulary

Modifications to the assessment procedure include:

- allowing extended time for the test
- having the test administrator read directions aloud
- allowing administration by a familiar test administrator (Rivera, Stansfield, Scialdone, & Sharkey, 2000).

5.4.7 Destination: Formal vocabulary

Research findings indicate that vocabulary instruction for ELLs must be intentional, systematic, and rigorous. The journey for English language learners is long and winding. The instructional framework presented here contains guidelines for teachers and gives a few recommendations of activities, strategies, etc. The framework is underpinned by evidence-based research, but the guidelines are in no way comprehensive, and teachers are encouraged to add their own tried-and-true strategies under each emphasis. Through consistent application of the framework, teachers can structure rich, meaningful vocabulary interactions for maximum impact with English language learners and help them move from informal to the more formal mathematical vocabulary required to be successful in the mathematical content area.

5.5 Recommendations

From the results of the study, recommendations are made to a number of key stakeholders.

5.5.1 Mathematics Teachers

The Mathematics teachers should be sensitized on the effects of Mathematics Vocabulary on learners' performance in Mathematics. Simple and appropriate mathematical language should be used in the teaching, learning and assessment of Mathematics, especially when the learners are not mother tongue speakers of the language of teaching and learning. Teachers and school language policies need to be willing to change and accept teaching strategies that are different from current "English-only" practices.

5.5.2 Mathematics Textbook Writers

Mathematics textbook writers control the commercial curriculum. Therefore, they should be sensitized on the effects of Mathematics vocabulary on learners' learning of Mathematics. They should lay emphasis on the exposition of mathematical vocabulary in their textbooks before their use in mathematical text and questions. They should use, for example, the Frayer model in explaining the terminologies that learners would encounter in every section of their textbook. This can enhance learners' understanding of Mathematics.

5.5.3 Mathematics teacher educators

Mathematics teacher educators should also be sensitized on the need to train Mathematics teachers on the strategies that can be used to enhance learners' mastery of Mathematics vocabulary instruction. For example, research indicates that the Frayer model with ICT integration may enhance deep understanding of the mathematical vocabulary and lead to relational understanding of mathematical concepts.

5.5.4 Mathematics Education Researchers

The study recommends further research in the area of mathematical vocabulary instruction for the content areas, specifically mathematics.

5.6 Conclusion

The conceptual load of content-area texts is remarkable. Abstract concepts, reading level, sentence structure, and academic vocabulary all contribute to the complexity of textbooks and other curriculum materials (Barton, Heidema, & Jordan, 2002). One specific challenge is the large number of new or unfamiliar words that may inhibit connections to students' existing knowledge and create barriers to comprehending content area texts (Kieffer & Lesaux, 2010). Vocabulary knowledge, a significant predictor of reading comprehension, is a major challenge for students from diverse backgrounds, especially for ELLs in terms of academic vocabulary and the specialized meanings associated with these words (Blachowicz, Fisher, Ogle & Watts-Taffe, 2006).

Harold Herber (1970) published the first textbook devoted primarily to content area reading and instruction. He introduced a method for teaching reading, not taught separately by reading experts, but as an integrated process that content area teachers could use in guiding students' comprehension of their texts (Herber, 1970, 1978). According to Herber (1978:4):

Reading skills and subject content can be taught simultaneously. There need not be a dichotomy between the content of a subject and the skills for learning the content. Such a view of reading instruction requires one to change traditional views about how to teach reading.

Content area reading is based on the notion that all learners are required to learn from a variety of texts. To learn successfully from these texts, Bean and Readence (1989) urge that learners must be exposed to a variety of reading and learning strategies that will help them meet the demands of coping with the new vocabulary, concepts, and text organization. Thus, in teaching reading in content area classes, teachers should consider themselves as facilitators of learners' textbook learning. It is their job to see that learners interact with text at a high level of understanding through a wise use of reading and learning strategies (Bean & Readence, 1989).

Vocabulary development is a critical element in helping students learn from content area texts. In their report on reading comprehension, the RAND Reading Study

Group (RRSG, 2002: 13) contends that successful text comprehension requires students to have various types of knowledge, including “vocabulary, domain and topic knowledge, linguistic and discourse knowledge, and knowledge of specific comprehension strategies”. Therefore, it is important for instruction in content areas to provide stronger support for the development of academic vocabulary and content knowledge (Bulgren, 2004). According to Ruddell (2005), vocabulary instruction in content areas serves the dual purpose of removing barriers to text comprehension and promoting long-term acquisition and development of the language used in an academic discipline.

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Appendix A

INTERVIEW SCHEDULE: TEACHER INTERVIEWS

1. Leina la morutabana :
2. Dingwaga tsa morutabana :
3. Maitemogelo a borutabana :
4. Maitemogelo a go ruta Mophato wa bone :
5. Dithutego tsa morutabana le ngwaga:
6. Ngwaga o morutabana a boning lekwalo la borutabana :

DIPOTSO KA GA THUTO PUO YA DIPALO TSA SEISEMANE

1. A barutwana ba gago botlhe ke Batswana, Setswana L1?
2. A o katiseditswe go ruta dipalo mo Mophatong wa bone ka Seisemane?
3. A go na le dikgwetlho fa o ruta Mmetshe mo Mophatong o wa bone? Ke dife? Di tthalose tsotlhe.
4. O akanya gore bothata ke eng?
5. O ruta jang tlotlontswe?
6. O ruta jang tekatlhaloganyo/ gore ba buise ka go tthaloganya?
7. O thusa jang barutwana ba ba nang le bothata ba thuto?
8. Lefapha le Thuto le go tshegetsa jang mo go ruteng Dipalo tsa Mophato o ka Seisemane?
9. A o a itse gore o ka dirisa Setswana fa o ruta barutwana Dipalo?

SEMI-STRUCTURED INTERVIEW QUESTIONS

1. The teacher`s name:
2. The teachers` age:
3. How many years of teaching experience :
4. How many years of experience in teaching Grade 4:
5. The teacher`s qualification:
6. The year that the teachers received his/her qualification:

QUESTIONS WITH REGARD TO ENGLISH MATHEMATICS CLASSES

1. Are all your learners Setswana Home Language speakers?

2. Have you been trained to teach Math in Grade 4 in English?
3. Do you experience any challenges when you teach Math in this Grade?
4. What do you think could be the problem?
5. How do you accommodate struggling learners during the Math lesson?
6. How do you teach maths vocabulary?
7. How do you teach maths comprehension?
8. How does the DoE support you in the teaching of Math in English to Grade 4s?
9. Do you make use of Setswana when you teach your learners?

Appendix B

FOCUS GROUP INTERVIEW SCHEDULE: LEARNERS

1. Ke dipotso dife tse di neng di le bokete mo go lona? / *Which questions were difficult for you on the maths assessment?*
2. Ke eng se se neng se dira potos gore di nne bokete/ *What made the questions difficult?*
3. O dira eng fa o sa tlhaloganye potso? / *What do you do when you do not understand the question?*
4. A go na le sengwe se o ratang morutabana a se dira fa o sa tlhaloganye? Ke eng? / *Is there anything that you want your teacher to do when you do not understand the question? What is it?*
5. Ke mafoko afe a a neng a le bokete mo go lona? / *Which words were difficult to you?*

Appendix C



NORTH-WEST UNIVERSITY
YUNIBESITHI YA BOKONE-BOPHIRIMA
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Ethics Committee

Tel +27 18 299 4850
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Email Ethics@nwu.ac.za

Prof C Nel

23 October 2012

ETHICS APPROVAL OF PROJECT

The North-West University Ethics Committee (NWU-EC) hereby approves your project as indicated below. This implies that the NWU-EC grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the project may be initiated, using the ethics number below.

Project title : Reading literacy in the content areas: The development of an instructional support framework.

Project Leader: Prof C Nel

Ethics number:	N	W	U	-	0	0	0	6	7	-	1	2	-	A	2
	Institution				Project number							Year		Status	
	N = North-West University, W = Waterburg, U = University of the Free State, - = Hyphen, 0 = Zero, 6 = Six, 7 = Seven, 1 = One, 2 = Two, A = Authorisation, 2 = Two														

Approval date: 2012/08/07

Expiry date: 2017/08/06

Special conditions of the approval (if any): None

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:

- The project leader (principle investigator) must report in the prescribed format to the NWU-EC:
 - annually (or as otherwise requested) on the progress of the project,
 - without any delay in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
- The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the NWU-EC. Would there be deviation from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the NWU-EC and new approval received before or on the expiry date.
- In the interest of ethical responsibility the NWU-EC retains the right to:
 - request access to any information or data at any time during the course or after completion of the project;
 - withdraw or postpone approval if:
 - any unethical principles or practices of the project are revealed or suspected,
 - it becomes apparent that any relevant information was withheld from the NWU-EC or that information has been false or misrepresented,
 - the required annual report and reporting of adverse events was not done timely and accurately,
 - new institutional rules, national legislation or international conventions deem it necessary.

The Ethics Committee would like to remain at your service as scientist and researcher, and wishes you well with your project. Please do not hesitate to contact the Ethics Committee for any further enquiries or requests for assistance.

Yours sincerely

Prof Amanda Lourens
(chair NWU Ethics Committee)

Appendix D



education and training

Lefapha la Thuto le Katiso
Departement van Onderwys en Opleiding
Department of Education and Training
NORTH WEST PROVINCE

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DR KENNETH KAUNDA DISTRICT

TLOKWE AREA OFFICE

OFFICE OF THE AREA MANAGER

TO: PROF CHARISMA NEL
NORTH-WEST UNIVERSITY
POTCHEFSTROOM CAMPUS

FROM: MS S.S. YSSEL
AREA MANAGER
TLOKWE AREA OFFICE

DATE: 16 AUGUST 2012

SUBJECT: PERMISSION TO CONDUCT RESEARCH AT SCHOOLS IN DR KENNETH KAUNDA DISTRICT

The above matter refers.

Permission is herewith granted to you to conduct research at schools in the Dr Kenneth Kaunda District under the following provisions:

- You seek permission from the Principal. You can only proceed with his permission.
- Written permission from parents and learners taking part must be obtained.
- The activities you undertake at school should not tamper with the normal process of learning and teaching.
- You inform the principal of your identified school of your impending visit and activity;
- You provide my office with a report in respect of your visit;
- You will obtain prior permission from this office before availing your findings for public or media consumption.

Wishing you well in your endeavour.


MS S.S. YSSEL
AREA MANAGER
TLOKWE

AO1270/dp

"A vibrant, top achieving region offering accessible quality education"
"Business unusual: All Hands on Deck to speed up Change"

Appendix E



NORTH-WEST UNIVERSITY
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5 September 2011

To Whom it May Concern

BORROWING OF SCHOOL BOOKS FOR RESEARCH PROJECT

At the NWU (Potchefstroom Campus) we are currently busy with an international project on Reading Literacy within the Content Areas. We have the permission of Dr. Mvula (Dr. Kenneth Kaunda District) to conduct our research in this district. As project leader, I respectfully request that you please allow Ms. Dolly Dlavane to borrow a copy of your Mathematics textbook in order for us to draw up relevant assessments. Upon completion of the assessment development the teachers will have access to these assessments for their own future use in the classroom. The book will be returned to the teacher/school within two weeks.

We appreciate your cooperation.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Carisma Nel'.

Prof. Carisma Nel
Project Leader

Research Professor: School for Curriculum-based Studies

Appendix F

READING LITERACY IN THE CONTENT AREAS: THE DEVELOPMENT OF AN INSTRUCTIONAL SUPPORT FRAMEWORK.

Researcher: FDG Dlavane

Study Leader: Prof C Nel

Grade 4

Mathematics Vocabulary

English

LEARNERS NAME:

SCHOOL NAME: Nanogang Primary School (SN)

NB: ANSWER ALL QUESTIONS BY DRAWING A CIRCLE AROUND THE CORRECT ANSWER:

Question 1

Mr. Moleme checked the grade 4 books a day after the school was opened and made this tally chart for the amounts sold.

English books	Mathematics books	Setswana books	Spelling books

How many more Setswana books than Mathematics books were sold?

- A. 9
- B. 43
- C. 7
- D. 28
- E. None

1

Question 2

243 is ...

- A. 3 times itself, 5 times
- B. the product of 3 and 5
- C. 3 times 5
- D. 3 added 5 times
- E. None

2**Question 3:**

You were born in 2002. Write 2002 in words.

- A. twenty-twenty
- B. two thousand and two
- C. twenty thousand and two
- D. two hundred and two
- E. None

3**Question 4:**

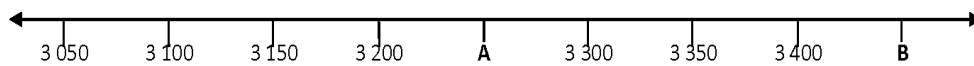
Round the number 2 471 to the nearest 100.

- A. 2 500
- B. 2 005
- C. 2 450
- D. 0 025
- E. None

4

Question 5:

The values of **A** and **B** respectively on the number line are



- A. 3 255 & 3 410
- B. 3 210 & 3 410
- C. 3 520 & 3 530
- D. 3 250 & 3 450
- E. None

5

Question 6:

You have 4 friends. Each of your friends gives you $\frac{1}{8}$ piece of one orange. How many oranges do you have?

- A. 4 oranges
- B. 8 oranges
- C. 1 orange
- D. $\frac{1}{2}$ orange
- E. None

6

Question 7:

Thapelo was given R 30.00 by his mother. On Monday Thapelo went to Bona café and found this price list on the wall:

Items	Price (VAT included)
Coca-cola	R7,50
Fish and Chips	R26,79
Chocolate	R15,55

If Thapelo buys his friend one can of Coca-cola and a chocolate, how much money is left for him?

- A. R6,07
- B. R9,65
- C. R5,96
- D. R6,95
- E. None

7

Question 8:

Complete the following number pattern 695; 790; 885; 980; 1 075; 1 170; ____; ____; ____.

- A. 1 260; 1 355; 1 450
- B. 1 266; 1 356; 1 456
- C. 1 265; 1 360; 1 455
- D. 1 206; 1 306; 1 405
- E. None

8

Question 9:

The daily start times for showing a movie are listed below:

Show	Start Time
1 st movie	2:00 p.m.
2 nd movie	3:30 p.m.
3 rd movie	5:00 p.m.
4 th movie	?

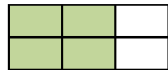
If this pattern continues, what is the starting time for the 4th show?

- A. 5:30 p.m.
- B. 6:30 p.m.
- C. 6:00 p.m.
- D. 7:00 p.m.
- E. None

9

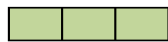
Question 10:

In this diagram, 2 out of every 3 squares are shaded.

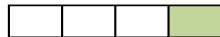


Which diagram has 3 out of every 4 square shaded?

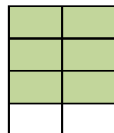
A.



B.



C.



D.



E. None

10

Question 11:

Lebo wanted to use her calculator to add 1 250 and 250, she entered 1 150 + 250 by mistake. Which of these could she do to correct the mistake?

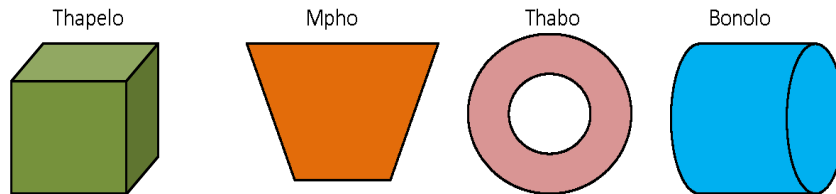
- A. Subtract 100
- B. Add 10
- C. Subtract 10
- D. Add 100
- E. None

11

8 of 12

Question 12:

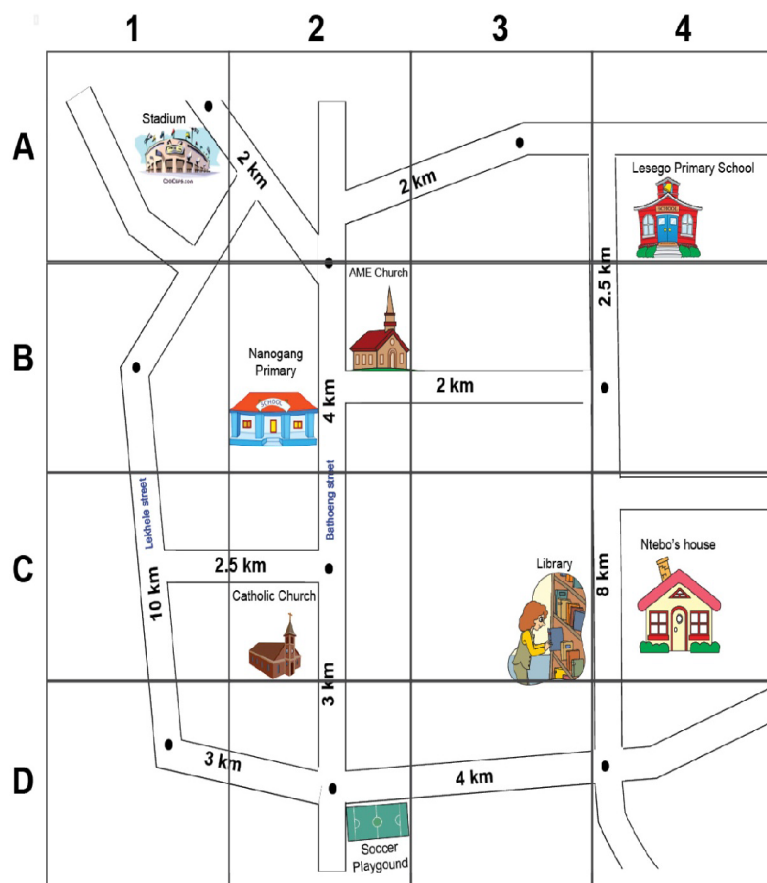
Thabo, Mpho, Thapelo and Bonolo are all grade 4 learners in Mr. Sekate's class. Each one takes one shape and tell the class what dimension is their shape. Tell who has three dimensional (3-D) shapes?



- A. Thapelo and Bonolo
- B. Mpho and Thabo
- C. Thabo and Bonolo
- D. Thapelo and Mpho
- E. None

12

Instruction: Questions 13, 14, 15, 16, and 17 are about using the map below.



Question 13

1 km equals 1000m. If Ntebo walks from her house to the stadium via the soccer play ground by Bathoeng street how far would he have walked?

- A. 21 000 m
- B. 12 000 m
- C. 21 m
- D. 14 000 m
- E. None

13

Question 14

If Ntebo walks to the stadium either via Soccer play ground in Bathoeng or via Lesego Primary school, which distance is longer?

- A. via the Soccer play ground
- B. via Lesego Primary school
- C. via Lekhele street
- D. all distances are short
- E. None

14

Question 15

If Ntebo leaves her home at 06:00 a.m. to go to Nanogang Primary school and arrives at 07:00 a.m., how many minutes has she walked to school?

- A. 60 minutes
- B. 6 000 minutes
- C. 6 minutes
- D. 1 minute
- E. None

15

Question 16

After school Ntebo must go to the stadium. She walks 60 minutes from school to the stadium. Convert the 60 of minutes she takes to walk to the stadium in hours.

- A. $\frac{1}{2}$ an hour
- B. 6 hours
- C. 1 hour
- D. 10 hours
- E. None

16

Question 17:

Find what is in square C2.

- A. AME church
- B. Nanogang Primary
- C. Library
- D. Catholic church
- E. None

17

Question 18

It takes Mpho 6 minutes to clean one classroom. She wants to know how many minutes it will take her to clean 6 classes at this rate. She should

- A. Add 6 and 6
- B. Multiply 6 by 6
- C. divide 6 by 6
- D. Subtract 6 from 6
- E. None

18

Question 19

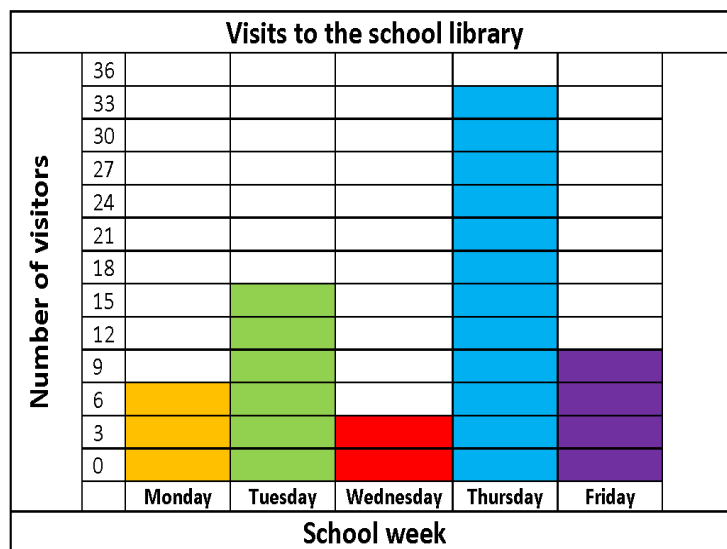
Which perimeter is the longest distance between the following?

- A. 4,30 cm
- B. 3,40 cm
- C. 43 cm
- D. 33 cm
- E. None

19

Instruction: Questions 20, 21, and 22 are about using the graph.

Graph: This graph shows how many learners visited the library during the school week.



Question 20

How many more learners have visited the library on Tuesday than Monday?

- A. 90
- B. 9
- C. 12
- D. 3
- E. None

20

Question 21

Which day did the learners visit the library less than other days?

- A. Thursday
- B. Monday
- C. Wednesday
- D. Friday
- E. None

21

Question 22

If in the next four Thursdays the same number of learners visits the library, how many learners will have visited the library after four weeks?

- A. 41
- B. 37
- C. 8
- D. 132
- E. None

22

Question 23

October 2012						
Sun	Mon	Tues	Wed	Thurs	Fri	Sat
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

The learners of Tshupane School will be writing the examinations on Tuesday, the 2nd October 2012. The school is closing for holidays exactly three weeks later. On what date will the school close?

- A. 16
- B. 24
- C. 17
- D. 23
- E. None

23