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

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Declaration

I, the undersigned, hereby declare that the work contained in this thesis is, to the best of my knowledge, original. This thesis has not been previously submitted, either in part or in its entirety, for the award of any other degree at any other university.

Signature…………………..

Date: ………………………

Abstract

The underperformance of South African learners in literacy and numeracy is a source of grave concern, especially at the transition from Grade 3 to Grade 4. The challenge that complicates this shift is to some extent linguistic, since at Grade 4 in South Africa the majority of learners begin learning in English, which is an additional language for most. The study adopts a sociocultural view of language and learning. Vygotsky's influential theoretical work on language and learning, in which language is considered central to learning and learning is a social process embedded in sociocultural settings, informs the study.

The introduction of the Annual National Assessments (ANAs) across primary and secondary grades in South Africa in mathematics and literacy in 2011 provides the context for this research. It is against this background that the present study aimed, through a case study approach of three Grade 4 classes of English additional language (EAL) learners, to achieve four things, namely: to investigate the linguistic challenges of the 2013 Grade 4 mathematics ANAs; to analyse the learners' written responses to the 2013 mathematics ANA items; to explore the 2013 Grade 4 learners' difficulties and experiences of the 2013 mathematics ANAs, and to investigate the Grade 4 mathematics teachers' perspectives of the language of the ANAs. In order to achieve these aims, the data was collected in four phases.

The first phase of the study addressed the nature of the linguistic challenges of the Department of Basic Education Grade 4 mathematics ANAs. Data collection occurred in two parts: 1) Comparing Grade 4 ANAs to exemplars provided and 2) Analysing the language of the 2013 mathematics ANAs. This was done through content analysis and Shaftel et al.'s (2006) linguistic complexity checklist. Findings for part 1 of the study revealed that there were several inconsistencies in the questioning format and language used in the ANAs and in the exemplars. Findings of the content analysis done on the 2013 mathematics ANA test items using Shaftel et al.'s (2006) linguistic complexity checklist and Vale's (2013) Linguistic Complexity Index formula point to many linguistic complexities in several test items, particularly in relation to recurrent use of: 7 or more letter words, homophones, prepositional phrases and specific mathematics vocabulary across the majority of questions.

In phase 2, the analysis of 106 learners' written responses for the 2013 mathematics ANA questions revealed that for many of the questions the language used was unfamiliar for Grade 4 learners using English as an additional language. This was aggravated by the inclusion in the ANAs of linguistic forms learners would not have encountered in their workbooks or exemplars intended to prepare the learners for the assessments. Therefore, linguistic complexity of items was a key contributing factor to learners' poor performance in the test.

In the third phase, the quantitative and qualitative analysis of the 26 learners' interviews revealed that during the task-based interviews, learners experienced difficulties in the following skills: reading, comprehension, transformation, process and encoding. The greatest difficulties were experienced in comprehension and in reading, especially in the two classes where the learners were less proficient in the English language.

The fourth phase, in which two Grade 4 mathematics teachers' perceptions of the linguistic demands of the Grade 4 mathematics ANAs were presented and analysed, the teachers' perceptions indicated that the mathematical language was mostly too difficult for the Grade 4 learners. Teachers also were of the opinion that learners' reading skills were poor and they struggled to comprehend what they read. A dilemma regarding whether teachers should assist learners during the ANAs, satisfying the local needs for mediating the language or whether they should comply with the ANA policy which states that they may not assist learners was expressed by one of the teachers. A range of language challenges that teachers managed with various strategies were raised. These included one teacher's use of code-switching during the teaching of mathematics.

The study concludes with implications and recommendations. These include that test designers should minimise the language complexity of test items, especially in the early transition grades of learning in English. Research should be conducted on possibilities for allowing teachers to provide linguistic mediation to ANA questions in these transition years of learners learning in English.

Dedication

To my dear husband Jabulani, my son Kudzai Carlos, my daughter Mutsawashe Mitchelle, to my father Nebson and to my mother Emily and all those who inspired me in many different ways

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ACRONYMS AND TERMS USED IN THIS THESIS

ANA	Annual National Assessment
PIRLS	Progress in International Reading Literacy Studies
DoE	Department of Education
LiEP	Language in Education Policy
LoLT	Language of Learning and Teaching
DBE	Department of Basic Education
FAL	First Additional Language
CAPS	Curriculum and Assessment Policy Statement
RNCS	Revised National Curriculum Statement
FP	Foundation Phase
IP	Intermediate Phase
L1	First language
L2	Second language
HL	Home language
DIF	Differential Item Functioning
CUP	Common Underlying Proficiency
CALP	Cognitive Academic Language Proficiency
BICS	Basic Interpersonal Communicative Skills
ELL	English Language Learners
EAL	English Additional Language
NEA	Newman's Error Analysis
ZPD	Zone of Proximal Development
LCI	Linguistic Complexity Index
NICLE	Numeracy Inquiry Community of Leader Educators
SANC	South African Numeracy Chair

TAKS	Texas Assessment of Knowledge and Skills
TIMMS	Trends in International Mathematics and Science Study
SES	Socio-economic Status
FFL	Foundation for Learning

CHAPTER 1: INTRODUCTION

1.1 Context of the study

The introduction of the Annual National Assessments (ANAs) across primary and secondary grades in mathematics and literacy in South Africa provides the context for this research. The assessments formed part of the 2011 Foundation for Learning (FFL) campaign and emerged as a result of increased international monitoring and evaluation of education in 1990 following the Jomtein conference (Howie, 2012). Since 1994 South Africa has adopted assessments in large-scale testing as a means for increasing achievement in education quality. The ANAs are the most recently introduced national assessments; focusing on the two areas of mathematics and literacy which have been identified as critical areas needing intervention both at primary and secondary levels.

The present study investigates the linguistic challenges presented by the mathematical ANAs introduced in South Africa in 2011. The study is situated within the South African literacy and numeracy context, the nature of which is reflected in international and national evaluations, all of which point to extreme underperformance of learners in both literacy and numeracy. The Trends in International Mathematics and Science Study (TIMSS) (Reddy, 2006, Reddy, Zuze, Visser, Winnaar, Juan, Prinsloo, Arends & Rogers, 2015) confirm the poor performance of South African learners in mathematics and science, while the Progress in International Reading Literacy Studies (PIRLS, 2006) assesses reading literacy through comprehension tests in order to provide comparative data for different countries (40 countries in 2006 and 55 countries in 2011). Both the PIRLS and the local Department of Education (DoE) systemic evaluations (2011) found the literacy attainment of South African learners poor (Mullis, Martin, Kennedy & Foy, 2007). Regional comparisons, SACMEQ II (2000) and SACMEQ III (2007) similarly showed poor results in South African Grade 6 literacy and numeracy performance with no improvement over the seven year period (Spaull, 2013). The SACMEQ 111 indicated that South Africa ranked 10th out of fourteen education systems for reading, and 8th for mathematics; performing below less resourced countries like Tanzania, Kenya and Swaziland (Spaull, 2013, p. 3). The SACMEQ 111 study showed that South African learners lacked basic literacy and numeracy skills rendering them functionally illiterate and innumerate (Shabalala, 2005). The DoE ANA results from 2012 to 2014 (DoE, 2012, 2013, 2014) point to continued poor performance in literacy and mathematics with the 2014 Grade 4 national averages for these at 57% (Home language), 41% (First Additional Language) and 37 % (Mathematics) and the percentage of learners achieving over 50 percent at 66.4% in Home language, 35% in First Additional Language and 27.4% in Mathematics.

Causes of underachievement in literacy and numeracy in South Africa have been identified as stemming from: high levels of poverty, learning in an unfamiliar additional language, poorly resourced schools, child labour, lack of reading and reading material at home, poor methods of teaching (including ‘rote’ and ritualised) (Barbarin & Richter, 2001; Fleisch, 2008; Hoadley, 2010), misinterpretation of the new curriculum, poor subject knowledge of teachers (Fleisch, 2008; Venkat & Spaull, 2015), and passive learning dispositions (Graven, 2014; Graven, Hewana & Stott, 2013) among a host of other constraining factors. Of particular interest to the present study is the challenge of learning in an additional language and its influence on learner performance. Language engenders access to mathematical concepts (Setati, 2014). By extension, learning in an unfamiliar language compromises that access to mathematical concepts.

The majority of South African learners learn in a second, third or even fourth language that they are not familiar with (Setati & Barwell, 2008; Setati, Molefe & Langa, 2008) as most use indigenous languages for day-to-day communication. The 1997 Language in Education Policy (LiEP) requires that in the first three years of formal learning, learners use their home language (HL)(the language that learners learned as a child at home) as the Language of Learning and Teaching (LoLT). The majority of South African learners, by virtue of having HLs which are not LoLT, switch to English as the LoLT in Grade 4. As Setati and Barwell (2008) note, the majority of learners learn mathematics in the language that they are not fluent in. Heugh (2006) also confirms a zero level of understanding by children being taught in non mother-tongue languages. Tables 1 and 2, taken from Robertson and Graven (2015) show the percentages of learners using English as the LoLT.

Table 1: Percentage of learners using English as the Language of Learning and Teaching (Grades 1-12) (2007)

Grade	1	2	3	4	5	6	7	8	9	10	11	12
%	22	24	28	79	81	82	81	81	80	81	82	82

(Data derived from DBE, 2010, p. 16)

As Table 1 shows, close to 80 % of South African Grade 4 learners use English as the LoLT. There is an overwhelming increase of learners using English from Grade 4 (from 28% in Grade 3 to 79% in Grade 4). The majority of South African learners therefore, have the unenviable task of simultaneously learning the English language and having to access mathematical concepts through a language in which they are not yet proficient. This fact compromises their ability both to comprehend and express mathematical ideas.

Table 2 shows that most learners learn in English at Grade 4 as many schools and parents choose English, not an indigenous language, as the LoLT. Although only 6.9% of Grade 4 learners have English as their HL, 79.1% have English as their LoLT.

Table 2: Percentage of learners using English as LoLT (Grades 1-12) (2007)

	Percentage of learners by home language group	**Percentage of learners by LoLT**	**Percentage difference**
Afrikaans	10.3	12.3	+2.0
English	6.9	79.1	+72.2
isiNdebele	1.8	0.3	-1.5
isiXhosa	21.1	3.1	-18.0
isiZulu	24.3	1.5	-22.8
Sepedi	10.6	1.1	-9.5
Sesotho	6.4	0.5	-5.9
Setswana	7.6	0.6	-7.0
Siswati	3.3	0.4	-2.9
Tshivenda	2.9	0.3	-2.6
Xitsonga	4.9	0.7	-4.2
TOTAL	100	100	

(Data derived from DBE, 2010, pp. 12; 16)

The present study straddles both literacy and numeracy, two key areas of learning where national and international benchmark assessments have consistently reported underachievement. It does this by investigating linguistic challenges faced by English as an additional language learners within the discipline of mathematics focusing on the experiences of the Grade 4 mathematics ANAs.

The study, located in two schools in Grahamstown, focuses on the reading challenges of the 2013 ANAs of three Grade 4 classes of isiXhosa speaking learners. Despite all three being Grade 4 classes, they had different exposure to English in terms of the time available for learning in English. The first class learnt in English from Grade 1, the second and third classes of learners learnt to read in their mother tongue from Grades 1-3 and then transitioned into learning in English from the fourth grade.

1.1.1 Grade 3-4 transitional challenges in the present context.

In South Africa, as in several international education systems, Grade 4 is a critical stage where learners experience four significant transitions from the Foundation Phase (FP). The first transition from Grade 3 to Grade 4 is from using a HL (isiXhosa, in the Eastern Cape where the present study is located) to using English as a LoLT (as in the case of two of my classes). The second transition is from reading mostly narrative, story-like texts whose language closely approximates ordinary language of everyday social interaction in the FP, to reading expository texts with more content-dense vocabulary in Grade 4 (Chall, Jacobs & Baldwin, 1990). The third transition is the shift from 'learning to read' to 'reading to learn' (DBE, 2008). In the FP, learners are trying to develop the skill and art of reading but when they arrive in Grade 4 they are expected to read different content subjects and learn from what they read. The mechanics of reading, which underpin learning to read, are supposedly developed in the home language in the FP and used in English in Grade 4 to access information from texts. The fourth transition is the movement from more concrete thinking in the FP to more abstract thinking in the Intermediate Phase (IP) (Grades 4-6 in South Africa). Mathematical abstraction is particularly critical for learner progress and attainment in the IP.

The teaching of a First Additional Language (FAL) from Grade 1 was made compulsory in 2012 by the Curriculum and Assessment Policy Statement (CAPS) (DBE, 2011). However, the current Grade 3s and 4s did their Grades 1 and 2 under the Revised National Curriculum Statement (RNCS) dispensation when teaching a FAL was not compulsory. In this study, the two classes of learners in the school that used isiXhosa as the LoLT in Grade 1 to 3 only started learning English as an additional language in Grade 4 since the RNCS left it to the schools' discretion to decide when in the FP they wanted to introduce English as the FAL. As a result, these learners only had a year's exposure of five hours a week of English FAL by the time they reached Grade 4 however, they were expected to learn five subject areas in English. The lack of exposure to English was both as a LoLT and as a FAL. In this situation it is problematic to expect learners to have already acquired the basic vocabulary in English which they need to communicate and learn in that language. On the other hand, the third class in this study used English as the LoLT from Grade 1 so learners learnt all subjects in English, except isiXhosa and Afrikaans. Since they were introduced to English, and learnt in it, their reading and comprehension of English texts was better than the other classes.

Expecting learners who have had scant exposure to English language in the FP to adjust to the use of English as the LoLT in Grade 4 assumes that they will transfer the skills developed in the HL in the FP as the FAL. That is the basis of the Linguistic Interdependence Hypothesis postulated by Cummins (2000). While some skills like general reading skills have been known to make cross-linguistic transfers, the same cannot be said of other aspects of language like vocabulary, especially for languages like English and isiXhosa considering their orthographic distance. Cummins (2000) also proposes the threshold hypothesis which does not deny the cross-linguistic transfer of competencies but posits that learners should cross a certain threshold in their second language (L2) (for this study L2 refers to a language that is not native to a speaker but is used in the speaker's geographical context) proficiency for that cross-linguistic transfer to happen. The learner should, therefore, attain requisite thresholds in both languages for such transfer to occur. The limited exposure to the English language, characterising the learners in this study, casts doubt on the development of a sufficient threshold in learners' L2 proficiency to allow for the transfer of first language (L1) (speaker's native language) competencies.

What compounds the challenge of the preparedness of the learners in the present study for learning in English as the LoLT in Grade 4 is Hirsch's (2003) observation in the United States that "even with the HL English speakers there is also a sudden drop-off between third and fourth grade in the reading scores…" (p. 10). This confirms Halliday's (1989) assertion that it is not only English additional language (EAL) learners who struggle with mathematical English but also English HL learners. If English HL speakers are also challenged by reading despite their fluency in the language, the challenge can only be greater for those learning in English as an additional language with little exposure to the language. Learners additionally have to deal with challenges of learning *mathematical* language in English. They thus grapple with the English in mathematics and the mathematical register in English (Setati, 2002). They have to learn the English language, the mathematical language and the mathematical skills, concepts and operations. An additional challenge is that of being assessed in a language which is not their HL and where, in the case of the ANAs, teachers are not allowed to read or mediate the language.

1.1.2 The ANAs in South Africa

In South Africa, the DBE has made the ANAs a priority to test literacy and numeracy skills of learners for monitoring and tracking achievement of the goals set in the DBE Action Plan (DBE, 2011). The ANAs, introduced in 2011, aim to expose teachers to better assessment practices, help districts to identify schools in most need of assistance and inform parents about their children's performance (DoE, 2011). Results of the ANAs for the past three years are, however, disturbing. The 2012, 2013 and 2014 reports for the ANAs (DoE, 2012, 2013, 2014) reveal that learners performed poorly in mathematics across the grades. In the FP, learners perform better than when they proceed to the IP where the levels of achievement decrease significantly. The national average performance for Grades 1, 2, 3, 4, 5, 6 and 9 in numeracy in 2011, 2012, 2013 and 2014 is given in Table 3.

Table 3: Average percentage marks for mathematics by grade (2011 – 2014)

Grade	2011	2012	2013	2014	Grade averages across 2012 to 2014
1	63	68	60	68	64.75
2	55	57	59	62	58.25
3	28	41	53	56	44.5
4	28	37	37	37	34.75
5	28	30	33	37	32
6	30	27	39	43	34.75
9	n/a	13	14	11	12.6 (2012-2014)

(Data taken from South Africa. DBE, 2012; 2013; 2014)

The results of these assessments show alarmingly poor national mathematics skills across the primary grades (particularly from Grade 3 onwards) with average performance steadily declining each year from 68% in Grade 1 to 27% in Grade 6 and then to 13% for Grade 9 in 2012 (DBE, 2012). In 2013 the average performance declined from 60% in Grade 1 to 37% in Grade 4 and then to 14% for Grades 9 (DBE, 2013). In 2014 the average performance declined from 68% in Grade 1 to 37% in grade 4 and then 11% for Grades 9. The decline is more manifest from Grade 2 to Grade 3 where Grade 3 teachers are not allowed to read or mediate the texts for their learners (as is the case in Grade 1 and 2), and also from Grade 3 to Grade 4 (in 2012, 2013 and 2014) where the LoLT changes. The decline was particularly pronounced in 2014 where the Grade 4 average decreased by 19% from the Grade 3 average. Seeing that one of the major changes during this period is language related in the form of the change in LoLT, such massive decline in performance at Grade 4 suggests key challenges could be reading (with the shift from learning to read to reading to learn) or language-related. That 73% of Grade 4 IP and 98% of Grade 9 learners (in 2012, 2013 and 2014) did not meet basic numeracy requirements (i.e. achieve over 50%) suggests an urgent need for understanding the causes of such underperformance. The Eastern Cape results mirror the national pattern of decline across all grades in 2012 to 2014 as table 4 shows.

Table 4: Eastern Cape Province: average performance in mathematics (2012, 2013, 2014)

Grade	Year	Average mark	% of learners achieving 50%+
1	2012	65.2	72.8
	2013	56.2	65.5
	2014	64.5	76.1
2	2012	55.2	63.3
	2013	54.1	61.6
	2014	57.7	67.9
3	2012	40.5	34.9
	2013	50.6	54.9
	2014	48.8	52.3
4	2012	35.3	22.7
	2013	32.6	20.9
	2014	34.8	22.3
5	2012	28.1	12.0
	2013	29.1	14.6
	2014	32.2	18.6
6	2012	24.9	8.1
	2013	33.3	16.2
	2014	38.1	22.0
9	2012	14.6	2.6
	2013	15.8	3.3
	2014	11.1	2.2

The crisis of underperformance is possibly exacerbated in the Eastern Cape by its rurality and poverty relative to other provinces (Khau, De Lange & Athiemoolam, 2013). Most learners are in rural, under-resourced schools and have little access to English compared with learners in an urban environment (Setati & Adler, 2000). They have less 'English language infrastructure'.[1] The underperformance of learners reported in Tables 3 and 4 justify the need to investigate the extent to which the language in which the ANAs are administered, affects the English additional language

[1]In rural schools, learning and teaching proceeds within a context highly deprived of the English language infrastructure. In most such cases, English is only heard, read, spoken and written in formal school context (Setati & Adler, 2000, p. 251)

learners' chances of success in terms of their educational outcomes. The focus of the present study is therefore, on the readability and understandability of the ANAs, particularly at a linguistic level. Central to this is the assumption that mathematical tests also measure language skills (AERA, APA, & NCME, 1999) and not just mathematical skills. Learners have to be proficient in the language of assessment to gain epistemological access to the assessment requirements.

Cummins and Swain (1986) argue that questions that may be cognitively undemanding to a native speaker may be highly demanding for a second language learner. This is especially true in mathematics since, according to Halliday (1978), mathematical language is complex even for English HL speakers learning mathematics in English. Mathematical assessments may produce inaccurate results if the language background of learners being tested is not considered when the test is set (Abedi, 2006). Cummins and Swain (1986) also argue that English second language learners take longer to attain an appropriate level of academic language proficiency than English HL learners and by Grade 4 they would not have reached the requisite threshold. This is because the processing of texts requires comprehension and production strategies different from everyday oral interactions (Cummins & Swain, 1986). According to Halliday (2010) fairness in assessment depends on a consideration of learners' language proficiency. The role of language in validating outcomes about learners' educational attainment explains the present study's investigation of the linguistic difficulty of ANA test items (readability) namely learners' potential to access them and understand the demands they make on them (understandability).

Setati (2002) explains the similarity between learning a language and learning mathematics by noting that:

> As when learning a language, in learning mathematics, the learner has to learn new terminology and symbols, how to use conversations, and the different ways in which vocabulary is used in different contexts (p. 5).

The learner has to learn the grammar as well. A lot has to be known at a linguistic level before attempting to solve a mathematical problem and this is a real hurdle for

L2 learners. Halliday (1993) identifies some features that have a negative effect on the performance of English L2 learners. These include long phrases in questions, complex sentences, syntactic ambiguity, special expressions, lexical density and more. Abedi (2006) points out that these features slow learners down and cause cognitive overload. Their thinking is disturbed and confused leading to failure to understand the particulars of questions. In such a case, there is need for mediation of text so that learners can make progress. Mediation of texts written in English for learners who are not proficient in English is vital. Research by Graven and Venkat (2013) in the Eastern Cape and Gauteng indicates that teachers use the departmentally issued ANA exemplars and spend several weeks preparing for the ANAs, partly to familiarise learners with the language of the assessments.

This study consists of four parts. The first part explores the linguistic complexity of Grade 4 ANAs (2013). Establishing the linguistic complexity of ANAs in Grade 4 in South Africa is imperative as the grade marks the period when the majority of learners change from learning in their HL to using an additional language (usually English) as the LoLT as indicated in Table 1 above. The second part analyses the participating learners' written scripts in order to explore the learners' performance in the 2013 ANAs. The third part of the study investigates the way in which the Grade 4 learners experience the linguistic challenges of the ANAs. The fourth and last part investigates the Grade 4 teachers' experiences of the language of the ANAs. The study hopes to contribute to a better understanding of some of the linguistic challenges and how these may connect to, and in some part explain, the poor performance in numeracy, particularly those of a linguistic nature.

1.2 Purpose and significance of the study

The purpose of this research is firstly, to analyse the language used in the Grade 4 ANAs and establish the nature of the linguistic challenge that learners face as they solve mathematical problems. Secondly, it is to investigate how learners and teachers experience the challenges presented by mathematical text written in English. It is hoped that the empirical findings of the ANAs linguistic challenges will sensitise educationists, especially those involved in the design of national assessments, to the type of language challenges that learners face when writing the mathematics ANAs, and pay greater attention to the possibly limited language proficiency of the learners. Thirdly, it is also hoped that the in-depth case study that follows this analysis in the form of learner and teacher experiences of these ANA questions will inform teachers and teacher educators about ways to support learners in meeting the language demands in their preparation for the ANAs. Fourthly, the study presented in this thesis contributes to the knowledge of the field of Mathematics Education especially the subfields of mathematics and language, and assessment in mathematics. The specificity of isiXhosa context gives the study originality and hence further contribution to knowledge.

Historically, the South African education system only assessed learners at the end of Grade 12. That system did not generate feedback on learner progress to inform both teaching and learning along the way. As a result, educators did not know exactly at what stage learners struggle with language, numeracy and literacy. Now that learners' performance is assessed through the ANAs at different stages in primary school, it is possible to establish the point at which the difficulties arise across the 12 grades of their schooling. However, it is important that assessments are valid and pitched at the right level if they are to provide effective data to inform teaching practices. Graven, Venkat, Westaway and Tshesane (2014) note that some items are too difficult with the result that they do not inform teachers as to what learners can do and where to begin remediation. It is therefore essential that the ANA test is a fair and valid tool, with item difficulty levels neither too high nor too low (DoE, 2011). This research potentially contributes to the improvement of ANAs by exploring/exposing the linguistic challenges in mathematics ANAs that may impact the accessibility of the items. Test developers should be cognisant of such challenges and circumvent them where possible.

Being a relatively recent assessment tool, not much research has been done on the ANAs. In a press article, Henning and Dampier (2012) observe the need for research into the ANAs, especially in South Africa where the majority of learners grapple with learning in a second language. It is also hoped that the present study findings will have broader implications transcending to other countries where the issue of learners' writing assessments in a L2 or third language (L3) is a problem. In a study in South

Africa by Graven and Venkatakrishnan (2013), teachers noted that ANAs are important because they are standardized and provide guidance on what is expected. However, several noted that the ANAs have weaknesses, one of which was the complexity of language in which questions were couched. This study investigates the complexity of the mathematical questions by analysing the 2013 ANAs. In another study, Graven et al. (2014) suggest research on the inclusion of an oral component in the ANAs as a way to militate the reading challenge associated with the tests. It is envisaged that this study will work to sensitise educators who set ANA tests and teachers who prepare learners for the tests in terms of the several aspects related to the linguistic level of both the tests and the learners.

The above context, together with the literature on the interface between language and mathematics learning, inform the present research study which is guided by the following research goal and research questions.

1.3 Research goal and research questions

The research goal

To investigate the nature of the linguistic complexity of the 2013 Grade 4 mathematics ANA test items and learners' and teachers' experiences of them.

Research questions

1a. What is the nature of the linguistic challenge of the Department of Basic Education Grade 4 mathematics ANAs?

1b. What difficulties do learners experience as they solve mathematical problems?

1c. Which of these mathematical difficulties can be attributed to linguistic factors?

2. What are the teachers' experiences of the linguistic challenges of the ANAs?

1.4 Chapter summary and overview of the thesis

This chapter has outlined the purpose of this research and its location in the South African context. In order to understand what might be one of the causes of underperformance in mathematics assessments by primary learners in South Africa, it was important to explore the linguistic challenge of the DBE Grade 4 mathematics ANAs. Grade 4 was chosen because in South Africa it is a transitional grade with a myriad of changes and challenges.

Chapter 2 presents the literature that was reviewed to locate this study within the broader context of related studies that preceded it. It describes difficulties experienced by learners who use English as an additional language in relation to the complexity of various mathematical texts. The chapter points to ways in which language can potentially support or constrain learning depending on whether the learners possess the requisite linguistic proficiency to facilitate that learning. Cuevas (1984), Jasper et al. (2005), Simkins, cited in Taylor, Muller and Vinjevold (2003), Setati (2002), Webb and Webb (2008), Cummins (1979), Cummins and Swain (1986), Halliday (1978) and others all argue that when learners are learning mathematics in English as an additional language, the learning is complicated by the fact that they are learning in a language that is not familiar to them. Causes of difficulties for learners when they solve mathematical problems are also discussed in the chapter.

Following on from the literature review on the difficulties experienced by learners who learn mathematics in an additional language, Chapter 3 further locates the study within a theoretical perspective namely sociocultural theory. This framework serves to illuminate the nature of the study as well as inform it. In Chapter 3, the theory and the theoretical assumptions guiding the study are discussed. The study assumes that language is central to learning and particularly draws on Vygotsky's (1976) sociocultural view of language and learning.

Having established a clear focus for the study (in Chapter 1) and located it within related literature and theory (in Chapters 2 and 3), Chapter 4 then outlines the methodology of the research study. Chapter 4 explains the collection of data related to the four phases of the study, namely analysis of: the 2013 ANA question paper and exemplar; 2013 ANA learner scripts; learner task-based interviews; and teacher questionnaires. Furthermore, issues of validity, reliability and ethics are also described in this chapter.

Chapter 5 focuses on the analysis of the assessment items in the 2013 mathematics ANA question papers and exemplars. In the chapter I reveal that linguistic factors play an important role in compromising the readability of the mathematics ANA texts.

Chapter 6 analyses the 106 learner scripts from the three classes as described in Chapter 4. The learners' written responses to the 2013 ANA test items are analysed and discussed.

In order to understand why the learners responded the way they did, task-based interviews were done in Phase 3, with a sample of 26 learners (9 from two classes and 8 from the third class). An analysis of these interviews is done in Chapter 7.

The analysis of the Phase 4 data which focuses on the teacher questionnaires of two teachers of the three classes of learners is undertaken in Chapter 8. Experiences of the teachers on the mathematics ANAs are illuminated and discussed.

Chapter 9 concludes the thesis with a discussion of findings and implications for this study. It also provides tentative recommendations and avenues for further research for various stakeholders involved in the ANAs.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This study investigates the linguistic obstacles of the 2013 Grade 4 Mathematics ANAs and the way learners and teachers experience these linguistic challenges. Language is important and central to learning and teaching. Through language, learning may be enabled or hindered. Mathematical language is notorious for being complicated not only for L2 English learners. In most South African classrooms beyond the FP, mathematics is learnt in English and has its own language, different from the everyday English language known to learners. This therefore, complicates learning and the teacher's role involves mediating the mathematics texts and making them accessible to learners. However, in the ANAs, teachers are not allowed to play a mediatory role as the assessments are administered under defined invigilator procedures that prohibit mediation except for allowing the reading of the questions to Grade 1 and 2 learners.

This chapter presents a review of literature concerning mathematics learning and teaching in classrooms where English is learnt as a L2 and where mathematics is learnt in English. The literature reviewed pays attention to the following aspects:

- Learning mathematics in English as an additional or L2
- The complexity of mathematics language
- Mathematics assessments of learners in an additional language
- Learners difficulties with word problems (Error analysis is a useful analytical tool)
- Research on the ANAs in South Africa

Halliday (1993) notes that it is not only EAL learners who struggle with mathematical English, but also English HL speakers. If English HL speakers are also tested by reading English mathematics texts, despite their intuitive knowledge of language, it can only be worse for those learning in English as an additional language. A discussion on the relationship between language and mathematics is therefore relevant for both English HL and EAL classrooms. This chapter focuses more on the linguistic complexities in the classroom where the language of learning and teaching is not the learners' HL. The following section discusses various problems encountered by learners learning mathematics in English when their HL is not English.

2.2 Learning mathematics in English as an additional or second language

Bell (2003) observed that mathematics achievement is generally not easy for learners learning through their L2 because of the highly specialized mathematical terms with meanings that are different from those used in everyday language. Cuevas (1984) also argues that when learners are learning mathematics in English, when English is their L2, the learning becomes difficult because learners first have to learn the language of instruction. A variety of linguistic skills are needed in order to learn mathematics and it is likely that beginner L2 learners and users would not have mastered these skills. According to Jasper et al. (2005) ELLs need additional time to decode and comprehend the mathematical language. This less than ideal situation of learning mathematics in an additional language is the reality in South Africa. The majority of learners who underachieve in Grade 12 mathematics examinations have been found to be those learners whose HL is not English or who use it less frequently at home (Simkins, cited in Taylor, Muller & Vinjevold, 2003).

Webb and Webb (2013) observed that in bilingual and multilingual South African classrooms, learners are unable to express their reasoning in English. It was also noted that when learners are restrained to using only individual mathematical terms in English, their lack of confidence in communicating reinforces the cycle of teacher initiation, pupil response and teacher evaluation in which the learner does not learn much (Webb & Webb, 2013). Code-switching between English and isiXhosa (HL for the learners in Eastern Cape, where the study was done) has therefore, been found to be useful in enhancing learners' comprehension and discussions that were done in HL were found to be meaningful as learners were able to express themselves in their HL (Webb & Webb, 2008). Thus the use of HL in multilingual classrooms brings meaning to learners who struggle with learning in English, a language not familiar to them.

Transferring mathematical skills that learners have developed in their HL into contexts presented in English is difficult for these learners. According to Setati (2002), the movement from informal everyday language to formal, academic and written mathematical language should occur at three levels: “from spoken to written language, from main language to English, and from informal to formal language” (p. 10). English HL speakers however, are only required to make two movements; from spoken to written language and from informal to formal language, giving them a distinct learning advantage.

2.2.1 Second language acquisition and its relation to the first language

It is important to consider how a L2 is acquired in order to understand the complexities of learning in an additional language. As noted earlier, the Cummins’ (2000) threshold hypothesis states that a minimum threshold in language proficiency must be reached before a L2 speaker can become proficient in the language. Cummins (2008) also argues that in order to be proficient in a L2, the learner must have reached a certain level of competence in his or her L1. What the two hypotheses by Cummins imply for L2 acquisition is that it is expedited where the learner has attained mastery of his or her L1 (which contains elements that will need to be transferred to the L2 acquisition and form the basis of that L2 acquisition) and have attained a reasonable degree of L2 proficiency upon which elements from the L1 can build. Lack of proficiency in the L1 (or scant proficiency in the L1) constrains the acquisition and development of the L2.

A study by Clarkson (1992) revealed that bilingual students with proficiency in both HL and English outperformed learners who were proficient in either mother tongue or English, and bilingual learners with low competence in both languages performed very poorly. Research has revealed that most South African learners, especially at lower primary level, do not attain mastery levels in their HL. For example, PIRLS (2006) found that South African primary learners who were tested in literacy performed extremely poorly even in their HLs. These young learners lacked academic proficiency in their HL. Only 13% of South African Grade 4s reached the minimum international benchmark of 400 points. While only 1% of IsiXhosa, SiSwati and

IsiNdebele learners reached the minimum international benchmark by Grade 4. This means that 99% of these learners 'were almost illiterate in their HL after three years of schooling' (PIRLS, 2006, p. 21).

Cummins' (1979, 1981) theory of cognitive academic language proficiency (CALP) and basic interpersonal communicative skills (BICS) is an important contribution to understanding L2 acquisition. Cummins distinguishes between CALP and BICS in order to explain the challenges that L2 learners face as they try to catch up with peers who are HL speakers of the language used in the classroom. Armed with the knowledge of this distinction, teachers should therefore, assess their students' proficiency in two distinct areas and provide appropriate education (Cummins, 2008). According to Cummins, BICS is the day-to-day language needed to interact socially with other people. English language learners use BICS as they play and speak to one another. These social interactions are cognitively undemanding, context-embedded and the language used is not formal or specialised (Cummins, 2008). There is much reliance on context in the form of gestures, concrete objects etc. to fill in the linguistic gaps in communication. This language can be developed within a period of six months to two years. In a study, Cummins (1980, 1984) analysed more than 400 teacher referral forms and psychological assessments carried out on English as an additional language students in a large Canadian school system. He observed that teachers and psychologists often assumed that children had no difficulties with English when they could communicate easily in the language. According to him, although learners may be able to communicate in the L2 (for example, isiXhosa children speaking in English) they are not sufficiently proficient in the language to use it for specialised academic purposes. Classroom teachers therefore, need to understand the difference between social language and academic language acquisition in order to avoid making incorrect assumptions.

On the other hand, CALP refers to language proficiency associated with schooling, and the abstract language abilities required for academic work and formal learning. This includes listening, speaking, reading, and writing about subject area content material. This level of academic proficiency is essential for learner success in school. Learners need about five to seven years to develop proficiency in CALP and to become proficient in academic areas (Cummins, 2008; Hakuta, Butler & Witt, 2000). In a study by Thomas and Collier (1995) it was observed that if an ELL is not supported in his or her native language development, it may take seven to ten years to catch up with their peers who are English language speakers. Cummins (2008) argues that academic language acquisition is not just the understanding of content area vocabulary. Rather, it includes 'higher order thinking skills, such as hypothesizing, evaluating, inferring, generalizing, predicting or classifying' (Gibbons, 1991. p. 3). It is also cognitively demanding and context reduced or increasingly abstract thinking (Cummins, 1981).

That BICS (conversational language) precedes CALP (academic language) means that at their initial exposure to the English language, L2 learners can only develop proficiency in the language at the BICS level which L1 learners have tacitly developed prior to their schooling. This puts the L2 learners at a disadvantage, particularly when a language they have not developed proficiency in, even at the conversational level, is used to carry out the academic functions of schooling at the CALP level. In South Africa at Grade 4, the majority of learners are compelled to use a language that Cummins (2008) postulates requires 7-10 years to develop proficiency in.

Cummins (2008) further advances this social and academic language distinction theory stating that there is a common underlying proficiency (CUP) between the L1 and the L2. This is a common area of language proficiency which provides the foundation for both languages. According to that theory, the skills and concepts that are learnt in the L1 are transferred to the L2. The L1 builds the foundation for the L2. For CALP to transfer from a HL to L2, learners must have achieved CALP in their HL (Jiang, 2011). In the South African situation however, this sometimes does not apply because L1, L2 (L3 and L4 in some cases) do not come from the same language stem and therefore L1 does not necessarily build a foundation for L2. Cummins (1979) however, explains in his threshold hypothesis that although reading skills are well-developed in the HL, this will not necessarily transfer to successful reading in the L2 or English. Rather, a certain threshold needs to be achieved in the L2, as well as proficiency in the L1 so that the transfer of skills from L1 to L2 takes place easily (Cummins, 1979).

Mastering of skills in the L1 which will then be transferred to L2 is easier when there is reading material both at school and at home. Jiang (2011) notes that learners' reading performance in their L2 is related to their reading in their HL. Unfortunately, in South Africa there are fewer reading materials in African HLs compared to Afrikaans and English (Howie et al., 2008) and as a result most learners in South Africa lack a culture of reading (Pretorius, 2002; Land, 2003; Sisulu, 2004; Reddy et al., 2015). The majority of the South African population can be classified as infrequent readers (Department of Arts and Culture, & Print Industries Cluster Council, 2007) and this would include the learners in this study.

2.3 Complexity of the mathematics language

In the South African context, the 20 years of TIMMS data shows that learners who never spoke the test language at home were at a disadvantage (Reddy et al., 2015) because they used a language that was unfamiliar to them. According to Bergqvist, Dyrvold and Osterholm (2012), mathematics has words, symbols, sentences and grammatical structures which are essentially part of the language. This mathematics language component serves to describe mathematical concepts, which cannot be described by everyday language. Patkin (2011) also describes mathematics as having some unique linguistic features and also makes use of the four operations of addition, subtraction, multiplication and division. The mathematics register defined as "a set of meanings that belong to the language of mathematics and that a language must express if it is used for mathematical purposes" (Halliday, 1975, p. 65) includes words, phrases, abbreviations, symbols and other ways of speaking, reading and writing that are specific to mathematics (Setati, 2002).

Research reveals that performance in mathematics is generally poor for learners learning through their additional language partly because of the highly specialized mathematical terms which have a variety of meanings from those used in everyday language (Bell, 2003). Hammil (2010, p. 1) describes mathematics as being "informationally dense and structurally complex." He also describes it as having ideas that are expressed in dense noun phrases, relationships described by verbs and extensive use of logical connectives. Schlleppegrell (2007) also describes mathematical language as a language with:

> … [M]ultiple semiotic systems that bring together symbolic representations and visual images that do not match up exactly with their ‘‘translation’’ into the oral and written language used to develop the meanings they present. In addition, the technical vocabulary and grammatical structuring associated with it make the oral and written language challenging in its own right (p. 145).

From the description of mathematical language given above, it is apparent that for one to be able to understand mathematical language, one must understand the symbols and visual images that come with it, which do not always correspond with what they mean.

Abedi and Lord (2001) and Abedi, Lord, and Hofstetter’s (1998) research also reveals that linguistic features of complex vocabulary (lexical complexity) and sentence structure (syntactic complexity) create comprehension difficulties for ELLs. Lexical features of complexity include “number of low-frequency words, abstractions, polysemy of words, and idiomatic and culture-specific” features (Martiniello, 2008, p. 336). On the other hand, syntactic features include “mean sentence length in words, item length in words, noun phrase length, number of prepositional phrases and participial modifiers, syntactically complex sentences, use of passive voice in the verb phrase, and complex sentences, which are sentences with relative, subordinate, complement, adverbial, or conditional clauses” (Martiniello, 2008, p. 336). In addition, learning mathematics is problematic for learners of English as an additional language because they first have to learn English and then learn the mathematics language in English (Setati, 2002; Cummins, 2000). These learners may struggle to comprehend the whole meaning of a paragraph, although they might have been able to understand individual words and sentences (Flick & Anderson, 1980). Lewis (1989) observes that most errors made by learners as they solve mathematics word problems are due to misrepresentation of the problem structure as communicated by the text rather than computational errors. Failure to understand the problem is the problem, not failure to work out the problem. This study will investigate whether this is the case for learners working with problems in the ANAs.

Since the language of mathematics is different from the language that learners use socially at home, with their peers, and in other subject areas at school, and because mathematics language is necessarily abstract and decontextualized, it requires CALP, which is the basis for a learner's ability to cope with the academic demands placed upon them in various subjects (Cummins, 2000). The language of mathematics is thus compounded with the need for CALP in an additional language. The majority of South African learners, especially those in primary schools located in townships and in rural areas, have only developed BICS and some CALP in their HLs and may not have developed BICS in the LoLT (Howie et al., 2008). For a learner to perform better, she or he must have a good command of the LoLT. In the case of mathematics, learners must have a good command of the language of instruction (English in the case of South Africa) and mathematical language (symbols, syntax, rules, among others).

According to Nagy and Scott (2000), for a reader to comprehend a text, approximately 90 to 95 percent of the words in a given text should be known to the reader. Those words that are frequently used (high-frequency words) are likely to be known by learners since they are usually exposed to them. On the other hand, if the text is full of low-frequency words, the text is likely to be difficult to read and comprehend. This study will investigate the level of language difficulty on the mathematical ANAs in relation to such frequencies.

Pimm (1987) sees mathematical language as constituting specialized vocabulary (new words and new meanings for familiar words, e.g. denominator, triangle etc.) and as extended discourse that includes syntax and organisation (Crowhust, cited in Moschkovich, 2012). These pose a problem to students' ability to interpret and conceptualize mathematical texts, especially when they are in the form of word problems. As Bell (2003, p. 4) asserts, "mathematics vocabulary, special syntactic structures, inferring mathematical meaning, and discourse patterns typical of written text all contribute to the difficulties many second language students have when learning mathematics in English". Similarly, Saville-Troike (1991) notes that vocabulary knowledge is key to academic achievement.

According to Halliday (1993), the difficulty of mathematics lies also in the grammar of the language used and not only with the vocabulary. Halliday (1993) identifies several features that have a tremendous effect on the performance by L2 learners. These include long phrases in questions, complex sentences, syntactic ambiguity, special expressions, lexical density and many more. Abedi (2006) points out that these features slow down students and cause learners' cognitive overload leading to failure in understanding the question items. In this case, there is need for mediation of text so that learners can make a breakthrough.

The above section emphasized the way in which both vocabulary and grammar contributes to the complexity of mathematical language. The next section briefly elaborates on each of these in the context of the complexity of mathematical assessment items and the notion of readability that comes to play in standardised written assessments.

2.3.1 Vocabulary

Five aspects of word difficulty that Bergqvist et al. (2012) analysed include word length, word form (e.g. verbs in a passive voice or adjectives), word type (e.g. pronouns), word familiarity, and word meaning (e.g. complexity of a concept). A word may be considered familiar in relation to the specific people using it. What learners speak every day is different from what they read and speak in school mathematics. Although the mathematical language may be unfamiliar to learners, they have to learn it even though this learning involves linguistic complexity. According to Bergqvist et al. (2012, p. 66), the complexity of the text as a whole may be categorised, after the complexity of individual words have been analysed. The issue of the "amount of difficulty" in a text can be determined in different ways which include focusing on the number of difficult words, or the proportion of difficult words or the existence of difficult words. This will then determine the level of difficulty in a task.

2.3.2 Grammatical complexity

A lot has to be known at a linguistic level before a learner attempts to solve a mathematical problem and this is a real hurdle for both English HL speakers and L2 learners. Halliday (1993) argues that the difficulty of scientific (including mathematics) language lies more with the grammar than with the vocabulary. Although technical terminology may be difficult for learners, Halliday (1993, p. 74) observes that the difficulty is not in the technical words themselves but in the complex relationship they have with each other. The technical words are related to one another in different ways. Halliday (1993) identifies seven features that have a negative effect on the performance of English L2 learners. These are:

1. Interlocking definitions

   In these definitions, a learner has to first know a cluster of related concepts at the same time and then use them to understand the new concept. The definition of circle, radius, circumference and diameter interlock. They are used to define each other. One has to know what a radius is in order to define a diameter.

2. Technical taxonomies

   These are related to the interlocking definitions but they are organised into groups (taxonomies) of related items which have definite functional value. There are different types of taxonomies, for example, super ordination and composition.

3. Special expressions

   These are expressions used in mathematical language, which have a special grammar of their own. For example, "The table shows how the value of houses in Grahamstown appreciates with time." Halliday calls this "technical grammar" and not technical terminology (p. 79).

4. Lexical density

   Lexical density measures the proportion of the content (lexical) words over the total words.

   Content words are nouns, adjectives, most verbs, and most adverbs. Grammatical (sometimes called functional) words are pronouns, prepositions, conjunctions, auxiliary verbs, some adverbs, determiners, and interjections. The higher the number of content words, the more difficult the text is to understand. The lower the number of content words, the simpler and easy to understand it becomes. Mathematical texts are usually lexically dense, containing a large number of technical words per clause.

5. Syntactic ambiguity

   This is the presence of two or more possible meanings within a single sentence or sequence of words. This is common in mathematical texts. For example, *the difference between 90 and 70 is 20.* In this case 'difference' is not used in the everyday meaning to mean 'dissimilar' but it means the number we get after subtracting 70 from 90.

6. Grammatical metaphor

   Halliday describes grammatical metaphor as "the substitution of one grammatical class, or one grammatical structure by another (1989, p. 86) and he gives an example, "glass crack growth rate" and "how quick cracks in glass grow". What has changed are words as well as grammar but the meaning of these phrases are the same.

7. Semantic discontinuity

   Halliday (1989, p. 86) notes that "sometimes writers make semantic leaps, across which the reader is expected to follow them in order to reach a required conclusion".

Apart from the unfamiliar mathematical language presenting a barrier to the uninitiated L2 learner, other readability factors come into play, largely to confound rather than ease the learner's engagement with the text. Readability of texts is therefore, discussed below.

2.3.3 Readability

Dale and Chall (1949, p. 23) define readability as:

> The sum total (including the interactions) of all those elements within a given piece of printed material that affects the success a group of readers have with it. The success is the extent to which they understand it, read it at an optimum speed, and find it interesting.

In the mathematics ANAs, it is relevant to assess the readability of the text which describes the context and the readability of the test items as this will affect learners' access to the assessment items. Learners' language proficiency has to be prioritised especially since learners are not L1 speakers of English but they are expected to read test items in English. For the test items to make sense to learners, learners have to be able to read them with comprehension. Oakland and Lane (2004, p. 7) also argue that "reading requires the ability to recognize words, know their meaning, read quickly and fluently, and ultimately comprehend intended meaning." Of all these qualities, reading comprehension is of key importance.

In my earlier study of the readability of science texts (Sibanda, 2014) I found that much of the lack of text readability was due to the vocabulary used, which was seldom explained or exemplified. This made the texts less readable. It was suggested that authors of science texts could consider factors that affect the readability of texts and present content in more readable ways. Some aspects are technical words, graphics and the content which should be familiar to learners. When these aspects are used well, learners are more able to learn and understand their textbooks. In this respect, teachers are able to use sound criteria to evaluate textbooks and choose the ones appropriate and accessible to their English as an additional language learners (Sibanda, 2014).

Oakland and Lane (2004) note that those who develop tests should try and attend to issues of language and reading as they develop the test items. They used readability formulae to estimate the grade level or difficulty level of text and test items so as to match text with the reader's reading ability. Sattler (2001) also used the readability formulae to review tests. Many readability formulae have been developed over time and these include Dale & Chall, (1948); Flesch, (1951); Fry, (1968); Gunning, (1968); Spache, (1953). Oakland and Lane (2004) suggest that in order for reading not to influence construct validity of items for learners with lower reading ability, test items would need to have lower levels of reading difficulty. In the context of this study, it seems the ANAs have not been subjected in the test design process to readability tests (Henning & Dampier, 2012).

Although readability formulae have been widely used, there are various arguments regarding their validity and reliability. Some have argued that their limited scope of data (relying principally on vocabulary and syntax) and low reliability compromise their use (Oakland & Lane, 2004). I share these reservations with using a formula to produce a particular grade level of readability. Instead, I draw on an approach that considers features of research frames like that of Shaftel, Belton-Kocher, Glasnapp and Poggio (2006) to examine the readability of mathematics texts but supplement this analysis with learner interviews in order to develop a better understanding of the learner experiences of the readability levels of the assessment items.

2.3.4 The Shaftel et al. (2006) linguistic complexity checklist for mathematical texts

Shaftel et al. (2006) evaluated the language characteristics that most affected learners' performance in mathematics assessments that were given to English language learners in Grade 4, 7 and 10. They analysed each individual test item. All test items were in a multiple-choice format and all items were presented as word problems, though the number of words per item differed. A learners' performance was determined by the item difficulty as well as the ability to answer the question correctly. Items were coded according to their linguistic complexity, taking into consideration the "total number of words, sentences, and clauses in each item; syntactic features such as complex verbs, passive voice, and pronoun use; and vocabulary in terms of both mathematics vocabulary and ambiguous words" (Shaftel et al., 2006, p. 11). The results of this study revealed that the mathematical and linguistic features of the test items measured, had a statistically significant impact on learner performance, "with a moderate-to-large effect at Grade 4, a medium effect at Grade 7, and a smaller effect at Grade 10" (p. 120). At Grade 4, prepositions, ambiguous words, complex verbs (verbs with three or more words), pronouns, and mathematics vocabulary showed unique effects on item difficulty. The greater the number of linguistic elements in an item, the more difficult the item was.

A tool was developed to calculate the linguistic complexity of test items. Three levels of language were established: word level, sentence level and paragraph level. Shaftel et al. (2006) listed some individual language features that he considered to be challenging. These are:

A: Basic level: Number of sentences
Number of words in an item

B: Word level: words of 7 letters or more
Relative pronouns (e.g. that, whom, whose)
Slang/ambiguous/multiple meaning or idiomatic words (e.g. change, set)

Homophones (e.g. two/too, prize/price)

Homonyms (e.g. there, their, they're)

Specific mathematics vocabulary (e.g. pentagon, symmetry)

C: Sentence level: Prepositional phrases (e.g. beginning with, from, by, at)

Infinitive verb phrases (to make, to sell)

Pronouns (e.g. his, her, they)

Passive voice (were sold, were rounded off)

Complex verbs of 3 words or more (e.g. could have been)

Complex sentences (e.g. with subject and predicate)

Conditional constructions (e.g. if….then)

Comparative constructions (e.g. less than, greater than)

D: Paragraph level: references to specific cultural events and holidays.

The Linguistic Complexity Index (LCI) (which was later developed from the linguistic complexity checklist by Vale (2013) is calculated as:

LCI = (Number of words + Sum B + Sum C + Sum D) ÷ Number of sentences

Table 5: Summary of items included in the Linguistic Complexity Checklist (Shaftel et al., 2006)

LINGUISTIC COMPLEXITY CHECKLIST	
(A) BASIC LEVEL	Number of sentences
	Number of words
(B) WORD LEVEL	Number of different words with 7 letters or more
	Number of pronouns
	Examples of homophones, homonyms, slang, passive and ambiguous words
	Number of specific mathematics vocabulary
(C) SENTENCE LEVEL	Number of prepositional phrases
	Number of infinitives
	Number of complex verbs
	Number of complex sentences
	Number of conditional constructions
	Number of comparative constructions
(D) PARAGRAPH LEVEL	Number of holidays
	Number of cultural events

For this study, test items are defined as each item of the ANA for which a learner could get one or more marks. I used the above tool to calculate the linguistic complexity of each of the 2013 mathematics ANA test items. The tool allowed me to see the features of language that caused problems in the test items and to identify which items were the most complex in terms of language. Other studies have usefully drawn on this LCI for analysis of text complexity, including in the mathematics assessment context. I briefly review the findings of these studies in the following section.

2.3.4.1 Other research focusing on linguistic complexity of word problems on mathematics achievement tests

Much research has focused on linguistic complexity of word problems in mathematics achievement tests. The majority of the studies (Abedi & Lord, 2001; Martiniello, 2008; Wright & Li, 2008) have found that linguistic complexity contributes to the difficulty of mathematics word problems for English language learners with item length having the strongest correlation (Schuitema, 2011).

In 2008 Wright and Li conducted a linguistic analysis of test items from a Grade 5 mathematics Texas Assessment of Knowledge and Skills (TAKS) as well as learners' worksheet for English additional language learners in a fourth Grade mathematics class in Texas. The words from the assessment and the worksheets were compiled and compared using software. Further analyses were conducted on both the assessment and the worksheet at the sentence level for syntactical complexity. Wright and Li (2008) noted that the language complexity of the items on the Grade 5 Math Texas Assessment of Knowledge and Skills (TAKS) was far above that of the math worksheets provided to students.

Martiniello (2008, 2009) also investigated the linguistic complexity of items that showed increased difficulty for English as an additional language learners as compared to native speakers of English with equivalent mathematics proficiency. In both studies Martiniello used results from differential item functioning (DIF) procedures conducted on the 2003 Massachusetts Comprehensive Assessment System Grade 4 mathematics test. Ten out of the thirty nine publicly released items from the MCAS showed DIF disadvantaging English as an additional language learners (Martiniello, 2008, 2009). Think-aloud procedures given to 24 English as an additional language Grade 4 learners confirmed that the linguistic complexity of those ten questions was possibly the cause of DIF (Martiniello, 2008). Some of the shared linguistic features found in those ten items include: multiple clauses, long noun phrases, unfamiliar vocabulary, polysemous words, and words or expressions referencing mainstream American culture (e. g. coupon, spelling bee championship) (p. 358).

Similarly, Leon (2009) found linguistic complexity a key aspect in explaining DIF. Specific academic vocabulary was a notable feature characterizing linguistic complexity. General academic vocabulary was more likely to cause DIF than other types of vocabulary among items requiring relatively easy content knowledge (Lee & Randall, 2011). Further findings showed that more DIF was found when the focal group consisted of English as an additional language learners with low English proficiency rather than high proficiency, and for easy items than for difficult items. In items that were relatively easy, "higher linguistic complexity was associated with greater uniform DIF against ELLs. For difficult items, the pattern was inconsistent, which indicated that factors other than linguistic complexity might influence DIF" (Lee & Randall, 2011, p. 7).

In South Africa Vale (2013) conducted a study which focused on describing the cognitive and linguistic complexity of Level 4 (Grade 12) Mathematical Literacy examination items as well as the types of responses from a sample of students. Using content analysis, and the Shaftel et al.'s (2006) linguistic complexity checklist and LCI, Vale investigated the language-related sources of difficulty and interrogated how the cognitive and linguistic complexity of items might be related to the types of errors made by learners as they solve mathematical problems. Statistically significant "correlations were found between the linguistic complexity of items and language-related errors, and between the cognitive complexity of items and all types of errors" (Vale, 2013, p. iv). Language features that were significantly correlated with linguistic complexity were noted and these included prepositional phrases; words of 7 letters or more and complex/compound sentences (Vale, 2013, p. iv). About 19.22% of all errors made by learners were identified in her study as language-related.

The studies described above show that when learners are not proficient in English language, their performance in tests is compromised. The research showed that across several contexts, assessments aimed at testing learners' mathematical competence, they also tested the learners' English language proficiency. It is therefore, important that those who set the tests take into consideration both the language complexity appropriate for the age of learners and the English language proficiency of the learners taking the tests. Since the vast majority of South African learners are ELLs, the latter is particularly important. The next section discusses the assessment of mathematics in an additional language.

2.4 Mathematical assessment of learners in an additional language

According to Halliday (2010), fairness in assessment depends on a consideration of learners' language proficiency. Limited English proficiency may also make it difficult for learners to understand fully the instructions for the assessment questions. Abedi (2006) also argues that standardized achievement tests that take no consideration of ELL's language proficiency cannot depict what learners really know. Abedi (2006) and Abedi, Hofstetter and Lord (2004) found that much of the underachievement by English language learners in the U.S. context is caused by the linguistic challenges presented by the assessments. Similarly, Graven and Venkat (2013) have questioned the fairness of ANAs in terms of the inaccessibility of the language of several ANA test items.

Furthermore, large scale international studies such as TIMMS show a strong relationship between mathematical performances of learners who speak a HL which is also the language of assessment. Whereas the international average of learners speaking the same language as the assessment language in the TIMMS 2011 test was 79%, the South African average for 2011 was only 26% (Reddy et al., 2015). This strongly suggests a linguistic component at play in the South African learners' relatively poor performance. The analysis of 20 years of TIMMS data shows that across 'all types of schools, learners who never spoke the test language at home were disadvantaged' (Reddy et al., 2015, p. 33).

Since the ANAs are mostly text-based it is reasonable to expect that learners' performance will be partly determined by their proficiency in the language of testing. Almost all assessments measure language and reading proficiency to some degree. There are many different factors that negatively affect the performance of ELLs in assessments but language factors as argued in the studies reviewed above seem to have a greater impact than many other factors. It is therefore, important to investigate whether the language in which the ANAs are administered gives English L2 learners a fair chance of success, taking into consideration the text readability and learner understandability, particularly at the linguistic level.

In relation to Cummins and Swain's (1996), research on CALP and BICS discussed earlier, South African primary learners' poor literacy performance was also symptomatic of a lack of academic proficiency in their HLs (PIRLS, 2006). Learners' reading proficiency therefore, also plays a role in learners' performance in assessments because the less proficient the learners are in reading, the less they are likely to read with comprehension and understand the questions. Abedi (2006) notes that assessments with complex language negatively affects the performance of learners and the performance gap between ELLs and English HL speakers is thus increased. For Abedi, such assessments are unfair and invalid and may have an impact on the decisions made regarding the inclusion and accountability system of the ELLs (2006). The Council of Chief State School Officers in the USA has also criticised the large scale, standardized tests and suggested that the academic assessments for ELLs should be supplemented to avoid bias (Kopriva, 2000).

Tsang, Katz and Stack (2008) describe a study that addressed the question of when it is appropriate to administer content area tests in English to ELLs. They examined the effect of language demands on the SAT/9 mathematics scores of Chinese-speaking and Spanish-speaking students. Although the English language demands of the problem solving subscale affected all students, their effect was more pronounced on Chinese-speaking and Spanish-speaking students' performance, 'rendering the tests inaccurate in measuring English learners' subject matter achievement' (p. 18). The results also indicated that the effect of language complexity gradually decreases as students become more proficient in English, taking five to six years for students to be up to par with expectations (Tsang et al., 2008). These findings have implications especially for those education systems which base learners' progress to subsequent grades on standardized tests.

Since validity (i.e. the extent to which a test measures what it claims to measure) is an important attribute in assessing ELLs, Shaftel et al. (2006) argue that those who develop tests ought to take into consideration the general language proficiency of the learners being tested and then use language that does not introduce additional comprehension hurdles above the required content. In the case of the ANAs, if the majority of learners are failing dismally, it is of no value to teachers to know that learners cannot do mathematics at their grade level, in order to be useful, the test needs to show teachers what their learners do not know and where to start remediation.

Several researchers whose work is reviewed above point to the complex interplay between language (and mathematical language) and the complexity of abstract cognitive concepts required for solving problems. In the next section I discuss this complex interplay of difficulties learners encounter as they solve mathematical problems.

2.5 Error analysis as a useful analytic tool for learners' difficulties with word problems

Newman's research in the seventies found that nearly half of the errors that learners make as they solve word problems were related to language (Newman, 1977). Subsequent research confirmed these findings (Clements, 1980; White, 2005). Newman specified five skills that are crucial to the solving of word problems namely; reading, comprehension, transformation, process skills and encoding (Newman, 1977). These skills also represent the hurdles learners have to surmount as they respond to written mathematical questions. Learner errors manifest themselves in a variety of ways as learners respond to mathematical items. White (2005) notes that Newman's Error Analysis (NEA) provides a framework for explaining the difficulties learners face as they solve mathematical problems. It allows the determination of potential problem areas and furthermore identifies ways to resolve these problems. Additionally, White (2005) notes that the NEA tool enables a linkage between literacy and numeracy. This is why NEA was identified as being particularly useful for my study. Newman highlighted the following errors leading to failure to solve problems:

- Reading errors refer to inability to read a key word or symbol in a written problem.
- Comprehension errors refer to when a child has failed to get the meaning of the words that he or she has read.

- Transformation errors refer to when a child has understood the question but is not able to identify the operation needed to solve the problem.
- Process skills errors refer to when a child fails to know the procedure needed to carry out an operation (having identified the correct operation).
- Encoding errors refer to when a child has failed to express a solution in an acceptable written form (having worked out the problem correctly).

Besides these errors, Newman also acknowledges that learners can make careless errors when they solve mathematical problems due to a range of reasons including a lack of motivation. Newman (1977) then assigned such errors to a composite category or other errors (which include careless errors and unwillingness to try).

From these errors, Newman then developed a diagnostic tool, the NEA which links numeracy and literacy using an interview involving five questions posed to learners while solving a problem (White, 2005). This tool was useful as a framework for discovering the types of errors that learners made while completing word problems and thus became the framework on which the learner interviews in this study were based. The five interview questions or prompts are given below.

The Newman's Error Analysis Interview Prompts

1. Please read the question to me. If you don't know a word, leave it out.
2. Tell me what the question is asking you to do.
3. Tell me how you are going to find the answer.
4. Show me what to do to get the answer. "Talk aloud" as you do it, so that I can understand how you are thinking.
5. Now, write down your answer to the question (Newman, cited in White, 2005, p. 134).

Following an analysis of 106 ANA written scripts looking for learner difficulties in responding to ANA test items, this study examined the errors made by 26 learners from three classes of Grade 4 learners as they answered selected Grade 4 mathematics ANA questions mediated by adapted NEA prompts. Particular attention was paid to those errors which point to language proficiency and literacy issues. Since I used the

NEA interview prompts, in the next section I review studies that have used the NEA approach to analyse errors made by learners as they solved mathematical problems. Of interest, while widely used internationally, I have not come across published research to date in Southern African countries on primary mathematics learner assessments which uses the NEA approach as an analytical tool. Although some researchers like Bansilal (2012) and Graven (2014) did their research in primary schools, none of them used the NEA approach.

2.5.1 Review of studies that have used the Newman's Error Analysis approach

Since the 1980s, the Newman approach to error analysis has been widely used in Australia (Clarkson, 1980; Nanayakara, 1994; Clements, 1980; Clements & Ellerton, 1992) in India (Kaushil, Sajjin Singh & Clements, 1985) in Malaysia (Ellerton & Clements, 1992) to name just a few countries.

Clements (1980) conducted research using the Newman's Error Analysis Model (NEA) in Australia. His finding was that 66.67% of the errors that learners made when solving the word problems occurred at the reading, comprehension and transformation stages (first three stages). These three stages are closely related to language proficiency.

Nanayakara's (1994) study in Sri Lanka with Sinhala medium Grade 3 and 5 students also used the NEA model to analyse the data and found that 60.4% of the errors made by learners were related to the reading, comprehension and transformation stages of problem solving. Both Clements and Nanayakara's findings point to more than 60% of the learners' errors in mathematical problem solving being language-related.

In 1992, Ellerton and Clements conducted a cross country study in which 206 Year 7 students, 145 in four schools in Malaysia, and 61 in two schools in Australia, answered 24 mathematics questions. They were interviewed according to the NEA interview technique. The types of errors that the learners made were analysed and compared. The findings revealed that (a) about 70% of all errors were related to language proficiency and were found either in the comprehension, transformation or careless categories. (Ellerton & Clements, 1996).

In a recent study, Mung, Ngee, Ramakrishnam, Chock, Kwun and Hup Tee (2014) investigated learners' careless mistakes during mathematics assessment. Their hope was that the learners who made these careless mistakes would manage to demonstrate their skills after the intervention and then build their confidence in mathematics and eventually improve on their learning experiences (Mung et al., 2014). A group of learners who made careless mistakes in an assessment were selected to go through an intervention, based on Newman's classification of reading, comprehension, transformation, process skills and encoding errors where learners who underwent the Newman interview were guided to classify their errors. The purpose of this practice was to make learners aware of the errors they made and where they made the errors. Afterwards, mediation was provided on those problems that learners could not solve (Mung et al., 2014). Following the mediation, learners were able to say where they made errors and this was claimed to improve their learning experiences.

Recently, in 2014, Flagg researched mathematical errors in word problems made by Grade 4 learners who attended a low socio-economic school in the U.S. The case study investigated how these Grade 4 learners completed 15 word problems and responded to five NEA prompts. The NEA diagnostic tool was used for this study (Flagg, 2014). Flagg analysed her data qualitatively basing her coded errors on Newman's five skills. The findings for this study were that reading and comprehension errors occurred before the learners began with the mathematical computations, thus often leading to inappropriate choice of computation to solve the problem. This, according to Flagg (2014), was a good way of determining when and where exactly learner's experience difficulties when they solve word problems. The suggestions resulting from this study were that mathematical language should be a focus of classroom instruction (Flagg, 2014).

The studies that have used the NEA have been useful to researchers and teachers as they have indicated where most learners struggle in the problem solving process. Similarly in this study, the use of the modified NEA tool allowed me to observe where learners experienced difficulties as they solved mathematical problems and what skills they could demonstrate with mediation in the form of adapted NEA prompts. This was important as the analysis of the written ANA scripts (in phase 2) could not show where difficulties in the process of attempting to answer assessment items occurred so the NEA tool was both necessary and useful. While the NEA has not been used in Southern Africa in the primary mathematics context, there has been some local research on the language of the mathematics ANAs. The next section discusses this research.

2.6 Research on the ANAs in South Africa

In Chapter 1, I showed that the ANA reports for 2011 to 2014 indicate that the average performance of Grades 3, 4, 5, 6 and 9 learners in Mathematics and Language is consistently below 50% and worsens as one moves up the grades and furthermore the situation is worse in the Eastern Cape (DoE, 2011, 2012) where the present study is located. However, this problem of underperformance transcends provincial boundaries and is a national problem. This section discusses some studies related to the mathematics ANAs. Since the ANAs were only introduced in 2011, this is a relatively new area of research.

Bansilal (2012) carried out a study which analysed the pre-trial ANA mathematics results for Grades 1 to 6 in the province of KwaZulu-Natal for 2010. Bansilal wanted to identify broad trends in these results. She found that learners in lower grades (Grades 1 and 2) performed better than those in higher grades. Bansilal's conclusion was that Grade 1s and 2s performed well in the tests because their teachers read the instructions aloud to them as they wrote the tests. Grade 3 learners had to read the instructions for themselves so it is possible that some learners were unable to read and understand the written instructions. Grade 4 learners performed even worse than Grade 3 learners, perhaps because of the switch in the language of instruction used in the assessments to mostly in English from the LoLT in their FP education. Another finding was of the learners who wrote the ANAs in Afrikaans, the learners whose HL was Afrikaans performed better than other learners whose first language was not Afrikaans, from Grade 1 up to Grade 9. Bansilal (2012) recommended that further research be done to identify reasons for the poor results so that interventions can be implemented to address the problem. She also recommended research on the individual items, in order to investigate their fitness for purpose. This research feeds into this call for research from across provinces and considers individual test items to see if the language used provides learners a fair opportunity to demonstrate their mathematical learning.

Henning and Dampier (2012) similarly argue that the language used in national assessments such as the mathematics ANAs combined with learners' reading abilities contribute to poor performance in assessments, especially in the context of African HL children writing assessments in English or Afrikaans. Of interest however, is that Green, Parker, Deacon and Hall (2011) note that there is evidence in South African assessments that points to lower average performance for learners who are assessed in African languages in comparison to those who are assessed in English or Afrikaans. While a multitude of complex intersecting factors are likely to impact, here one contributing factor could be Bohlman and Pretorius' (2008) findings that mathematics achievement is determined more by reading ability in English than English language proficiency. Another factor could be due to learners being assessed in African languages not having sufficiently developed in CALP to enable access in an assessment context (as discussed in Chapter 1).

Graven and Venkat's (2013, 2014) research revealed that across Grahamstown and Johannesburg primary schools the mathematics/numeracy teachers participating in their projects spent several weeks (a range of one to eight weeks with a mean average of 3. 97) of school time on the preparation and writing of the ANAs. While the teachers agreed that ANAs are important because they are standardized and make clear what will be assessed, and provide guidance on what should be covered, they had several weaknesses like using complex unfamiliar language to ask questions. Teachers complained about not being allowed to mediate the questions or read to the Grade 3 and 4 learners who struggled to read. This, to them, was unfair to weaker learners who struggle with reading and comprehension of English (Graven & Venkat, 2013). According to that research, teachers also complained that the ANA exemplars and memorandums do not allow for different methods of problem solving and this discourages teachers who believe that there are many ways of solving mathematical problems (Graven & Venkat, 2013). In addition to this, some teachers felt that the people responsible for setting the tests should consider what the learners have covered up to the time of writing so that learners are not tested on what they have not learnt. Other teachers felt the papers were too long, and some questions were not clear. Some learners were said to be nervous because the tests were being administered by unfamiliar (Graven & Venkat, 2014). These points reveal a wide range of factors other than linguistic challenges that contribute to learner stress and difficulties with the ANAs.

Given the newness of the ANAs, it is to be expected that there is little published research on them. Although Henning and Dampier (2012) reviewed the language of Grade 1 and 2 ANAs in 2011, there is, however, no published research to date which analyses the Grade 4 Mathematics test items to explore the readability and accessibility of the language used in the items.

This is particularly important given the many transitions learners experience when moving into Grade 4 as the first year of the IP as discussed earlier. The present study's contribution looks to address this gap and contribute towards informing the design of increasingly valid test instruments, not only for the ANAs, but more generally for mathematics assessments involving second language learners who lack proficiency in the language.

2.7 Chapter summary

This chapter presented a review of the literature related to the present study. The chapter reviewed literature on the challenges faced by learners learning mathematics in an additional language. Since mathematics has a language with its own vocabulary and grammar, learners have to master these in order to access and answer mathematical assessment items, this makes them doubly disadvantaged.

The chapter also examined the linguistic features that hinder learners from understanding mathematical texts. Shaftel et al.'s (2006) checklist and related LCI formula was reviewed. These are used in this study as analytical frameworks for the data analysis in this study.

As learners solve mathematical problems, they encounter difficulties and often make errors during the process. These errors became increasingly visible to researchers drawing on the NEA and thus the NEA and related research was reviewed in this chapter. This included a range of international research that made use of the NEA diagnostic tool and noted an absence of its use within the Southern African primary assessment context. The next chapter presents the broader theoretical framework guiding this study.

CHAPTER 3: THEORETICAL FRAMEWORK

3.1 Introduction

This study was guided by an assumption that language is central to learning in general and the learning of mathematics in particular. It also is guided by the view that language is complex and while essential to learning, complexities of language, and differences in language across discourses, can result in difficulties in learning. Studies have identified linguistic structures that are used in mathematics which are different from how language is typically used in everyday life, suggesting that these forms present challenges to many learners (Schleppegrell, 2007; Abedi & Lord, 2001; Adams, 2003). This study focuses on the linguistic challenges of current South African ANAs. These challenges in the ANAs are explored through linguistic complexity analysis of the 2013 mathematics ANA items, content analysis of 106 learner ANA scripts and through 26 learner and two teacher interviews.

This study uses a sociocultural view of language and learning based on Vygotsky's influential work on the theory of language and learning. According to sociocultural theory language is central to learning. For research question 1, which sought to establish the linguistic difficulties posed by the 2013 mathematics ANAs, I drew on various analytical tools that cohered with and were developed from a Vygotskian perspective of learning. Vygotsky's theory of learning is guided by six assumptions that guide this research:

- Children develop through formal and informal interaction with adults.
- Thought and language become more independent in the first few years of life and this is when development is critical.
- Complex mental activities begin as basic social activities.
- Children can perform more difficult tasks with the help of a more informed individual.
- Tasks that are challenging promote cognitive development.
- Play is important and allows children to stretch themselves cognitively (Vygotsky, 1978).

The key idea in Vygotsky' theory of learning is that interaction facilitates language learning and leads to language acquisition. All learning is considered as basically a social process which is founded in sociocultural settings (Saville-Troike, 2006). Humans use tools that develop from culture, such as speech and writing, to mediate their social environment. Vygotsky (1978, p. 25) posits that "Children not only speak about what they are doing; their speech and action are part of one and the same complex psychological function, directed toward the solution of the problem at hand". For Vygotsky, without speech, learning goals cannot be accomplished.

Vygotsky (1978) maintains that speech is a major psychological tool in the child's development of thinking. Young children are curious and actively involved in their own learning, and in discovery and development of new understanding. As the child ages and develops, his or her basic speech becomes more complex. According to Vygotsky, "sometimes speech becomes of such vital importance that, if not permitted to use it, young children cannot accomplish the given task" (p. 26).

3.2 Development and learning

In his model of human development, Vygotsky (1978) posits that culture provides children with the means to think, what to think and how to think. As learning takes place, the child's own language becomes his or her primary tool of intellectual transformation. This applies even in learning mathematics. Steele (2001)) explains Vygotsky's view as follows:

> For Vygotsky, individuals come to learn the meanings of a culture by internalising the meanings and being transformed by them as they learn to speak the language of the culture. Thus, students … develop mathematical meanings as they learn to explain and justify their thinking to others. As they learn to speak the mathematical language, they transform their thinking of the mathematical concepts. The mathematical language comes from society, and thought comes from the individual (pp. 404-5).

The above quote argues that according to Vygotsky, children can eventually use their internal speech to direct their own behaviour in much the same way that their parents' speech once directed it. Vygotsky's theory of learning suggests that we learn first through interpersonal interactions and then individually through an internalisation process that leads to deep understanding (Fogarty, 1999, cited in Blake & Pope, 2008, p. 61). Blake and Pope (2008) note that Vygotsky examined three different types of speech, important in a child's learning. These are: social, private and internal and are defined as follows:

1) Social speech: These are, for example, the instructions given to children by adults.
2) Private speech: the speech that allows children to process what the adult has said and to apply it to similar situations, for example, instructions that learners are given by their teachers in the classroom. Both the teacher and the learners share the responsibility of developing the learners' private speech (Blake & Pope, 2008, p. 61).
3) Internal speech: this takes place "as the learner's silent, abbreviated dialogue that she carries on with self that is the essence of conscious mental activity" (Wilhelm, 2001, cited in Blake & Pope, 2008, p. 61).

Huitt (2000) posits that thought results from social speech that becomes internalised private speech. He also argues that "when the cultural signs become internalised, humans acquire the capacity for higher order thinking" (Huiitt, 2000, cited in Blake & Pope, 2008, p. 61).

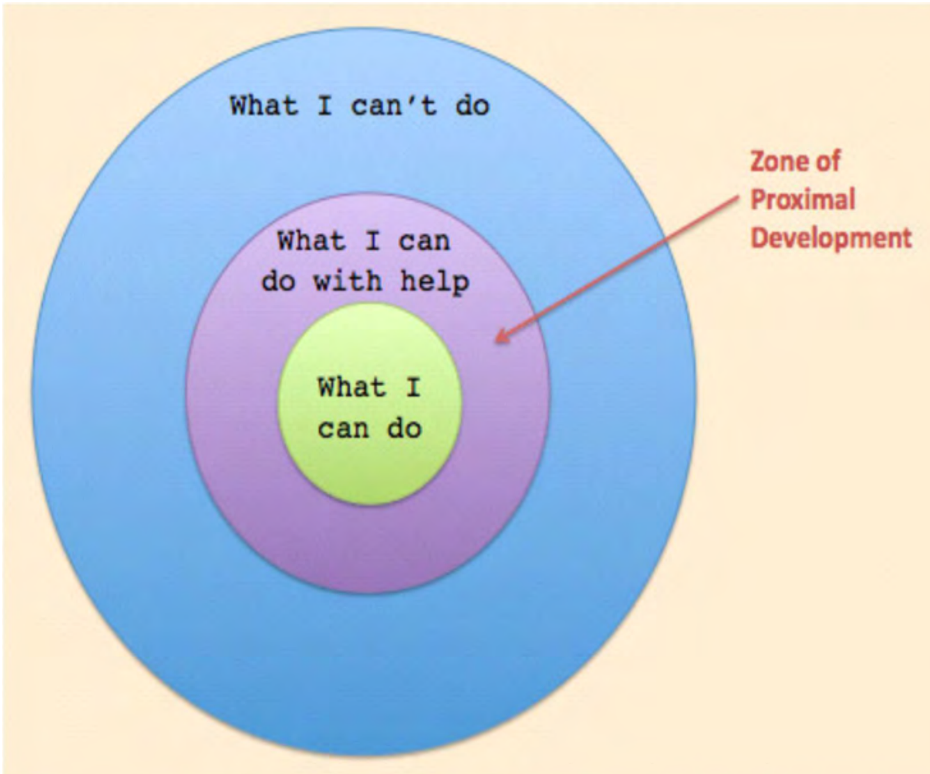
As children interact with others they also acquire signs or symbols which they will then use together with their own speech to interact and solve problems (Wells, 1986, cited in Smidt, 2009). This reflects Vygotsky´s theme of development as a process of internalization (Vygotsky, 1978). He argues that language is the main tool that promotes thinking, develops reasoning, and supports cultural activities like reading and writing. In mathematics children use mathematical language to solve mathematical problems. Vygotsky asserts that concepts are external in dialogue or action and then gradually become internalised as ways of thought as children mature. Hence, as children use language to talk aloud, discuss and argue, the development of their mental structures is enhanced. In short, Vygotsky's (1978) hypothesis on learning is that "the speech that we use aloud and with others eventually becomes internalized as part of our repertoire of strategies for problem solving" (Darling-Hammond, Austin, Orcutt & Martin, (2003, p. 125).

Vygotsky (1978, p. 126) posits that one of the essential aspects of development is the "increasing ability of children to control and direct their own behaviour". This is brought about by development of new mental processes and by using signs and tools in the process of development, while collaborating with others. The teacher or a more expert peer is essential to this learning process. Individual development takes place in the context of activities modelled or assisted by this more skilled person. Vygotsky argues that development does not precede socialization, but rather social structures and social relations lead to the development of mental functions (Huitt, 2000, slide 22).

In his theory of the zone of proximal development (ZPD), Vygotsky argues that a child learns through the best use of potential through assistance, support, or instruction. The ZPD refers to:

> The distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978, p. 86).

Vygotsky notes that the ZPD is the current or actual level of development the learner is at and the next level attainable through the use of mediating semiotic and environmental tools and capable adult or peer facilitation (Vygotsky, 1978, cited in Denhere, Chinyoka & Mambeu, 2013, p. 371). ZPD is what a child can do alone at a particular time. Adults assist children by cuing or even by showing them how to do something, but in a way that emphasises "overcoming obstacles rather than simply copying behaviour demonstrated by an adult" (Kritt, 2013, p. 19). Instruction and learning occurs in the ZPD. When learners are in this zone, they can be successful with instructional help (Blake & Pope, 2008). The diagram below exemplifies the ZPD according to Vygotsky (1978).



Adapted from (InnovativeLearning.com)

Figure 1: A Model of the Zone of Proximal Development

Explanation of the diagram:

- The yellow colour is the zone of achieved development (ZAD). The ZAD indicates that the child has mastered the concepts and can independently perform them without assistance.
- The purple area is referred to as the ZPD where learning can proceed with the assistance of an expert. This is an active learning zone.
- The blue colour denotes the area in which even with the assistance of an expert, the child will not learn (Denhere et al., 2013, p. 371).

Vygotsky (1978, cited in Siyepu, 2013) argues that learner's thinking and problem solving ability fall into three categories:

1) Those that can be performed independently: This is what a child can do on his/her own at a particular point in time. There is nothing new for the learners to learn (Blake & Pope, 2008). This is "a measure of development that is already completed, which he calls the "actual developmental level" (Kritt,

2013, p. 20). In a mathematics class the zone of actual development suggests that the child has mastered the mathematical concepts and can independently solve the problems without assistance from peers or from the teacher.

2) Those that can be performed "under adult guidance or in collaboration with more capable peers" (Vygotsky, p. 86). An example is of a child who completes something an older peer or the teacher has started, or used cues to solve a problem (Vygotsky, 1978). This is where development takes place. (Gauvain & Cole, 1997, p. 33). If a child can do a task on their own, it means that the functions for the task have matured in them (Gauvain & Cole, 1997). The ZPD then indicates the functions that have not yet matured, but are in the process of maturation (Gauvain & Cole, 1997, p. 33). In mathematics the ZPD is important for learning and instruction because, according to Denhere et al., (2013) it determines what has to be taught and is suitable for the child. Beal and Arroyo (2002, cited in Denhere et al., 2013) argue that in mathematics learning, a learner is said to be in the ZPD if the learner manifests effective learning. If the learners' behaviour suggests that they are bored or unable to solve the problem then they are not in the ZPD. This zone will also differ according to each learner's tolerance for boredom and confusion (Denhere et al., 2013, p. 272). This is important in that the NEA interview prompts provide mediation that might allow the ZPD to emerge in interviews through this prompting.

Vygotsky illustrates ideas regarding assessment relating to the ZPD:

> Imagine we have examined two children and have determined that the mental age of both is seven years. This means that both children solve tasks accessible to seven year olds. However, when we attempt to push these children further in carrying out the tests, there turns out to be an essential difference between them. With the help of leading questions, examples and demonstrations, one of them easily solves the test items taken from two years above the child's level of (actual) development. The other solves test items that are only a half year above his/her level of

(actual) development (Vygotsky 1956, cited in Wertsch & Tulviste 1992, p. 549).

For Vygotsky the mental functioning for the two children described above is different. The reason for this is because when children are assisted by adults, the adults notice what the children can do and for Vygotsky, this is the child's ZPD (Vygotsky, 1956, cited in Wertsch, 1985, p. 68). Thus, through the use of mediating semiotic and environmental tools and capable adult or peer facilitation, children have the capacity to improve and learn more. Vygotsky's idea is that different children of the same age can successfully do the given tasks of different complexity when assisted by the same adult and "this difference between the child's actual level of development and actual level of performance that he achieves in collaboration with others, defines the zone of proximal development' (Vygotsky, 1987, cited in Gauvain & Cloe, 1997).

Lantolf and Poehner (2004) argue that potential development differs independently of actual development. This means the actual development on its own cannot be used to predict the potential development. This is "because potential development is not a priori prediction but is derived from concrete mediated activity" (Lentolf & Poehner, 2004, p. 51). Observing a person's actual level of development presents only part of what is actually happening but the full picture emerges only when we take the account of their future, which can be done by the dynamic assessment (Lantolf & Poehner, 2004). Thus, in the ZPD, it is important to see what a child can be able to do in the future, rather than just focusing on what the child has achieved.

3) Those that cannot be performed even with assistance. If ZPD is that which a learner can do alone at a particular time, then that which cannot be performed even with assistance of more knowledgeable one is out of the ZPD and should be avoided. Utah Education Network (2005, p. 11) argues that "It's a waste of time to teach kids what they already know and what they cannot do even with assistance."

Based on the evidence drawn from the clinical studies he conducted, Vygotsky observed that children's achievement, when assisted by an adult, tells more about what they can learn than intelligence quotient tests. Thus, what children can accomplish with the help of an adult tells more about their mental ability to learn in the future than tests they undertake without any assistance (Denhere et al., 2013). Vygotsky administered tests to children, some with support and others without. Vygotsky's findings from the tests with adult support showed him what the children's later development might be like, but the results from tests written without support from an adult did not reveal what the children's development would be like (Utah Education Network, 2005).

The theory of ZPD therefore, challenged the intelligence quotient tests for their "static" means of assessment and their failure to show what learners are able to do when interacting with a more capable peer. In intelligent quotient tests, a learner works independently yet in real life people mostly seek help from each other. Vygotsky argued against such static testing and indicated that a learner's potential may be optimized if assistance, support, or instruction is given. In addition, Vygotsky (1978) argued that:

> … Learning which is oriented toward developmental levels that have already been reached (e.g. tests) is ineffective from the viewpoint of the child's overall development. It does not aim for a new stage of the developmental process but rather lags behind this process (p. 89).

According to Lantolf and Poehner (2004) Vygotsky advocates for 'dynamic assessment' that provides information which is not readily available through standardized testing, but is crucial for effective remediation (remediation is claimed to be the ultimate goal of the ANAs by the DBE ANAs purpose feedback). Dynamic assessment focuses on promoting development through mediation in the ZPD (Lantolf & Poehner, 2004). Lidz and Gindis (2003, p. 103) observe that traditional standardized assessment tracks the child's cognitive development to the point of 'failure' in their individual working, while dynamic assessment in the Vygotskian tradition leads the child to the point of their achieving success in shared activity. Lidz (1991) also argues that dynamic assessment integrates assessment and instruction into a unified activity which aims to promote a learner's development through appropriate forms of mediation that are sensitive to the individual's current ability (cited in Lantolf & Poehner, 2004, p. 50). For Lantolf and Poehner, Dynamic assessment is when a learner develops in the ZPD when assessment and promoting development take place simultaneously. Dynamic assessment focuses 'on modifying ability and on producing suggestions for interventions that appear successful in facilitating improved learner performance' (Lidz, 1991, cited in Lantolf and Poehner, 2004, p. 50). According to Lantolf and Poehner (2004, p. 53), in dynamic assessment, as called for in Vygotsky's ZPD, assessment and instruction are 'dialectically integrated' leading towards an emergent future which would mean maximum understanding.

In this study, although the task-based interviews with learners (to explore the difficulties they experience as they solve mathematical problems), were an assessment, they relied more on dynamic assessment than static assessment since they integrated instructions, prompts and assistance to learners so that they could 'move toward an emergent future' and not only dwelling on their failure, as advocated by Vygotsky. In static assessment, which is usually done for summative purposes, any kind of interaction or assistance during the assessment is not allowed. In fact, interacting and assisting learners in any way during the assessment is seen as cheating (Lidz, 1991). On the other hand, dynamic assessment maintains that teachers can only get important information about a learner's abilities through assisting them during the assessment. The main aim of dynamic assessment is to modify the performance of learners as they are assessed (Lantolf & Poehner, 2004). In this study, the task-based interviews (assessment) achieved the goal of modifying the performance of learners because all 26 learners were able to improve on their results in the written ANAs. By integrating instruction and assessment practices in one single systematic activity, I was able to offset the shortcomings of the 'static' assessment of the ANAs.

While the ANAs (the focus of this study) are a standardized 'static' assessment in the way they are administered, Vygotsky's perspective of learning remains relevant to the study even while it points to being cautious of reading the results of such assessments as indicators of the learners' 'abilities,' which may be seen differently in dynamic assessment contexts. Indeed the ANA interviews that I used, with mediatory prompts, enabled a more dynamic form of assessment of learner interaction with the language of the ANAs.

3.2.1 Mediation

In the ANAs, the isiXhosa speaking learners in this study had to read mathematical texts independently in English from Grade 3 and solve mathematical problems encoded in this language (and of course mathematical symbols). As a result of these challenges, it was important to interview the learners using the task-based questions in order to enable the learners to solve mathematical problems with mediation and see how far they could demonstrate their mathematical skills and also explore the difficulties they experienced as they solved mathematical problems.

Research (National Centre for Curriculum and Research Development, 2000; Adler, 1996, 1998, 2001; Setati, 2002) indicates that code-switching is a linguistic feature of multilingual classrooms where learners' HL is used to scaffold understanding of English mathematical text. In this study, it is assumed that the use of the learner's HL could be used in the task-based interviews as a way of mediating learning in answering the ANAs. In the next section I discuss mediation of learning.

Mediating learning and scaffolding

Mediated learning is the subtle social interaction between teacher and learner in the enrichment of the learner's learning experience (Presseisen & Kozulin, 1992). Lerman (2014) has this to say about mediation:

> Vygotsky argued that the response to any stimulus is always mediated or interpreted, it is explained, and its use is elaborated: by a parent, by a sibling, by a peer, by a text and, of course, by teachers. […] Thus mediation is Vygotsky's way of breaking the direction of the response to a stimulus. The response is mediated: stimulus → mediation → response (p. 18).

Drawing on this quote, for learning to take place effectively, a more knowledgeable other has to assist in the learning process by explaining, or exemplifying in order to make concepts understandable. Such mediation is imperative especially for learners struggling with learning L2, like the learners who participated in this study. Kozulin et al. (1995, cited in Turuk (2008, p. 251), assert that Vygotsky conceives the learning process not as a lonesome discovery of the environment by the child on his own, but as a process of the child's appropriation of the methods of action that exist in a given culture. Since Levykh (2008) notes that effective learning is never direct but always mediated, symbolic tools are essential in this process of appropriation. For Vygotsky, mediation represents the use of tools, psychological, material, and human, which are adopted to solve a problem or reach a goal (Vygotsky, 1978, cited in Lantolf, 2000). Among these tools, language is the most significant (Kao, 2010). The use of language to help learners move into and through their ZPD is of great significance to sociocultural theory (Turuk, 2008). William and Burden (2009, p. 40) note that "mediators can also be people who play an important role in enhancing a child's learning by selecting and shaping the learning experiences presented to them." Mediation is, thus, the instrument of cognitive change and learning (Donato & MacCormick, 1994). Poehner (2008) argues that being responsive to mediation is essential for understanding cognitive ability because it provides insight into the learner's future development.

Kao (2010) also argues that mediators do not only provide knowledge, but also provide learners with confidence, willingness to learn as well as helping them to become independent individuals. Therefore, the interaction and negotiation between learners, tasks, learning materials and mediators bring learners to a position of being active constructors of knowledge (Kao, 2010). In relation to this study, in the written ANAs, learners had to independently read mathematical text in English and solve mathematical problems encoded in this language (and of course mathematical symbols). The study investigates the difficulties learners encountered as they solved the ANAs mathematical problems and how learners performed when they solved these problems with mediation.

The issue of mediation is important to this study, as research question 1b addresses how learners demonstrate their reading, comprehension, transformation, process and encoding skills (as according to Newman) with mediation. Learners make errors when they solve mathematical problems and sometimes fail dismally in assessments where they have to write without assistance. However, in assessments where there is instruction and mediation, learners are sometimes able to demonstrate their mathematical skills and perform better than they would do without assistance. Thus the modified NEA diagnostic tool that I used in this study coheres well with this Vygotskian theory of learning, especially the concept of mediation. The assumption was that with linguistic mediation, learners can perform better in assessments especially as the mediation takes place within the ZPD. Vygotsky (1978) mentions the ZPD in connection with his work on both assessment and instruction. For Vygotsky (1987, p. 206), “what a child is able to do in collaboration today, he will be able to do independently tomorrow”. This means with assistance and collaborative effort, a child has the potential to learn what he does not know now. This confirms the assumption that I had when I decided to use the modified NEA approach. Learners had performed poorly in the 2013 mathematics ANAs and it was important for me to understand the difficulties they faced as they solved those mathematics problems. In the process of observing their experiences and difficulties in task-based interviews, mediation was used in order to help the learners move on to the next level of problem solving.

This present study also sought to analyse the complexity of mathematical test items written by South African Grade 4 learners. I drew on the key features of the Shaftel et al. (2006) study. These were useful for the analysis and comparison of these mathematics ANAs and ANA exemplar texts, through emphasis on the structure of language. The linguistic complexity checklist was also used to evaluate the linguistic complexity on an item by item basis as outlined by Shaftel et al. (2006). According to Vygotsky (1987), the greatest tool for mediation is language. Language enables people to carry on activities and “mediates the associated mental activities in the internal discourse of inner speech” (Wells, 1994, p. 46). Language is a human invention which is used as a means of achieving goals of social living (Wells, 1994). As such, if language becomes complicated for children or learners, it stops serving the purpose it is meant to. Hence using the Shaftel et al. (2006) linguistic complexity checklist helped to identify some language features that added complexity to language. This identification could help educators consider the language they use when they set assessments and encourage them to make the language accessible to learners. Vygotsky argues that a “child first seems to use language for superficial social interaction, but at some point, this language goes underground to become the structure of the child's thinking" (Nath, 2010, p. 7). This language can only become a structure of a child's thinking only if it is accessible to the child. When working in the ZPD, it is important to consider the language being used since the language of learner's influences the way they interpret and build understanding (Bell & Woo, 1998, cited in Nath, 2010).

3.3 Chapter summary

The chapter presented the theoretical framework that informs this study, that of Vygotsky's theory of development and learning. Key to this theory are his ideas about the prominence of language in mediating learning, the Zone of Proximal Development and the importance of language as a tool for learning. The theory supported all the research question posed in earlier chapters.

Vygotsky's theory of development and learning explained the importance of language in learning and explained the importance of collaborative learning and mediation. This theory of development and learning has been chosen because of its emphasis on language as a tool that enables learning. It furthermore gels with the use of the Shaftel et al.'s (2006) linguistic complexity checklist and the NEA tools in analysing the texts used by learners and the learners' experiences as they solved mathematical problems.

According to Vygotsky (1978), learning, including L2 acquisition, is a semiotic process where participation in socially mediated activities is essential. The sociocultural approach asserts that the quality of mathematics activities comes from the culture and society. As a result, knowledge is developed through the activities in which human beings interact with others using signs and tools of mediation which are known to that society and culture. Language is both a carrier and creator of knowledge and reality (Usher, 1996). These assumptions about knowledge and reality informed the methods and data gathering tools used in this study. The next chapter presents the research design and methodology used in this study.

CHAPTER 4: RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

The aim of this study was to investigate the nature of the linguistic complexity of the ANA test items and how learners experienced and responded to them. The study additionally explores the teachers' experiences of the linguistic challenges of the ANAs. In this chapter, I explain the research design and methods used in the study and conclude with a discussion of the steps taken to ensure that ethical and validity considerations were met. A recap of the research questions that steered the study in the direction it took is appropriate for understanding the methodological decisions made in this study:

1a. What is the nature of the linguistic challenge of the Department of Basic Education Grade 4 Mathematics ANAs?

1b. What difficulties do learners experience as they solve particular mathematics problems in the ANAs?

1c. Which of these difficulties can be attributed to linguistic factors?

2. What are the teachers' experiences of the linguistic challenges of the ANAs?

Although this study is predominantly empirical, it provides methodological insights. These insights are largely in respect of the use of some linguistic mediation tools in understanding the challenges of the Grade 4 South African mathematics ANAs. This assessment occurs at a critical language and mathematical transition stage (taking place in Grade 4 when learners move from the FP to the IF as discussed earlier). These insights and possible adaptations to methods of data gathering (such as adaptations to the NEA interview) may provide pathways for future research into linguistic issues related to assessments at this level of early transition from FP.

4.2 Research orientation

The methodological approaches used in this study drew on both qualitative and quantitative methods. The nature of the study necessitated the deployment of a mixed method approach to the understanding of the research problem.

4.3 Mixed methods

Denscombe (2010) defines mixed methods as using data collection methods that collect both qualitative and quantitative data. According to Denscombe (2010. p. 138) there are three crucial features of mixed method research:

- First, it uses both quantitative and qualitative methods in one study.
- Second, it uses triangulation (i.e. viewing something from more than one perspective).
- Third, it is problem driven since it focuses on different philosophical traditions in order to create practical value out of the research.

The quantitative dimension brings to the research numerical data usually in the form of frequencies and the qualitative dimension would add textual description of the phenomenon. In this study, elements of qualitative and quantitative research featured at different stages. Neuman (2000) differentiated between the qualitative and quantitative approaches thus:

> Quantitative research is more concerned about issues of design, measurement and sampling because its deductive approach emphasizes detailed planning prior to data collection and analysis. Quantitative research is more concerned about issues of the richness, texture and feeling of raw data because its inductive approach emphasises developing insights and generalizations of the data collected (p. 122).

In this study I used the mixed method design because it allowed me to use both the qualitative and quantitative approaches to shed light on the problem. In this respect I gathered both numerical and descriptive data.

In the first phase of the data collection, a comparison of the 2013 Grade 4 Mathematics ANA with the Grade 4 DBE 2013 ANA exemplar was made. This comparison involved content analysis and was qualitative in nature. I found qualitative research more useful in this case because it is more intensive and enabled me to probe into the nature of the problem (Corbetta, 2003). Secondly, an investigation into the linguistic challenge of each item in the 2013 Grade 4

Mathematics ANAs was carried out. This required quantification of linguistic aspects of each test item which enabled the use of the linguistic complexity index (LCI) for each test item. The second phase involved quantitative analysis of learner written responses and performance on ANAs across the three case study classes. A quantitative approach was more appropriate here as it could deal with a large amount of "hard data", which I gathered from 106 learners and mathematical and statistical tools could be used to analyse them (Hossain, 2013. p. 132).

The third phase of the research involved interviewing learners and drew on both quantitative and qualitative methods as it both quantified difficulties experienced by learners in the interviews and provided a thematic analysis which drew on learner responses. The fourth phase of interviewing of Grade 4 mathematics teachers gathered qualitative data. Mixed method research's flexibility to numerical and textual data suited the present study which dealt with complex word use frequencies and test scores (quantitative) as well as textual descriptions of teacher and learner experiences in interviews (qualitative).

According to Denzin (2010), a mixed method approach increases the probability that the data collected will be richer, useful, as well as meaningful in answering the research questions. Collins, Onwuegbuzie and Sutton (2006) point out that using mixed methods is advantageous because mixed methods improve the accuracy of data. It also produces a more complete picture by combining information from complementary data or sources. Biases intrinsic to single-method approaches are avoided, with some methods compensating for the weaknesses of other methods and the research drawing from the strengths of diverse methods. The validity of the data generated is, in that case, supported.

As Cresswell (2008) observes, in the mixed method approach, both methods provide a fuller understanding of the problem under examination. Indeed in this study the quantitative analyses in phase 1 and phase 2 inform the more qualitative analysis in phase 3 and phase 4.

4.4 Case study

A case study research approach was chosen for the present study. I investigated the case of the 2013 mathematical ANAs and used a multiple case study of three classes of Grade 4 learners to investigate learner experiences of the specific case of the 2013 mathematics ANAs. Yin (2009, p. 18) defines case study as an approach to qualitative research that "investigates a contemporary phenomenon in depth and within its real-life context". It is apparent from the definition that a case study focuses on a single object of analysis in order to understand its complexities. The case study method involves detailed, holistic investigation of a case under investigation (Denscombe, 2010). Multiple methods can be used in a case study in order to illuminate the problem being researched and these methods allow a lot more detail to be collected than by using other research designs (Denscombe, 2010).

Since case studies involve analysis of small data sets, such as one or two ANA tests and the experiences of only three classes of learners as in the case of this study, it may become problematic to generalize the findings. According to Yin (2009), it is possible however, to generalize the findings to similar samples if the case has been purposively selected.

In order to understand the linguistic challenges in the ANA items it was necessary to examine in detail the case of one mathematical ANA. Similarly, it was important to use a multiple case study of three classes of learners and the two teachers of these classes to gain a deeper understanding of their experiences of the ANAs. Both the classes and the teachers were studied in their schools using interviews and questionnaires based on the ANAs the learners had written. The case study method allowed me to use interviews and content analysis to gather data enabling rich description and detail about the complexity of mathematics language, and learner experiences of the assessments.

4.5 Research sites and participants

This study was situated within the South African Numeracy Chair (SANC) Project in which I was a full-time doctoral fellow. The two selected schools were part of the Numeracy Inquiry Community of Leader Educators (NICLE), a teacher development program run by the SANC project. In the NILCE program, there are 12 participating schools and 43 regularly attending teachers, including principals, deputy principals, as well as district officials (Graven, 2012). NICLE focuses on the critical transition of learners from Grade 3 to Grade 4. As a doctoral fellow, I have participated alongside NICLE teachers in this program since 2013. As I wanted to focus on Grade 4 mathematics ANAs, I chose to work with two teachers from two schools in the project I had developed a close relationship with the two teachers through my NICLE participation. The schools were also chosen because they were near to the university, for ease of access. The two schools served relatively less affluent sectors of the community in the Eastern Cape. Biko School is a Quintile 3 school. Learners attending this school do not pay school fees. Santa Anna School is a Quintile 4 which charges learners a small of R140, 00 per month, according to Anesipho, the teacher from the school. Thus the schools fall in the middle of this quintile range, with Quintile 1 representing the poorest schools and Quintile 5 the least poor schools (Kanjee & Chudgar, 2009).

One teacher taught two classes at Biko Primary and the other one taught one class at Santa Anna (the names of the schools are pseudonyms). Additionally, I wanted to work with schools in which English was the Grade 4 LoLT but in which the majority of learners were not English L1 speakers.

The two teachers and their three classes of learners were an opportunity sample. From the participating Grade 4 NICLE teachers, I used convenience sampling which, according to Plano, Clarke and Creswell (2008), involves drawing samples that are both easily accessible and willing to participate. Therefore, for this particular study, the Grade 4 teachers in the two schools invited to participate came from the NICLE schools falling within the Grahamstown district. With the teachers', parents', learners' and schools' permission, I accessed the 2013 Grade 4 ANA scripts of learners in the two Grade 4 teachers' classes so that I could assess the learners' understanding of the mathematics ANAs and identify a sample of learners from these classes to interview. All the Grade 4 learners in each class who were willing to participate, and whose parents had given informed consent, constituted the sample. These sampling decisions yielded a study sample of three Grade 4 classes of children aged nine to eleven year olds, one class from Santa Anna (40 learners) and two classes from Biko (32 and 34 learners in the two classes). I also interviewed the two teachers on their experiences of the linguistic challenges of the ANAs.

4.6 Data collection phases and connection to research questions

The research questions determined the collection and analysis of the data. Data was collected and analysed in four phases. The first phase sought to determine the linguistic complexity of the 2013 Grade 4 mathematics ANAs. The second phase sought to analyse the Grade 4 learner written responses to the ANA items (written under the ANA invigilation conditions with no linguistic mediation). The third phase, through learner interviews, investigated the difficulties experienced by learners as they solved the 2013 ANAs in order to investigate possible language-related challenges. Phase 4 sought to investigate the participating Grade 4 teachers' experiences of the linguistic challenges of the ANAs. The first and second phases were largely quantitative while the third and fourth phases were predominantly qualitative. Table 6 summarises the data gathering and analysis procedure.

Table 6: Data gathering and analysis procedures

Phase	Research question	Data generation and instruments	Analytical tool	Data source	Chapter
1	1a. What is the nature of the linguistic challenge of the Department of Basic Education (DBE) Grade 4 Mathematics ANAs?	Document/content analysis	Linguistic complexity checklist, LCI	ANA mathematics Grade 4 2013 (DBE, 2013) Exemplar DBE guidelines to administration of ANAs	Chapter 5
2	1b. What difficulties do learners experience as they solve the mathematics problems?	106 learner scripts (i.e. written responses to 2013 ANAs)	Performance analysis across items	Learner scripts (n=106)	Chapter 6
3	1b. What difficulties do learners experience as they solve the mathematics problems? 1c.Which of these difficulties	26 learner interviews (Adapted Newman's Error Analysis interview)	Newman's error analysis	Learner scripts, three Grade 4 classes of purposively selected learner interviews	Chapter 7

	can be attributed to linguistic factors?				
4	2.What are the teachers' experiences of the linguistic challenges of the Grade 4 mathematics ANA tests?	Semi-structured questionnaires for teachers' experiences[2]	Thematic analysis of teachers' experiences	Two teachers	Chapter 8

4.7 Data collection instruments and procedure

The instruments and data analysis that were used for the present study involved content analysis and LCI analysis of ANA items and learner written scripts, learner interviews (Newman Error Analysis) and teacher questionnaires (thematic analysis). As indicated earlier, data were collected in four phases. The instruments and procedures are discussed in the following sections in relation to the phases of the data collection process they were employed.

4.7.1 Phase 1: ANA Content and LCI Analysis

This phase addressed the first research question 1a: What is the nature of the linguistic challenge of the Department of Basic Education (DBE) Grade 4 Mathematics ANAs? Data collection in this phase was in two parts: Part 1-Comparing Grade 4 2013 ANAs to the Grade 4 2013 ANA exemplars and Part 2- Analysing the language of the 2013 mathematics ANAs.

4 7.1.1 Part 1: Comparison of the 2013 ANAs and 2013 exemplar papers

Exemplars of the ANA papers were provided to schools by the DBE a month prior to the writing of the ANAs in September 2013. I therefore, used content analysis (and basic language and format analysis) to analyse the 2013 Grade 4 ANA test comparing them with the DBE 2013 exemplars. The reason being to establish the extent to which the testing format, and language used in the ANAs corresponded to that of the exemplars the learners were exposed to, and that they used to prepare for the ANAs.

[2] Interviews were initially planned but teachers requested replacing these with questionnaires due to time constraints

This would give me a sense of which terms and phrases learners may have encountered before they wrote the ANAs and which would potentially be new. Analysis of exemplars was important because they were used by both teachers in the study to prepare learners for the assessments. It was necessary to compare the two (2013 ANAs and 2013 ANA exemplar) before analysing the language of the 2013 ANAs. A comparison was made to see whether the number of questions, length of questions, questioning style/format, nature of language demand, mathematical vocabulary used and content area assessed in the two documents corresponded. Three categories of questions were used to aid the comparison of items in the two documents. These were:

- Questions with minimal instruction or no language e.g. complete or calculate
- Questions with simple instruction (where simple language has been used) e.g. Complete the following table
- Questions with complex instruction (where several mathematical words have been used) e.g. draw the reflection of the arrow on the vertical dotted line.

The similarities and differences in the questioning format were noted, as well as how the differences could influence the familiarity of the learners with the assessment.
Further, in part 2 of the first phase, the ANAs were analysed in detail to examine the linguistic complexity in each of the test items. The following section discusses this analysis.

4.7.1.2 Part 2: Analysis of the language of the 2013 ANAs

The 2013 mathematics ANA items were analysed looking at the grammatical patterns that caused linguistic complexities in the texts. Based on the linguistic complexity checklist as outlined by Shaftel et al. (2006), individual items were evaluated according to the different features outlined. In each item, the number instances of use of linguistic features (i.e. number of words, words with 7 or more letters, relative pronouns, prepositions, ambiguous words, complex verbs, prepositional phrases, infinitive verb phrases, pronouns, passive voice, complex verbs, complex sentences, conditional constructions, comparative constructions and mathematics vocabulary) were counted. This was done at a basic level, word level, sentence level and paragraph level as discussed in the literature review. The total number of these language features for each item was divided by the number of sentences, to get the

LCI. The LCI was calculated as: LCI = (Number of words + Sum B + Sum C + Sum D) ÷ Number of sentences. The letters A, B, C and D are described in the table 7 below:

Table 7: Linguistic complexity checklist

LINGUISTIC COMPLEXITY CHECKLIST	
(A) BASIC LEVEL	Number of sentences
	Number of words
(B)	Number of different words with 7 letters or more
	Number of pronouns
	Examples of homophones, homonyms and slang passive words
	Number of ambiguous words
(C) SENTENCE LEVEL	Number of prepositional phrases
	Number of infinitives
	Number of complex verbs
	Number of complex sentences
	Number of conditional constructions
	Number of comparative constructions
(D) PARAGRAPH LEVEL	Number of holidays
	Number of cultural events

It was then possible to tell which items were more challenging linguistically, as well as which features caused complexity in the items.

I chose to use the LCI analysis because it allowed me to determine which linguistic features caused complexity. This may have been difficult without the quantification enabled by LCI. Content analysis was also done on the Grade 4 learners' ANA response scripts in order to discover how they performed across items in the 2013 mathematics ANAs. This was done in Phase 2 discussed below.

4.7.2 Phase 2: Learners' answer scripts analysis using descriptive statistics

The second phase of the study analysed the mathematics ANA answer scripts that were written by learners in the three case study classes in 2013. All the 106 Grade 4 learners in the two schools were tested in the ANA tests in September 2013. It was important to understand how the three classes performed and to note similarities and differences in patterns of performance across questions in all the three classes. Since the aim of this study was to investigate the nature of the difficulties learners experienced in responding to the ANAs, analysing the learner scripts helped the researcher to identify the questions that posed problems to many learners and later to interview learners to see where they experienced difficulties.

According to the ANA policy, the answer scripts were marked by the learners' teachers and these marked scripts were the scripts that I analysed. Firstly, the overall performance of the learners for the three classes was analysed, taking note of:

- overall mean average, mode and range of performance of the learners in the test,
- the highest scores in each class,
- the lowest scores in each class, and
- how many learners achieved the basic requirement of 50%?

Secondly, learners' responses across each of the test items were analysed in terms of frequencies of responses in the following four categories per class:

- Number of learners who correctly answered each item.
- Number of learners who partially answered each item (where a learner showed an understanding of the given instruction but failed to use the correct operation, or the learner got the correct operation but later failed to work out the problem).
- Number of learners who wrongly answered each item (seemingly not understanding or misinterpreting what was asked).
- Number of learners who did not attempt to answer each item.

Several items were identified where learners across the three classes performed very poorly. It was important to understand the reasons for this poor performance on the items identified, hence the following criteria were used to extract a sample of questions to use in the interviews in order to explore a possible explanation for the results:

- Items not answered by more than 50% of learners.
- Items wrongly answered (and/or misinterpreted) by more than 50% of the learners.
- Items answered correctly by less than 10% per class.

The third category, items answered correctly by less than 10% per class, was included because it was important to know why so few learners managed to answer these questions correctly.

Although the analysis of these test items pointed to items that were particularly difficult, it was not possible to tell *what* difficulties learners experienced when they responded to these questions based on their written answer scripts. For this reason, learner interviews were required to investigate the learners' thinking and the difficulties they experienced when they responded to the questions the way they did. Therefore, the findings from the analysis of the learner scripts established the groundwork for the learner interviews using NEA (discussed in Chapter 2) protocols (phase 2) to gather evidence of the comprehension difficulties the 26 sampled participating Grade 4 learners encountered.

4.7.3 Phase 3: Learner interviews

Phase 3 comprised learner interviews conducted to answer the following research questions:

1b. What difficulties do learners experience as they solve the mathematics problems and what kind of errors do they make?

1c. What kinds of difficulties can be attributed to linguistic factors?

After the analysis of the learner scripts, a purposive sample of learners was selected from the three classes. From each of the three classes, nine learners were chosen, three top performers, three middle performers and three poor performers in the test[3]. These learners were then interviewed using the Newman's Error Analysis interview. The Newman questions were modified in order to allow exploratory questions to be asked of learners in order to gather more information as to why they experienced difficulties. Probing was also done to prompt learners through the problem solving stages in order to enable access to the skills required in later stages (post reading and comprehension stages) of problem solving.

All of the learners were learning mathematics through the medium of English at school in Grade 4, though English was not their home language. While interview questions in relation to learners' interpretation and working with ANA questions were initially asked ('read') in English (the language of the ANA and instruction at Grade 4 level), many learners required translation and that translation provided learners with the opportunity to comprehend and engage with the question in isiXhosa. Since I knew only some basic conversational isiXhosa, an interpreter, who was experienced in isiXhosa within the context of mathematics lessons, assisted me with interviews. The learners were encouraged to use isiXhosa to answer the interview questions when necessary.

During the interviews, learners were taken through a process of reading, explaining the questions and solving the problems, seeing where the difficulty lay. I was cautious not to fix errors during questioning. Where a learner read a word incorrectly or failed to read a word (this was noted as a reading difficulty), the word was read for them and they were asked to read the whole sentence before saying what the question required them to do. Where they failed to understand the meaning of a word or the meaning of the question (this was noted as a comprehension difficulty), the meaning of the word or question was explained or translated. Where a learner understood the question but failed to identify the mathematical operation or sequence of operations to successfully pursue the problem, (this was noted as a transformation difficulty), the learner was then probed to find the operation, and if unsuccessful, the operation was given to them in order to assess their processing skills. Where they were able to choose the correct operation but failed to carry out the mathematical calculation correctly, I noted this as

[3] One learner in class B was unable to do the interview resulting in a total of 26 learners being interviewed

a process skill difficulty. Sometimes a learner was able to carry out a correct procedure in solving a problem but failed to provide an acceptable written form of the answer. That was noted as an encoding problem. These codes correspond with the NEA categories of errors.

Learners could experience several difficulties in one question. All the difficulties encountered by learners during the interviews were recorded in order to determine which skills posed more problems to learners, and determine whether the difficulties were due to a lack of language proficiency or due to lack of mathematical skills or both. Difficulties in reading and comprehension of words and questions implied challenges in understanding the language. Difficulties in other skills such as transformation, process skills and encoding implied mathematical challenges. The use of this modified NEA interview helped me to explore learners' difficulties and their possible causes (e.g. lack of proficiency in English language or lack of content-knowledge of mathematics).
Learner responses were later transcribed verbatim and then translated (again by an experienced translator of isiXhosa to English with a mathematics teaching context). Data obtained were grouped and discussed under four categories of questions: (1) word problems (2) data representation questions (3) mathematical representation questions and (4) direct skills assessment. The interviews provided access to learners' experiences in accessing and responding to the ANA test items.

The rationale for using the NEA was that it has been successfully used by many researchers across many contexts, (for example in Papua New Guinea by Clements, 1982 & Clarkson, 1983, 1991; in the Philippines by Jimenez, 1992; in Thailand by Singhatat, 1991, among others) to explore the linguistic challenges that learners face who are not English First Language speakers.

4.7.4 Phase 4: Teacher questionnaires

Initially, I intended to interview the two Grade 4 teachers whose classes participated in the study using a semi-structured interview guide which allowed for follow-up questions. However, the interviews could not take place at the various appointed times because of unexpected commitments of the teachers in the schools. The teachers therefore requested that the interviews be turned into questionnaires. While questionnaires were used because the teachers had requested, I was aware of their limitations. Verbal responses would have been better than written ones especially considering that the teachers speak English as their second or third language.

The interviews were meant to explore the teachers' experiences they had with the language used in the Grade 4 mathematics ANA tests. At the request of the teachers I therefore, instead of interviews, designed a questionnaire which asked the same questions that were in the intended interviews.

Denscombe (2010) argues that it is best to use questionnaires when what is required tends to be fairly direct information which is relatively brief and uncontroversial. I chose to use questionnaires out of necessity because the information I needed was straightforward. I needed teachers to describe their experience of the linguistic demands of the Grade 4 mathematics ANAs. Open questions were used which left the respondent open to decide on the wording and length of the answer, and what to discuss in the answer. According to Denscombe (2010), the advantages of using open questions include:

- the respondent gives information that is rich and complex about the views they hold on the issue under discussion, and
- the respondents are given space and allowed to express their opinions in their own words.

The questionnaire that was given to the teachers can be found in Appendix C. The responses were captured and data obtained was analysed and discussed under the themes represented by the questionnaire items. The questionnaire enabled access to the teachers' perspective on language issues of the ANAs. The relatively small sample of only two teachers across only two schools means that what is illuminated here could never be considered representative of the general population of teachers in South Africa but rather, they describe aspects of ANA administration that appear to require further consideration and research. There was however, some concurrence with Graven and Venkat's (2014) research findings of the experiences of the ANAs. While this data is limited both by the number of teachers and the questionnaire format, teachers' experiences was not the central question of the study. Rather the teachers' experiences provided supplementary information for considering learner data and implications of the study.

4.8 Ethics

According to Oates, Kwiatkowski and Coulthard (2010), research ethics refer to the moral principles guiding research from its inception through to completion and publication of results. In this research, as with all research, ethical issues formed a very important part of the process. As a researcher, I had an obligation to regard the rights of participants which included consent, anonymity and confidentiality, dissemination of the results, the right to withdraw from the study and ethical issues regarding instruments used in the research. It was also very important to establish a good relationship between the researcher and the participants, a relationship built on trust. This relationship was partly enabled by my co-participation with teachers in the NICLE prior to and during the study. Burns and Grove (2003) contend that participants in research must be respected as autonomous beings who should make their own sound decisions. The ethical measures that were taken are discussed below.

4.8.1 Informed consent

The issue of informed consent is important in research and cannot be ignored. Denscombe (2010) contends that before carrying out research, a researcher obtains the consent of the participants and the institutions involved in the research. My study, being part of South African Numeracy Chair research project benefitted from the previous granting of permission by the Eastern Cape Department of Education. Additionally, I obtained ethical clearance from Rhodes University for my study and I secured district and school permissions for the project. Kent (1996, p. 19) argues that in terms of informed consent, aspects that need to be considered are:

- giving information that is relevant to the subjects' decision about whether or not to participate,
- ensuring the participants understand that information,
- ensuring that participation is voluntary, and
- acquiring parental consent when working with children.

In my research, I obtained permission from the learners, parents and teachers and the principals to participate in the study. I was transparent about the nature of the study to the participants and indicated the nature and extent of their involvement. After being well-informed about what the involvement entailed, every participant willingly consented to participate.

4.8.2 Anonymity and confidentiality

Anonymity and confidentiality are guaranteed by ensuring that data obtained are used in such a way that no one other than the researcher, supervisor and participants knows the source. In this study, the anonymity of the schools, teachers and learners was respected, and confidentiality guaranteed as learners and teachers were given pseudonyms. Also the names of the schools have been replaced with School A and School B. Pseudonyms have been used in the writing of this thesis and will also be used in the publication of the findings in any research journals and in conference proceedings.

4.8.3 The right to withdraw from the study

All the participants were clearly informed about the reasons for the study and the benefits that might derive from the research and assured that their participation was on a voluntary basis. They were informed that they had the right to refuse to take part or to withdraw from taking part at any time or part of research without prejudice to the participant even if they had signed a consent form (Denscombe, 2010).

4.8.4 Dissemination of results

In this research, the teachers were informed that the results would be shared with them, a promise that has already been fulfilled. Additionally, recommendations emanating from this have been shared with them and other teachers in the NICLE through a workshop. I was invited to do a presentation on language implications of my research. Furthermore, respondent validity was ensured through asking teachers to check whether my reference to their responses in the questionnaires were accurate.

4.8.5 Ethical issues regarding interviews

The research used learner interviews as one of the instruments for data collection and ethical issues regarding this instrument had to be considered as well. Cohen, Manion, and Morrison, (2000) warn that there is a tendency that the interviews become biased because of the characteristics of both the interviewer and the respondent. Tuckman (1972, cited in Cohen et al., 2000) identifies potential pitfalls in the use of the interviews thus:

> … The interviewer should brief the respondent as to the nature or purpose of the interview (being as candid as possible without biasing responses) and attempt to make the respondent feel at ease. He should explain the manner in which he will be recording responses, and if he plans to record he should get the respondent's assent. At all times the interviewer must remember that he is a data collection instrument and try not to let his biases, opinions, or curiosity affect his behaviour … (p. 279).

In the case of my study, when I interviewed learners, I indicated to the learners that the task-based interview was meant to investigate the difficulties that they experience as they solve mathematical problems. I then asked them to allow me to audio record the interviews so that I would use this for my analysis of the interviews. All the learners I interviewed agreed to be audio recorded. Although some of them seemed initially apprehensive in these task-based interviews, (perhaps thinking that they were being tested, as interviews were related to the ANAs), I assured them that no marks were given for the tasks and they could respond freely without anxiety. I recorded the interviews and later transcribed them verbatim.

In the next section I discuss how the validity and reliability issues in this research were managed.

4.9 Authenticity of the research

As discussed earlier in this chapter, this research involved mixed methods, whereby the researcher combined both qualitative and quantitative approaches in one study. Hossain (2012) states that "mixed methods strive for combining each other's advantages and thus replacing the weakness of one method with the help of the strength of the other" (p. 138).

LeCompte and Preissle (cited in Cohen et al., 2007) argue that the rules of reliability for quantitative research may be simply unfeasible for qualitative research but also argue that qualitative research allows the use of some tools of quantitative research. As a result, many researchers (Cohen et al., 2000; Denscombe, 2010; Onwuegbuzie & Leech, 2006) contend that in qualitative research it is problematic to judge and verify the research according to the criteria of validity, reliability, generalisability and objectivity. Denscombe (2010, p. 298) posits that firstly, "it is not feasible to check the quality of research and its findings by replicating the research in the same way that scientists might repeat an experiment". Secondly, Denscombe (2010) contends that:

> The researcher tends to be intimately involved in the collection and analysis of qualitative data, so closely involved that the prospects of some other researcher being able to produce identical data and arrive at identical conclusions by other researchers are equally slim (p. 298).

Because of the above reasons, some researchers proposed doing away with such ways of evaluating the quality of research and use some approaches that are more pragmatic (Denscombe, 2010). In this respect, a focus on trustworthiness replaces reliability.

Four criteria are used to measure trustworthiness. The research demonstrates trustworthiness when the experiences of the participants are accurately represented by data: credibility, dependability, transferability and confirmability (Lincoln & Guba, 1985). In qualitative research, credibility is used instead of validity, confirmability instead of objectivity, transferability instead of generalizability and dependability instead of reliability (Denscombe, 2010). Next I discuss the four criteria that are used to measure trustworthiness in relation to their use in the present study.

4.9.1 Credibility

Denscombe (2010, p. 299), drawing from Lincoln and Guba's (1985) work, describes credibility as "the extent to which qualitative researchers can demonstrate that their data are accurate and appropriate". Lincoln and Guba (1985) argue that ensuring credibility is one of most important factors in establishing trustworthiness. Some activities that increasing the credibility of a study include: ensuring correct description of participants (Holloway, 2005); "the development of an early familiarity with the culture of participating organizations" before the researcher collects data for the first time (Shenton, 2004, p. 64); triangulation (Denscombe, 2010) and peer and supervisor consultations (Lincoln & Guba 1985). In my study I employed these strategies in order to increase the credibility of my findings as expanded on below:

4.9.1.1 Ensuring accurate description of participants

To ensure credibility in my research I made sure that the participants were accurately described. The schools, teachers and learners who were involved in the research were described in terms of several relevant aspects although pseudonyms were used instead of their real names for the sake of confidentiality.

4.9.1.2 Triangulation

I also employed multiple research methods, i.e. teacher interviews (questionnaires), learner task-based interviews and document analysis to study the same phenomena of the linguistic complexity of the 2013 ANAs and the difficulties learners experience as they solve mathematical problems. Lincoln and Guba (1985) note that this triangulation increases the chances of credibility in research.

4.9.1.3 Peer and supervisor consultations

Throughout this study, I consulted with colleagues. We discussed my study from the research proposal, theoretical framework, methodology, data collection, findings and analysis. This assisted in terms of constructive criticism. In addition to the colleagues' contribution, my supervisor reexamined the task-based interviews and made sure that the coding I used in the analysis was correct.

4.9.1.4 The development of an early familiarity with the culture of participating people

Lincoln and Guba (1985) recommend prolonged engagement between the researcher and the participants for the researcher to gain an adequate understanding of an organization and to establish a relationship of trust between the parties. Before engaging in data collection, I established a good relationship with the teachers and principals of the schools that were involved in my study. I attended workshops together with the participants and got to know them prior to the study. Therefore, when I started collecting data in their schools they already understood what my study involved and we had established a level of trust in each other. Next, I discuss the strategy of confirmability.

4.9.2 Confirmability

Lincoln and Guba (1985) as well as Streubert Speziale and Carpenter (2003) posit that a study possesses confirmability if it demonstrates credibility and fittingness. Therefore, confirmability is a neutral standard to measure the trustworthiness of qualitative research. According to Pandey and Patnaik (2014), the researcher must take some steps to ensure that the findings are the result of the true experiences and ideas of the participants rather than what the researcher wants to find out. In this case the findings of the research are as free from bias as possible. An audit trail may be used which allows an observer to trace the course of the research step-by-step through the decisions made and procedures described (Shenton, 2004).

According to Holloway and Wheeler (1996, p. 196) the following auditing measures can be used for analyzing the information in a study:

- tape recordings and field notes,
- findings of the study through analysed data,
- how the important themes, codes and categories were reconstructed,
- the research process, designs and procedure used,
- first intentions of the study, i.e. the research proposal, and
- the development of the data collection instruments, for instance open-ended questions and early interviews.

In my research, I used audio recordings to record learner interviews and later transcribed them. As I proceeded with my research I constantly referred to my research proposal to remain true to the procedures. In addition, I planned the four phases for my data collection in an order that could inform each subsequent phase. The questionnaire that I designed included open-ended questions to allow the teachers a forum to give their opinions. The themes, codes and categories for my questionnaire data were reconstructed to allow a deep analysis of the data. Respondent checks were used for reporting of teacher data as described earlier. In the next section I discuss the issue of transferability.

4.9.3 Transferability

The issue of generalizability is not feasible in qualitative research. Denscombe (2010) argues that because qualitative research is based on small-scale cases, it becomes tricky to take the findings from those cases to represent other cases. In this respect he asks "How can you generalize on the basis of such a small number?" (Denscombe, 2010, p. 300). An alternative notion has however, been suggested by Lincoln and Guba (1985, p. 36) and this is 'transferability'. They argue that "some degree of transfer is possible if enough 'thick description' is available about both the sending and the receiving contexts to make a reasoned judgement possible". Bassey (1981) proposes that, if other researchers believe that their situations are similar to that described in the study, they may relate the findings to their own positions. Therefore, it is important to give a clear description of what the phenomenon is about so that other people may judge if the findings are applicable to their situations and enable them to compare the cases of the phenomenon described in the research report with those emerging in their situations (Lincoln & Guba, cited in Shenton, 2004). For appropriate transfer to take place, the following issues should be clearly described at the onset:

- the number of organizations taking part in the study and where they are based,
- any restrictions in the type of people who contributed data,
- the number of participants involved in the fieldwork,
- the data collection methods that were employed,
- the number and length of the data collection sessions, and
- the time period over which the data was collected (Pitts, cited in Shenton, 2004, p. 70).

The schools, learners and teachers involved in this study are clearly described. The phases taken to collect the data and the methods are also clearly defined. The teachers I selected to participate had the knowledge and capability of implementing the ANAs and had experience in teaching Grade 4 mathematics. These descriptions possibly resonate with some other contexts and assist in the process of transfer of this study's findings to those related contexts. It is important to note that even if the findings of this study fail to apply to other similar cases, they could be valuable to other educators and those who set assessments. The complexities inherent in the mathematical language and particularly the ANA instruments could enable teachers to help their learners develop the mathematical language requisite for success in these assessments. Next I discuss the issue of dependability.

4.9.4 Dependability

Holloway (2005) describes dependability as consistency of findings. If this criterion is to be met, a study repeated in a similar context with the same participants, using the same methods, should yield findings that are consistent (Shenton, 2004). Lincoln and Guba (1985) argue that there is a close link between credibility and dependability, and in practice, a demonstration of credibility ensures dependability. The use of methods like the individuals interview achieved this. According to Shenton (2004) if the issue of dependability is to be addressed directly, the researcher should report in detail the research processes to make it easier for a different researcher to repeat the same research process. This in-depth thesis hopes to allow readers to examine the extent to which proper research procedures have been observed. According to Shenton (2004), in order to allow readers of the research report to have a thorough understanding of the methodology employed, the text should include sections devoted to:

- the research design and its implementation, describing what was planned and executed on a strategic level;
- the operational detail of data gathering, addressing the minutiae of what was done in the field; and
- reflective appraisal of the project, evaluating the effectiveness of the process of inquiry undertaken (Shenton, 2004, p. 72).

These criteria are undoubtedly met in this research where the design, how the methods were implemented and how the data was gathered are described in detail. This would allow readers to understand how the research procedures took place.

4.10 Chapter summary

This chapter presented the research methodology employed in this study namely the 2013 mathematics ANA questions; learner ANA scripts, learner Newman's Error analysis interviews and teacher questionnaires. The study used a mixed methods approach, using both qualitative and quantitative methods of data collection and analysis.

The research was done in four phases which are discussed in this chapter. The data gathering tools and methods are also described.

Ethical issues are important and as a researcher, I regarded the rights of participants which included consent, anonymity and confidentiality, dissemination of the results, the right to withdraw from the research if they so wished.

The issues of trustworthiness were discussed. Four criteria are used to measure trustworthiness. The research demonstrated trustworthiness when the experiences of the participants were accurately represented by data: credibility, dependability, transferability and confirmability.

The next chapter, Chapter 5 discusses the analysis of the ANA question papers and exemplars.

CHAPTER 5: ANALYSIS OF THE 2013 MATHEMATICS ANA QUESTION PAPERS AND EXEMPLAR (PHASE 1)

5.1 Introduction

This study sought to understand the linguistic challenges presented by the Grade 4 mathematics ANAs and how teachers experience these challenges. The Grade 4 learners and their two teachers at two Grahamstown schools, Biko Primary and Santa Anna primary (pseudonyms), participated in the study. There were three classes of Grade 4 learners in these two schools and these were my three case study classes. The first class (class A) at Santa Anna primary school had fourth grade isiXhosa speaking learners learning in their additional language (English) from their first grade of their schooling. The second and third classes (class B and C) at Biko primary school had Grade 4 isiXhosa speaking learners who learnt in their mother tongue from Grades 1-3 and then transitioned to learning in English from the fourth grade. The major distinguishing features of the two schools, and of class A in relation to classes B and C was, therefore, in the extent of learners' exposure to the English language rather than to mathematics. A second distinguishing feature was that while both schools are located in the township, school A is a low fee paying school while school B is a no-fee school. The representation of the differential exposure to the English language in the three classes was not meant for comparative analysis but rather to enable a rich analysis and insight from different groups of learners within the Eastern Cape context.

In the first part of the chapter, I focus on the analysis of data related to my first research question namely:

> 1a. What is the nature of the linguistic challenge of the 2013 Department of Basic Education Grade 4 Mathematics ANAs?

The data gathering and analysis for research question 1 occurred in two parts. In part 1, I analysed the 2013 Grade 4 ANA assessment, comparing it to the 2013 ANA exemplar provided to schools for that year. In part 2, I analysed learners' responses to the ANA items.

As discussed in the introduction, in South Africa Grade 4 is a critical stage where many Eastern Cape learners experience four significant transitions from the FP and underperformance is high in this transitional grade. That this underperformance of learners was confirmed by the ANAs motivated the investigation of the extent to which the language in which the tests are administered gives a fair chance of success to English L2 learners, hence the focus of the present study on the readability and understandability of the mathematics ANAs, particularly at a linguistic level. The need to examine the language of mathematical assessments is greater than other learning areas because mathematical tests also measure language skills (AERA, APA, & NCME, 1999) and added to that, mathematics has its own language with its own register. Thus learners have to be proficient in the language of assessment to record success in the assessment of mathematical competences.

In the next section, I discuss and analyse the data across each of the parts noted above.

5.2 Part 1: Analysis of the 2013 ANA and 2013 ANA exemplar papers

This study was a case study where the case was the 2013 Grade 4 mathematics ANA test items studied in relation to the learners' performance in the test items. Additionally, the DBE 2013 mathematics ANA exemplar (provided to all schools a month before the ANAs were written) was used to compare its linguistic similarity with that of the 2013 mathematics ANAs. It was important to establish the extent to which the testing format and language used in the ANAs corresponded to that of the exemplars the learners were exposed to during preparation for the ANAs. The 2013 exemplars were given to school A and B by the district in preparation for the ANAs. According to the teachers, classes A, B and C all spent two weeks using exemplars to prepare for the ANAs. The intention of these exemplars is to prepare learners for ANAs that are administered in September/October. The teachers are expected to make reference (in terms of the format and style of questioning) to these exemplars when they develop their own Assessment Tasks (DBE, 2012).

The 2013 mathematics ANA consisted of 11 pages and 19 assessment items. Some items consisted of two parts, others three parts (i.e. had sub questions). The mathematics ANA began with some instructions to the learners on page 1, followed by a practice exercise, and then some points learners needed to take note of. The 2013 ANA exemplar, on the other hand, consisted of 12 pages, with guidelines for the use of the exemplar on the first page. In terms of the length, the ANA test and the exemplar were thus almost the same length with the exemplar being a page longer. As for the actual number of assessment items, the exemplar had 30 items, 11 items more than the 19 in the ANA. This on its own points to a key difference between the two where there was a greater concentration of items per page in the exemplar than in the test with an item page ratio of 19:11 and 30:12 for the ANA and exemplar respectively. From comparative analysis it became apparent that the exemplar had less language and fewer diagrams to allow for more items per page than the actual ANA test. The linguistic similarity of these would only be apparent from an analysis of the items in the two documents. This is the focus in the following section.

Almost all (18 out of 19) of the items in the 2013 mathematics ANAs were word problems. Verschaffel, Greer and De Corte (2000) define word problems as any mathematical exercise where significant background information on the problem is presented as text rather than in mathematical notation. The word problems also may vary in the amount of language used in them. I used three categories of instruction to analyse the language demands of items. These were:

- Minimal instruction or no language e.g. complete or calculate.
- Simple instruction (where simple language has been used. For example, complete the following table).
- Complex instruction (where several mathematical words have been used. For example, draw the reflection of the arrow on the vertical dotted line).

In addition to these categories, I compared the mathematical vocabulary used in the corresponding questions.

The format of the exemplar resembled the 2013 ANA format and mathematical content assessed. Table 8 summarises the correspondence across the items in terms of similarities in question types and content in the 2013 ANA and exemplar.

Table 8: Comparison of 2013 ANA and 2013 exemplar

2013 ANA			2013 Exemplar		
Item	**Nature of language demand and mathematical vocabulary**	**Mathematical content area assessed**	**Item**	**Nature of language demand and mathematical vocabulary**	**Mathematical content assessed**
1	-simple instruction -Value, digit, rounded off, ratio, multiple, pattern, factor,	Learning Outcome (L.O) -number value -whole numbers (rounding off) -ratio -multiples -patterns -factors	1	-simple instruction -value, digit, pattern, number sequence, rounded off, factor, multiple, ratio	L.O -number value -patterns - whole numbers (rounding off) -factors -multiples ratio
2	-minimal instruction(one word) -no mathematical vocabulary	L.O -completing a number sentence (whole numbers)	4	-complex instruction (expanded notation) -expanded notation	L.O -completing a number sentence in expanded notation
3	-simple instruction -patterns	-completing numeric and geometric patterns	18	-simple instruction -patterns	-completing numeric and geometric patterns
4	-simple instruction -patterns	Number patterns(whole numbers and fractions)	No similar item	_________	________
5	-level 2 word problem -no mathematical vocabulary	-financial mathematics (including buying, selling)	9	-simple instruction -change	-financial mathematics (calculate making or giving change)
6	-simple instruction -calculate	-four operations + - × ÷	7	-minimal (one word) instruction -calculate	-four operations + - × ÷
7	-complex worded instruction -number sentence, difference	-number sentences	No similar item	_____	______
8	-complex worded instruction -hands, clock face, quarter	-time (representing time)	25	-complex worded instruction -clock face	-time (naming the time shown)
9	-simple instruction -no mathematical vocabulary	-time	No similar item	______	______
10	-complex worded instruction -grid, position	-viewing of objects (locate position on a grid)	No similar item	_____	_______
11	-complex worded instruction -reflection, vertical, dotted line	Transformations (drawing lines of symmetry)	22	-complex worded instruction -sketch, symmetrical, 2-D shape	-transformations (drawing lines of symmetry)

12	-minimal worded instruction -convert	-length (conversion between cm and m) -time (conversion between minutes and hours)	26	-minimal worded instruction -no mathematical vocabulary	-length (conversion between km and m) -time (conversion between year, weeks and hours)
13	-simple instruction -flow diagram, input, output, rule	-number sentences (relationship or rule presented in a flow diagram)	No similar item	_________	_________
14	-level 3 word problem -no mathematical vocabulary	-capacity (solving life problem involving capacity)	No similar item	_________	__________
15	-simple instruction -fraction wall, fraction strip, calculate, colour in	-fractions (comparing adding, colouring and problem solving of common fractions)	16	-simple instruction -fraction wall	-fractions (comparing common fractions)
16	-simple instruction -Hexagon, pentagon, quadrilateral, triangle, 2-D shapes	2-D shapes (naming)	21	-simple instruction -2-D shapes, trapezium, pentagon, parallelogram, hexagon	-2-D shapes (naming)
17	-simple instruction -faces, triangular prism, rectangles, triangles	3-D shapes (naming)	20	-simple instruction -2-D shape, faces, rectangular prism	-3-D shapes (naming)
18	-Simple instruction -bar graph, tally, difference	-organising, interpreting and analysing data (tally marks, interpreting data)	28	-simple instruction -tally marks, bar graph, frequency	-organising, interpreting and analysing data (tally marks, completing a bar graph)
19	-no instruction -triangles	Shapes(counting)	30	-no instruction -triangles	shapes(counting)

Table 8 shows that there was no one-to-one ordered correspondence in the items, for example, item 2 on 2013 ANA corresponded with item 4 on the exemplar, item 3 corresponded with item 18 in the exemplar and item 19 corresponded with item 30 in the exemplar. The table also shows that 6 of 19 ANA items did not have items in the exemplar that were similar to them, (i.e. items 4, 7, 9, 10, 13 and 14). These six items were a combination of three simple instruction items and three complex or level 3 word problem items.

The 2013 ANA test item number 1 consisted of six multiple choice questions. The questions had one sentence with three questions having more than eight words[4] and three having less than eight words. Consideration of the length of a sentence on the basis of whether it had more or less than eight words was based on the understanding that an average sentence should have eight to ten words (Korger, 1992). For this research, and supported by broader literature, a sentence with more than eight words was considered too long for Grade 4 learners who used English as an additional language.

Some of the 2013 ANA item 1 questions were very similar in wording and content to the 2013 item 1 exemplar questions. For example:

Table 9: Similar questions in item 1 for 2013 ANAs and exemplar

2013 ANA question	**Exemplar question**
1.1 What is the value of the underlined digit in 3 $\underline{8}$70? A 80 B 8 000 C 800 D 8	1.2 What is the value of the underlined digit in 7 $\underline{9}$99? A 90 B 9 C 900 D 9 000
1.3 The number 6 555 rounded off to the nearest 100 is: A 6 550 B 6 650 C 6 500 D 6 600	1.5 6 423 rounded off to the nearest 100 is: A 6 400 B 6 425 C 6 430 D 6 420

Table 10 summarises the nature of similarities and differences between the ANA test and the exemplar.

[4] The average line length is 13 to 17 syllables and eight to 10 words (Korger, 1992)

Table 10: Similarities and differences between corresponding items

ANA test item	Exemplar item	Nature of similarity/ difference
1	1	-similar questioning format -exemplar has 6 more questions than the ANA test item
2	4	- similarity in completing a number sentence -different way of questioning
3	18	-similar way of questioning -different in geometric patterns to complete
4		-none to compare with
5	9	-similar in learning outcome -different way of questioning
6	7	-similar questioning of the 4 operations -different in number of questions
7		-none to compare with
8	25	-both have complex worded instructions -difference in questioning
9		-none to compare with
10		-none to compare with
11	22	-Both items require learners to draw a reflection of the shape --difference in the questioning
12	26	-similar learning outcome of conversion -different conversions and number of questions based on conversion
13		-none to compare with
14		-none to compare with
15	16	-similar in the use of fraction wall -difference in the questioning and number of questions based on the fraction wall
16	21	- similar question and way of asking the question -different in number of shapes to name.
17	20	- similar way used for asking the questions -both items 17 and 20 had two shapes -different in that item 17, learners had to name the first shape and then name the shapes of the faces of the other shape. In item 20, learners were to name the second shape and then say what shapes made the faces of the two given shapes.
18	28	-similar in completing tally table -difference in the questioning and no graph to be drawn in item 18
19	30	-Exact wording only replacing triangle with square

From the above analysis of the 2013 mathematics ANAs and exemplar, it is apparent that although in some questions the testing format in the ANAs and exemplar were similar, in several cases there was no correspondence with that of the exemplar which the learners used in preparation for the ANAs.

From the analysis, five observations of the similarities and differences were noted:

1) There were items where the wording and questioning format were almost the same. For example, ANA question 16 and ANA exemplar question 21.

2) Several items, though not exactly the same had similar language, length and format. For example, ANA item 1 and exemplar item 1; ANA item 3 and exemplar item 18; ANA item 12 and exemplar item 26.
3) Six out of nineteen items were in the ANAs but not in the exemplars. For example, ANA items 4, 7, 9 and 10.
4) Three ANA items not in the exemplars (i.e. items 7, 10 and 14) were of a higher level of language complexity.
5) Several items were similar in the learning outcome assessed but were asked in different ways. For example, ANA item 5 and ANA exemplar item 9 or ANA item 11 and ANA exemplar item 22.

This analysis enabled me to gauge the extent to which the language of the ANA items, the formatting and the content may have been accessed by learners in the exemplars prior to the ANAs. This however, does not imply that learners necessarily knew the meaning of questions asked in the ANA exemplars but does indicate prior exposure to the language which provides contextual background for my analysis to come.

5.3 Research question 1: Linguistic complexity of the 2013 ANA test items

For this part of the study, I draw on Shaftel et al.'s (2006) linguistic complexity checklist and Vale's (2013) LCI formula drawn from the checklist, as an analytic tool for the content of the 2013 Grade 4 mathematics test items.

For this study, test items are defined as the 19 numbered (of which several had sub-questions) for which a learner was awarded marks. Unlike in Shaftel et al.'s (2006) study that looked only at multiple-choice items, this analysis includes the ANA multiple-choice and other word problems not in multiple-choice form.

I used the Shaftel et al.'s checklist because it is specifically designed for assessing mathematical test items. Four levels of language have been established and these are: basic level, word level, sentence level and paragraph level. Shaftel et al. (2006) list some individual language features that they considered to be challenging. These are:
A: Basic level: Number of sentences

Number of words in an item.

B: Word level: words of 7 letters or more; Relative pronouns (e.g. that, whom, whose); Slang/ambiguous/multiple meaning or idiomatic words (e.g. change, set); Homophones (e.g. two/too, prize/price); Homonyms (e.g. there, their, they're); Specific mathematics vocabulary (e.g. pentagon, symmetry).

C: Sentence level: Prepositional phrases (e.g. beginning with, from, by, at); Infinitive verb phrases (to make, to sell); Pronouns (e.g. his, her, they); Passive voice (were sold, were rounded off); Complex verbs of 3 words or more (e.g. could have been); Complex sentences (e.g. with subject and predicate); Conditional constructions (e.g. if … then); Comparative constructions (e.g. less than, greater than).

D: Paragraph level: references to specific cultural events.

The LCI is calculated as:

LCI = (Number of words + Sum B + Sum C + Sum D) ÷ Number of sentences5.3.1 Analysis of the 2013 ANA test items

The linguistic features of each of the 19 items were evaluated using the linguistic complexity checklist. In each item, the number of instances of the use of a linguistic feature was counted, as shown in table 11 , added together, and the result was divided by the number of sentences, (see bottom row of table 11) for the LCI of each item. For the purpose of this analysis, an item subsumes sub questions. An example is item 4 which comprised two sub-questions namely 4.1 and 4.2, with the instruction '*Complete each of the following number patterns*:' which is applicable to both questions. In this respect therefore, the 19 items analysed contained 38 questions. Each of the 38 question was analysed individually using the LCI features and formula. For those sub questions where the instruction is given at the start of the item the instruction is analysed together with the first sub question only. This means for example, item 4, the instruction '*Complete each of the following number patterns*:' is only analysed together with the first pattern in 4.1 and not again for 4.2. The reason for this is that learners are likely to read the instruction part and then go on to answer the first question followed by subsequent questions without re-reading the instruction for each sub-question. In my word count, I did not include number digits (e.g. 80) but

I included numbers written in words. The reason for leaving out digit numbers was that normally when a learner looks at 80, at a single glance he or she should know what that number is. On the other hand, for those numbers written in words, a learner would need to read all words and then 'translate' them into the number. This adds to the item's linguistic complexity.

This analysis resulted in the following questions having a LCI of 0: 3.2, 4.2, 6.2, 6.3, 6.4 and 16.2 (i.e. they had no language).

Table 11: Frequency of use of language features across the 2013 ANAs

Question	1.1	1.2	1.3	1.4	1.5	1.6	2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2	6.3	6.4	7	8	9.1	9.2	10	11	12.1	12.2	13	14	15.1	15.2	15.3	15.4	16.1	16.2	17	18.1	18.2	18.3	19
A-No. of words	16	8	13	6	5	6	1	6	0	7	0	20	12	5	0	0	0	17	18	39	16	19	11	3	3	8	23	23	10	6	18	17	0	16	31	8	14	9
B-Words with 7 letters or more	2	2	1	1	3	0	1	3	0	3	0	1	0	3	0	0	0	6	1	7	1	4	2	2	2	3	0	6	2	2	4	4	0	4	9	2	4	3
No. of pronouns	1	0	0	1	0	1	0	1	0	1	0	2	2	0	0	0	0	0	1	2	3	0	0	0	0	0	1	1	0	0	3	1	0	0	0	1	2	2
No. of ambiguous	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0	1	0
No. of homophones/ho	3	3	5	2	0	2	0	2	0	1	0	5	1	1	0	0	0	4	2	8	5	5	1	0	0	1	3	3	3	0	2	2	0	2	2	1	2	1
C-No. of passive sentences	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
No. of complex verbs	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of infinite verbs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2	1	1	0	1	0	0	2	0	0	0
No. of specific math	2	1	1	1	1	1	0	1	0	1	0	0	0	1	0	0	0	2	2	0	0	2	2	1	0	4	0	2	2	2	1	5	0	4	0	0	1	1
No. of prepositional	1	2	4	1	0	1	0	1	0	1	0	3	0	1	0	0	0	3	1	5	3	5	2	0	0	0	3	1	3	1	2	2	0	2	1	2	3	1
No. of conditional	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D-No. of references to	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total no. of features	25	17	24	13	9	12	2	14	0	14	0	31	17	11	0	0	0	32	28	64	29	36	19	6	5	16	33	38	21	13	30	32	0	29	45	14	27	17
No. of sentences	2	1	1	1	1	1	1	1	0	1	0	2	1	1	0	0	0	2	1	2	1	2	1	1	1	1	3	2	1	1	2	1	0	1	2	1	1	1
LCI	12.5	17	24	13	9	12	2	14	0	14	0	15.5	17	11	0	0	0	16	28	32	29	18	19	6	5	16	11	19	21	13	15	32	0	29	22.5	14	27	17

Note: questions 3.2; 4.2; 6.2; 6.3; 6.4 and 16.2 all have an LCI of 0

LCI range is 0-32   Average LCI is 14.49

5.3.2 Discussion of findings

Word level

At the word level, the number of words with 7 letters or more, number of pronouns, the number of ambiguous words and the number of homophones in each item were considered within LCI calculation. Table 11 above reveals the following at word level:

-the number of words with plus or minus 7 letters

30 of the 38 questions contained words with 7 or more letters. The questions that had the highest number of words with 7 or more letters were questions 9.1 (with 7 words), question 15.1 (with 6 words) and questions 7 and 10 (with 5 words). For example, question 9.1 read *"Write down the flight number of a flight which will depart for its destination before midday."* Such questions represented 78.9% of the total (38 questions) which demonstrates the linguistic challenge in terms of word length for the vast majority of questions. This is a cause for concern given Bergqvist et al.'s (2012) observation that word length is the major source of linguistic complexity. That words with 7 or more letters featured in the majority of questions shows the potential for the test items to hinder comprehension.

-number of pronouns

17 of the 38 questions (44.7%) contained pronouns most of which were interrogative pronouns like 'what', 'which', and demonstrative pronouns like 'that'. Other pronouns that were marginally used were indefinite pronouns like 'each', 'much' and subjective pronouns like 'she', 'it', and objective pronouns like 'her' and 'its'. Questions 9.2 and 15.4 had the highest number of pronouns (3). Pronouns cause confusion for less skilled English language learners because 'they introduce a (possibly ambiguous) reference to another sentence element' (Shaftel et al., 2006, p. 121). In question 15.4, *"Mom shared a cake equally amongst Mary and her 3 friends,"* a less skilled English language learner may be confounded by the referent of

the pronoun *her*, in terms of whether it is Mary's friends or mom's friends. Although pronouns may bring difficulty to mathematical texts, pronouns are essential in sentence constructions as they serve to indicate possession and to form questions, among other uses.

-number of ambiguous words

9 of the 38 questions (23.5%) contained ambiguous words. Examples of ambiguous words were 'factor', 'multiple' and 'hands' in questions 1.6, 1.4 and 8 respectively. According to Halliday (1989), syntactic ambiguity is the presence of two or more possible meanings within a single word or sentence. This is common in mathematical texts. For the present study, ambiguous words were those with multiple meanings where assignment of the unintended meaning compromised the comprehension of the item's demands and inevitably the response given. For example, in question 7, *'The difference between 1 613 and 859 is seven hundred and fifty-four,'* difference is not used in a everyday meaning which means 'dissimilar or unlike.' Here it refers to the answer you get after subtracting a number. From this example, we note that ambiguous words may bring complexity and can be confusing to learners who are not proficient in the English language. Although ambiguous words could potentially confuse the learners, they were not as prevalent as the two features discussed above.

-number of homophones

27 out of 38 (71%) questions contained homophones. Homophones are two or more words that have the same sound or spelling but differ in meaning. These words can make reading complicated as not knowing the definition of a particular homophone can change the meaning of what is read, thus affecting comprehension. Question 9.1 had the highest number of homophones (8). Examples are *write/right, buy/by*, *of/off* and *board/bored*. An example of this is in a sentence which read, 'Look at the departures board at the airport' – the word 'board' if read as meaning 'bored' would change the meaning of the sentence. Questions 1.3, 5.1, 9.2 and 10 all had five homophones each. Homophones are another major source of ambiguity, which could hinder and cause confusion in understanding test items. The fact that homophones appeared in the vast majority of the questions increased the LCI of these questions and could potentially affect learners' test performance.

Sentence level

At sentence level the linguistic features that were analysed were the number of passive sentences, number of complex verbs, number of infinitive verbs, number of specific mathematical vocabulary, number of prepositional phrases and number of conditional constructions.

-number of passive sentences

Only 3 of 38 questions (7.8%) were in passive form. These were questions 1.2, 11 and 14. Each of these questions had one passive sentence. In passive sentences, the sentence begins with the object rather than the subject, which is unlike the everyday use of language. For example question 1.2: '*The number 6 555 rounded off to the nearest 100 is…'* A learner may find this question difficult to understand because of its passive construction. The question could be more easily understood if it was asked in the active voice like 'Round off 6 555 to the nearest 100'. The more common voice construction in English is active voice, not the passive voice, and so passive voice constructions can be especially insidious, for failure to understand them correctly can actually lead to a misinterpretation of vital information (Tanko, 2010). According to Hinkel (2002, p. 1), learning and teaching the 'meanings, uses, and functions of the passive voice represents one of the thorniest problems in L2 grammar instruction', and many L2 learners of English appear to have difficulty with passive constructions. Although complex to unravel, particularly for L2 learners with limited English language proficiency, passive constructions were marginally employed in the test items.

-complex verbs

Four complex verb phrases in 4 out of 38 questions (10.5%) were employed in questions 3.1, 5.2, 9.1 and 9.2. Question 9.1 and 9.2 for example, asked learners to write down flight numbers *'which will depart'*. Complex verbs were infrequently used in the test items. Complex verb phrases in this study were phrases with at least three verbs. Use of complex verb phrases suggests the use of multiple or difficult verb tenses (Shaftel et al., 2006). In general, complex verb phrases consist of one or more auxiliary verbs plus a main (lexical) verb.

-number of infinitive verb phrases

Infinitive verb phrases were found in 9 out of 38 (23.6%) of the questions. An infinitive phrase is the infinitive form of a verb plus any complements and modifiers. Infinitive phrases are without doubt the most complicated of all verbs. They can be used as adverbs, adjectives, and nouns. Because infinitives begin with the word 'to' they are occasionally misidentified as prepositional phrases Question 15.1 had two infinitive verb phrases. An example is *'Use the fraction wall to calculate 1/4 + 2/4'*. In the given example, learners may confuse the infinitive verb with prepositional phrases and this compromises the comprehension of the questions. The other questions had one infinitive verb phrase each. Although these affected just under a quarter of the questions, they represent a substantial effect relative to other features at the syntactic level.

-number of specific mathematics vocabulary

Specific mathematics vocabulary was used across 23 out of 38 questions (60.5%). This is to be expected in a mathematics assessment since mathematics has a language unique to itself. Examples include 'ratio' (in question 1.3), 'multiple' (in question 1.4) 'factor' (in question1.6), 'number patterns' (question 4.1), 'number sentence' (question 7) and many others. Mathematical reading is dense, each word is conceptually-packed and full of specific mathematics vocabulary which children are not often exposed to in their homes and social environments (Murray, 2004), and without understanding of specific vocabulary, many learners struggle to understand concepts (Lee, 2007). For example:

Question 16.1:

Hexagon	Pentagon	Quadrilateral	Triangle

From the above frame choose the word to name each of the 2-D shapes.

That mathematics specific vocabulary appeared in the vast majority of the questions may have affected learner performance by adding to the linguistic complexity.

However, this is unavoidable as understanding mathematical vocabulary is imperative to developing mathematical thinking, reasoning and problem solving. In a study conducted by Wolf and Leon (2009) they report that the overall amount of academic vocabulary in word problem items was most predictive of item difficulty for English learners. While to some extent unavoidable, mathematics dense vocabulary led to test complexity considering that the vast majority of South African Grade 4 learners had only just switched from mother tongue instruction in the FP. This reality perhaps necessitates that in these early grades of ELL the substitution of difficult mathematical vocabulary with simpler vocabulary should be made wherever feasible in order to provide increased access to assessments for learners who have recently switched to learning English mathematics vocabulary.

-*number of prepositional phrases*

Prepositional phrases were employed in 26 out of 38 questions (68.4%). A prepositional phrase is a word group that begins with a preposition. A preposition is a joining word that links a noun to another word in a sentence. Questions 10 and 9.1 contained the highest number of these phrases (5) and question 1.3 had four. Examples include, question 10: '*Look at the grid* below and write down the position *of the picture*'. Prepositional phrases were the linguistic feature with the highest frequency. Prepositional phrases potentially confound English language learners because they mark the existence of an additional phrase in the sentence and hence another concept to be understood (Shaftel et al., 2006). They are, however, necessary when describing how nouns relate to one another. That prepositional phrases featured so frequently in items shows their potential to hinder the understanding of many test items.

-number of conditional constructions

Only 1 of the 38 questions involved a conditional sentence. Conditional sentences are statements discussing known factors or hypothetical situations and their consequences. They are conditional because the validity of the subject of the sentence is conditional on the existence of certain circumstances, which in the case of this question, may be understood from the context. Failure to get a correct answer for the first part of the sentence means failure to get the answer for the second question. Question 5 was the question with the conditional construction feature (i.e. '*How much* *does Mrs Mazibe make if she buys and sells 10 apples*?' Of all the features at the syntactic level, conditional constructions were the least manifest. Such questions can be rephrased more simply using two sentences. For example, Mrs Mazibe buys and sells 10 apples. How much does she make?

Paragraph level

Paragraph level complexity is considered when there is reference to cultural events. Analysis of the questions, however, shows no added complexity in this respect (see table above). Shaftel et al.'s (2006) contention that complexities at the word level are less inhibiting than those at the syntactic level and that complexities at the paragraph level are most inhibiting implies that the absence of linguistic complexities at the paragraph level is a welcome relief. The figure below summarises the frequencies of complexities across categories and shows that linguistic complexities were most manifest at the word level.

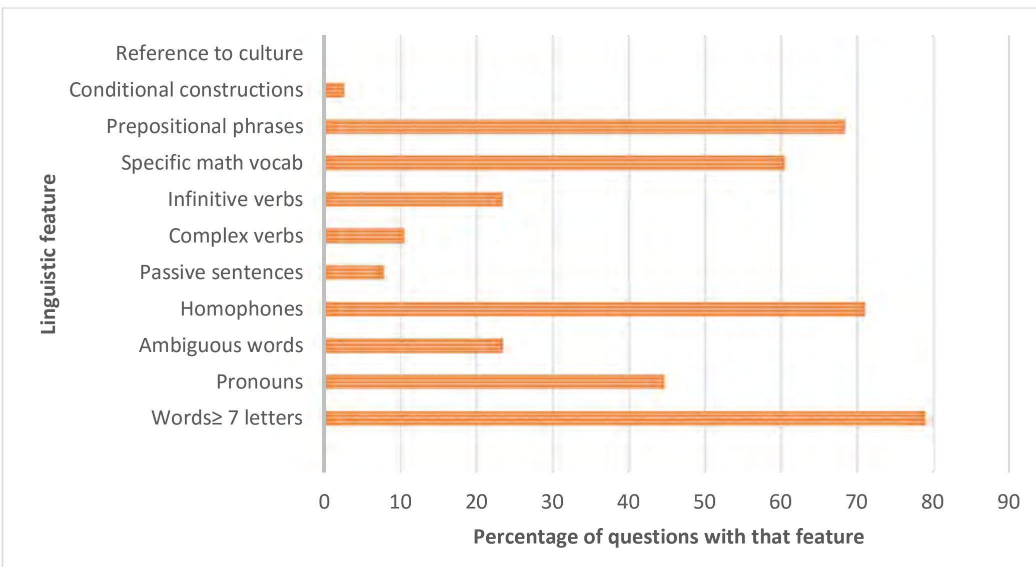


Figure 2: Frequencies of the use of different linguistic features in the 2013 ANA questions

Looking at the language use in the 2013 ANAs, the analysis of the linguistic features revealed that for each question analysed, a number of language features occurred and some appeared more frequently than others. When the language features that occurred across the items are arranged, starting from the most frequently used to the least frequently used, the features are as follows: words with seven or more letters (78.9%), homophones (71%), prepositional phrases (68.4%), specific mathematical vocabulary (60.5%), pronouns (44.7%), ambiguous words (23.5%), infinitive phrases (23.6%), complex verbs (10.5%), passive voice (7.8%), conditional constructions (2.6%) and references to cultural events (0%). As noted before, the greater the total number of linguistic features, the more difficult the question. In this case, question 16.1 may be considered the most linguistically challenging of all the questions because it has the greatest number of linguistic features:

‘Hexagon/Pentagon/ Quadrilateral/ Triangle

From the above frame choose the word to name each of the 2-D shapes’.

Table 12 presents a summary of the number of indicators of question complexity derived from table 11 along with the LCI for each question (in descending order of LCI i.e. from the most challenging or most linguistically complex question to the least challenging or least linguistically complex question). The summary is in terms of the 11 word and syntactic level features that were the focus of analysis, and the formula for the LCI which is (Number of words + Sum B + Sum C + Sum D) ÷ Number of sentences is applied. For the questions that had one sentence, the total number of the linguistic features was the same as the LCI. Therefore, for single sentence questions, the more the linguistic features the higher the LCI. For those questions that had two sentences, the LCI was half the total linguistic features. There was only one question with three sentences and so its LCI was one third of the total of its linguistic complexity features.

Table 12: Summary of the complexity of individual questions ranked in descending order of LCI

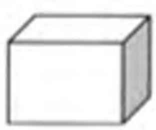
Question	No. of features present out of the 11 types of features	Aggregate No. of features	Linguistic Complexity Index	Question	Types of Features in Question	Aggregate No. of features	Linguistic Complexity Index
9.1	7	64	32	**3.1**	6	14	14
16.1	7	32	32	**18.2**	5	14	14
17	6	29	29	**4.1**	7	14	14
9.2	6	29	29	**15.3**	6	13	13
8	8	28	28	**1.4**	7	13	13
18.3	7	27	27	**1.6**	6	12	12
1.3	5	24	24	**1.1**	6	25	12.5
18.1	5	45	22.5	**14**	7	33	11
15.2	6	21	21	**6.1**	5	11	11
11	6	19	19	**1.5**	3	9	9
15.1	7	38	19	**12.1**	3	6	6
10	6	36	18	**12.2**	2	5	5
5.2	5	17	17	**2**	2	2	2
19	6	17	17	**3.2**	0	0	0
1.2	6	17	17	**4.2**	0	0	0
7	5	32	16	**6.2**	0	0	0
13	4	16	16	**6.3**	0	0	0
5.1	5	31	15.5	**6.4**	0	0	0
15.4	6	30	15	**16.2**	0	0	0

Column 1 indicates the number of all the 11 possible features in the questions which add to the nature of question complexity. When the complexity of questions is ranked in terms of the number of different features manifest, question 8 is the most complex: ‘Draw the hands of the given clock face to show that the time is a quarter past eight.’

However when applying the LCI formula the four most complex questions are 16.1[5]; 9.1, 17 and 9.2 (9.1 and 16.1 have the same LCI while 9.2 and 17 also have the same LCI) given below:

16.1 ‘Hexagon/Pentagon/Quadrilateral/Triangle/ From the above frame choose the word to name each of the 2-D shapes’

17. Complete the table:

OBJECT	NAME OF OBJECT	SHAPE(S) OF THE FACES
	________________	Rectangles
	Triangular prism	Triangles and ________________

[5] Although question 16.2 had no language in it, in order to answer it it was necessary for a learner to look back at the list of given geometrical names so as to choose one and thus adding to the linguistic complexity of the reading of question 16.2

9. Look at the departures board at the airport and answer the questions that follow.

DEPARTURES		
DESTINATION	TIME	FLIGHT NUMBER
Mossel Bay	07:45	SAA 769
Knysna	10:20	BA 172
Johannesburg	20:00	SAA 372

9.1 Write down the flight number of a flight which will depart for its destination before midday.9.2 'Write down the flight number of a flight which will depart for its destination after midday.'

Although questions 16.1 and 17 have the highest LCI, learners did not perform very badly in them.. While they receive a high LCI because of the mathematics specific vocabulary, once learners have mastered the names of the shapes they were likely to name the shapes correctly. Also this mathematics vocabulary is relatively familiar and visible in the curriculum and was included in the exemplars. Thus questions 16.1 and 17 were not among the questions that were selected for task-based interviews. Questions 9.1 and 9.2 were however, experienced by learners as complex (in terms of performance) so were among the questions selected for task-based interviews. The vocabulary used in these questions was unfamiliar to learners as the context of flights and related terminology is not part of the curriculum.

5.4 Chapter summary

This chapter of the study was designed to explore the linguistic complexity of the Grade 4 mathematics ANAs written by learners in English. For the majority of these learners, English had only been the LoLT of mathematics instruction for approximately 6 months before they sat for these ANAs.

Firstly, the chapter discussed and analysed the 2013 ANA items and exemplars in order to establish the extent to which the testing format and language used in the ANAs corresponded to that of the exemplars the learners were exposed to as preparation for the ANAs. It was established that there were some inconsistencies in the questioning format and language used in the ANAs but also strong similarities which in some cases led to some questions with a high LCI (such as 16.1 and 17) being relatively well answered compared to other questions. Although consistency in familiarity with the way of questioning is helpful for learners, caution should be taken that this consistency and similarities in the questioning format do not lead to drilling learners to the assessments.

This chapter also reports and discusses the findings of a content analysis done on the 2013 mathematics ANA test items using Shaftel et al.'s (2006)'s linguistic complexity checklist and Vale's (2013) LCI formula. Results point to some serious linguistic challenges presented by test items particularly in relation to recurrent use of: 7 or more letter words, homophones, prepositional phrases and specific mathematics vocabulary across the majority of questions. The next chapter presents and analyses the learner scripts and learner interviews to establish the difficulties learners experienced as they solved 2013 ANA mathematical problems.

CHAPTER 6: ANALYSIS OF LEARNER WRITTEN RESPONSES ON THE 2013 MATHEMATICS ANA (PHASE 2)

6.1 Introduction

Whereas Chapter 5 focused on the first phase of the study which analysed the linguistic complexity of the 2013 Grade 4 ANA test, this chapter focuses on the second phase of the study; the analysis of 106 mathematics ANA answer scripts that were written by the learners in the three case study classes in 2013. The two participating schools are hereafter referred to as Santa Anna primary and Biko primary. Santa Anna primary had isiXhosa speaking learners who had English as the LoLT from Grade 1, whereas Biko primary consisted of learners who had isiXhosa as their LoLT from Grade 1 up to Grade 3 but then switched to English at Grade 4. Santa Anna had only one Grade 4 class hereafter referred to as class A while Biko primary had two Grade 4 classes which were taught by the same teacher, hereafter referred to as class B and class C. Number codes were assigned to each learner with the code for learners from class A beginning with A and those from class B and C beginning with B and C respectively. The code letter was accompanied by the number allocated to the learner, for example, learner A22, B2 and C17.

6.1.1 Phase 2 Analysis and findings

In the analysis of the answer scripts I identify and compare the performance of the learners in the three classes, analyse the learners' responses to the test items, item by item, and identify the items in which the learners performed well and those where underperformed across the classes. The reason for this was to help me select the items that most learners did not respond to correctly and then interview learners in order to establish why they responded the way they did.

Overall performance across questions and classes

The three graphs which follow show the overall learners' performance in classes A, B and C respectively in the 2013 mathematics ANAs.

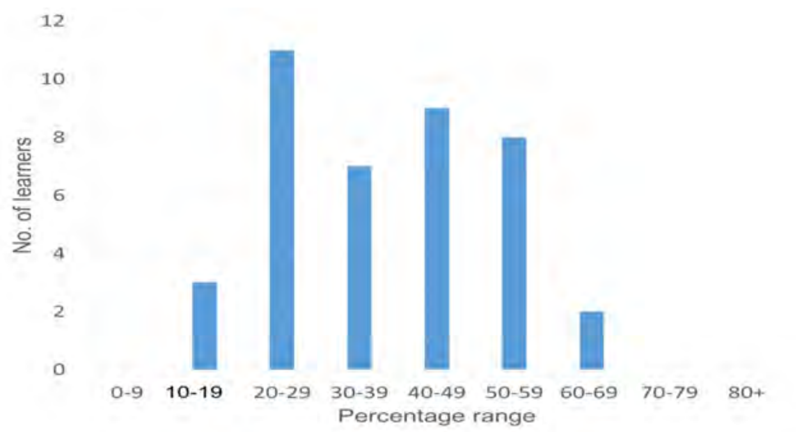


Figure 3: Class A learners' performance (n=40)

The graph shows that most learners in class A performed poorly in the test with three quarters of the scores falling in the 10-49% range (which is a failing range). Only two learners scored within the 60-69% range and there were no scores in the 70-79% and 80%+ ranges. In all, only a quarter of learners achieved in the basic competence range of 50%+. This reflects the overall poor performance of the class.

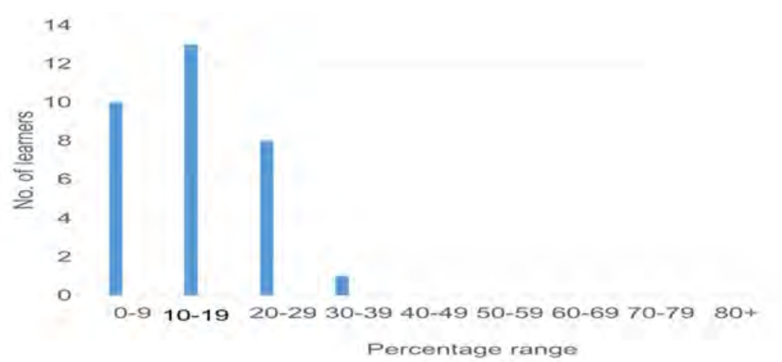


Figure 4: Class B learners' performance (n=32)

Figure 4 shows that all learners in class B performed very badly in the test with all scores falling between the 0-39% range. Had it not been for the sole candidate who scored in the 30-39% range, all the scores would have ranged from 0-29%. No learner came close to the 50%+ basic competence range.

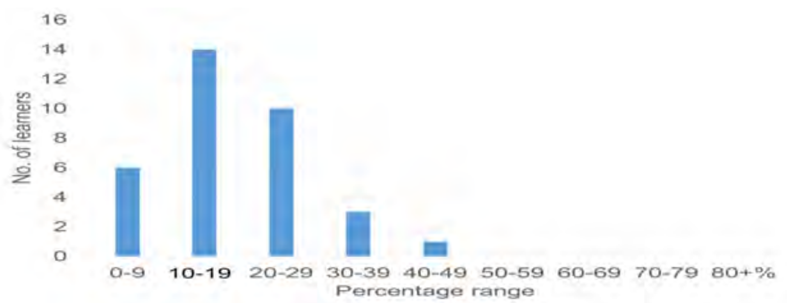


Figure 5: Class C learners' performance (n=34)

As in the case of class B learners, the scores for class C learners were similarly concentrated in the lower ranges, between 0 and 29% with only 3 learners in the 30%-39% and one learner in the 40-49%. This indicates that the test proved difficult for these learners to solve.

A test where only a quarter of the learners from class A passed (got 50%+) and none of the learners in class B or C attained above 50% is not only indicative of the critical level of learners' underperformance in mathematics in the two schools, but it also calls into question the validity of the assessment in terms of being pitched at a level where it can diagnostically assess the level at which learners are operating. The assessment tells teachers that learners cannot do Grade 4 mathematics but it is not telling teachers what learners do not know and where teachers should begin their remediation. One needs to remember that the key stated aim of ANA, as part of the FFL campaign, is to provide teachers with information for addressing the obstacles that learners face as discussed in the literature review. While the data above points to extremely poor performance overall, it does not tell us much about the nature of such underperformance. Thus, the next section analyses the learners' ANA test scripts to determine what is compromising learners' levels of attainment.

The use of the statistics of mean and range are used to further explore the results. These two measures allowed for a clearer understanding of the level of difficulty of the test for the learners. Table 13 shows the mean class averages for the three classes for the 2013 mathematics ANAs.

Table 13: Mean class averages for the 2013 Grade 4 mathematics ANAs

School	Mean	Highest score	Lowest score	Range
Santa Anna: n=40	37.6%	68%	12%	56
Biko: Class B n=32	14.5%	26%	2%	24
Biko: Class C n=34	16.9%	44%	2%	42

Table 13 shows mean average scores of 37.6%, 14.5% and 16.9% for classes A, B, and C respectively, which again indicate that the test was too difficult for Grade 4 learners from both schools. Santa Anna primary, however, has a wider performance range (although there were no learners in the 0-9% category). The range for class B is particularly small with all learners registering very low performance.

The fact that only 10 (25%) of Santa Anna primary learners attained the 50% basic requirement and only one learner from Biko primary got close to that basic requirement (44%) is significant.

A body of research (Setati, 2002; Martiniello, 2008; Zevenbergen, 2001; Schleppegrell, 2007; Halliday, 1978) has revealed that learning mathematics in the English language within multilingual classrooms (like classes in context) is complex as learners have to cope with the new language of mathematics as well as the new language in which the mathematics is taught (English). In the case of this study, it is important to explore the extent to which language was a factor affecting the performance of learners. A cursory comparison of the two schools' performance suggests that perhaps early exposure to English as the LoLT gave Santa Anna primary learners a slight edge over the Biko primary. However, socio-economic status (SES) and comparative quality of educational resources at the schools could also be a contributing factor as while Santa Anna is also a township school with learners predominantly from poor SES background, it does charge a nominal fee while Biko is a non-fee school.

This analysis provides a general picture of learners' performance. However, in order to explore this performance further and gain a fuller understanding of the nature of the linguistic complexities, I investigate learners' responses to individual test items. Following is the analysis of the test items in relation to how learners performed in the tests.

6.2 Analysis of learners' responses to test items

Learners' responses across each of the test items were analysed per class in terms of the following four categories:

- Number of learners who correctly answered the item
- Number of learners who partially answered the item (where a learner showed an understanding of the given instruction but failed to use the correct operation, or the learner got the correct operation but later failed to work out the problem)
- Number of learners who answered the item incorrectly (seemingly not understanding or misinterpreting what was asked)
- Number of learners who did not answer the item at all.

The test had 19 items with item 1 comprising 6 multiple choice questions. Item 1 questions were not analysed on account of the responses to multiple choice questions being open to guesswork which made them unreliable indicators of learners' knowledge of particular questions[6]. Of items 2 to 19, which were analysed individually, each had two or more sub questions which brought the total number of questions analysed to 32. The three graphs which follow show learners' performance on each item (and sub questions) in relation to the four categories identified. The bold horizontal lines show the '50% of learners' line to ease identification of the questions which more than 50% of learners got wrong or left out.

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[6] The low level performance ranges make it particularly tricky to interpret the performance on multiple choice questions. Since there were only four choices and learner performance was generally below 40% across test items there is a chance of getting 25% through pure guesswork.

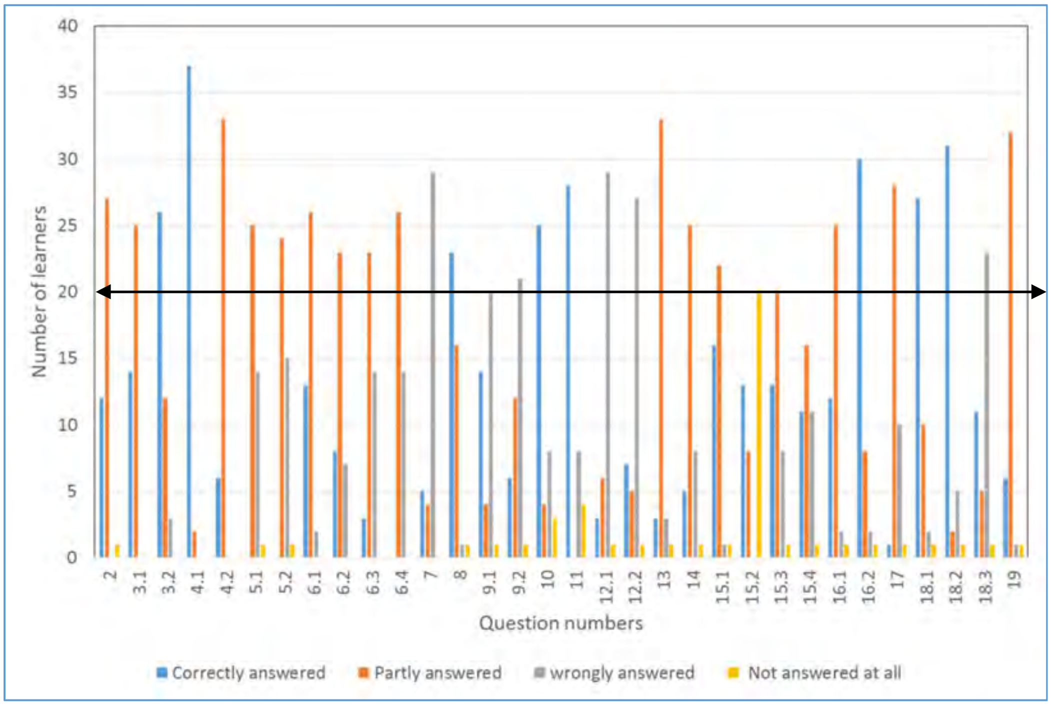


Figure 6: Class A: No. of learners in each response category on test items and sub questions (n=40)

The horizontal line shows the half way mark for frequencies of learners. In relation to this line note that:

- 8 of the 32 questions were correctly answered by half or more than half of the class A learners
- 16 of the 32 questions were partly answered by half or more than half of the class A learners
- 6 of the 32 questions were wrongly answered by half or more than half of the class A learners and
- 1 of the 32 questions were not answered at all by half or more than half of the class A learners

For class A it would therefore appear that questions 9.1; 9.2; 12.1; 12.2; 15.2 and 18.3 were experienced by most learners as difficult.

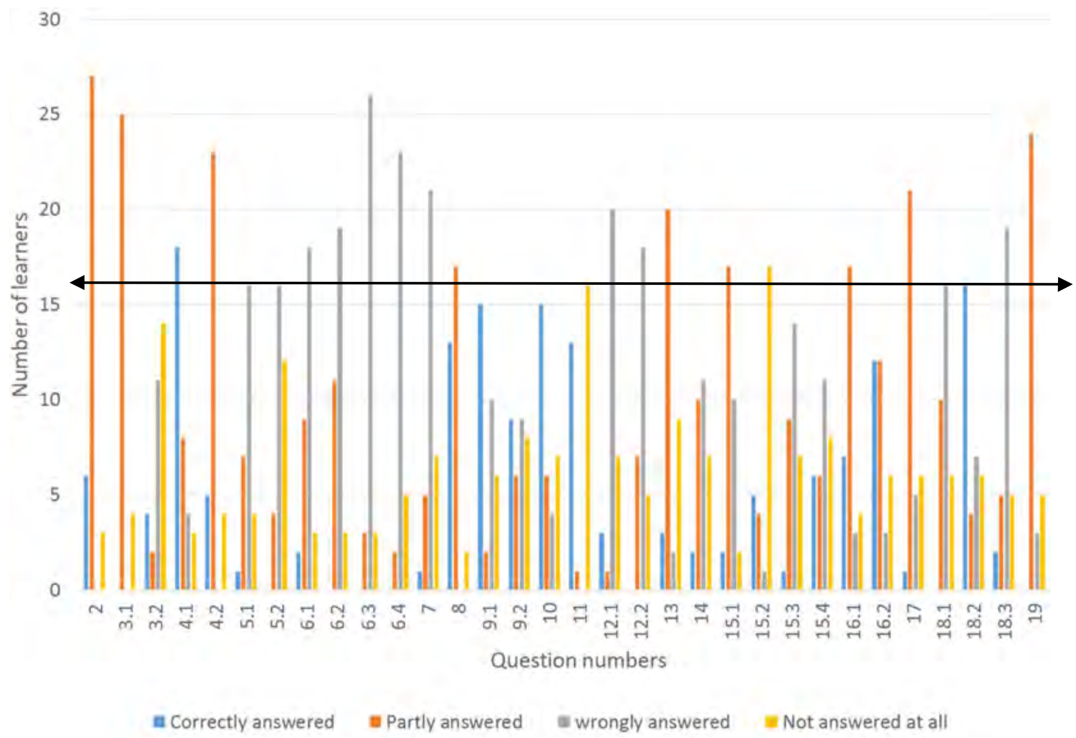


Figure 7: Class B: No. of learners in each response category on test items and sub questions (n=32)

- 2 of the 32 questions were correctly answered by half or more than half of the class B learners
- 9 of the 32 questions were partly answered by half or more than half of the class B learners
- 11 of the 32 questions were incorrectly answered by half or more than half of the class B learners and
- 2 of the 32 questions were not answered at all by half or more than half of the class B learners

For class B it would therefore appear that questions 5.1; 5.2; 6.1; 6.2; 6.3; 6.4; 7; 12.1; 12.2; 18.1 and 18.3 were experienced by most learners as difficult.

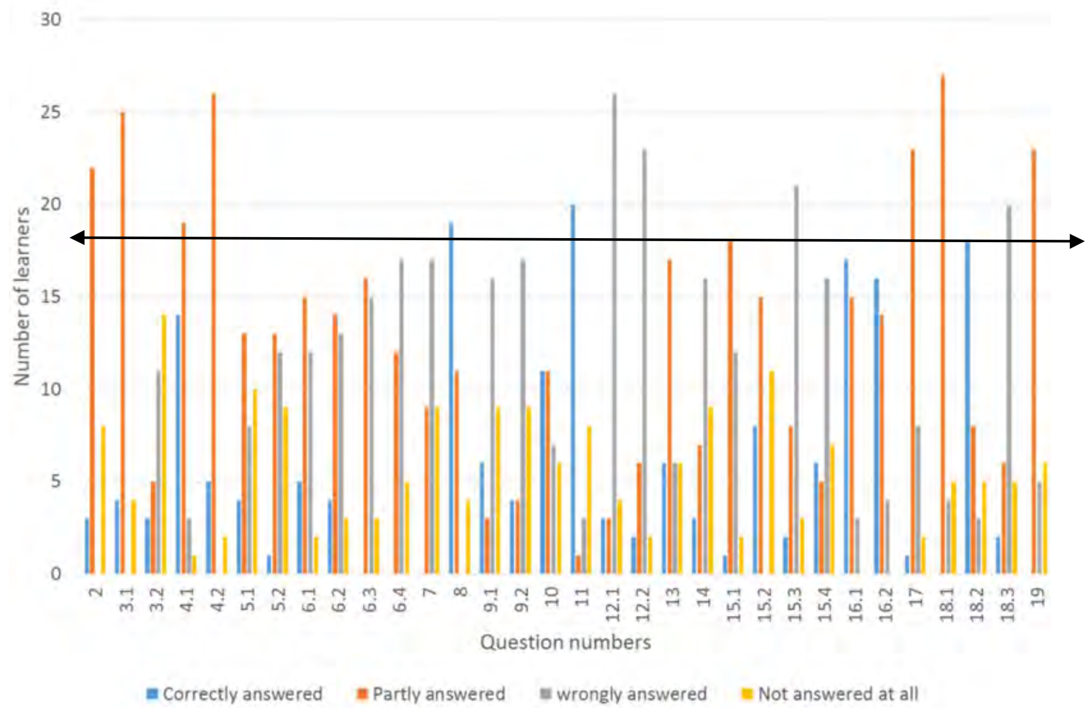


Figure 8: Class C: No. of learners in each response category on test items and sub questions (n=34)

- 4 of the 32 questions were correctly answered by half or more than half of the class C learners
- 9 of the 32 questions were partly answered by half or more than half of the class C learners
- 7 of the 32 questions were incorrectly answered by half or more than half of the class C learners and
- None of the 32 questions was not answered at all by half or more than half of the class C learners

For class C it would therefore appear that questions 12.1; 12.2; 15.3 and 18.3 were experienced by most learners as difficult. Data given in Figures 6, 7 and 8 across the classes is summarised in Table 14.

Table 14: Questions with ≥ 50% of learners answers in each category

Category	Class A: Questions with ≥ 20 learners answers in a category	Class B: Questions with ≥ 16 learners answers in a category	Class C: Questions with ≥ 17 learners answers in a category	Total number of distinct questions in each category across the 3 classes
Correctly answered	3.2; 4.1; 8; 10; 11; 16.2; 18.1; 18.2	4.1; 18.2	8; 11; 18.2	8
Answered partially correctly	2; 3.1; 4.2; 5.1; 5.2; 6.1; 6.2; 6.3; 6.4; 13; 14; 15.1; 15.3; 16,1; 17; 19	2; 3.1; 4.2; 8; 13; 15.1; 16.1; 17; 19	2; 3.1; 4.1; 4,2; 5.1; 17; 18.1; 19	19
Incorrectly answered (misinterpreted or not understood)	7; 9.1; 9.2; 12.1;12.2; 18.3	5.1; 5.2; 6.1; 6.2; 6.3; 6.4; 7; 12.1; 12.2; 18.1; 18.3	12.1; 12.2; 15.3; 18.3	14
Not answered at all	15.2;	11; 15.2	-	2

Table 14 presents the questions for which the four types of responses arose for more than or equal to 50% of learners in the three classes. It shows that only 8 questions were correctly answered by more than 50% learners across the three classes. It appeared that the easiest item was item 18.2 which was the only item correctly answered by more than 50% of the learners in all the three classes. This was followed by items 4.1, 8 and 11 which were correctly answered by the majority of learners in two of the three classes. Items 3.2, 16.2 and 18.1 were correctly answered by the majority of the learners in class A only.

The three classes differed in size. For class A with 40 learners, 50% was 20 learners and for classes B and C, their 50% was 16 and 17 learners respectively. It is beyond the scope of this part of the study to explore learner performance on every item of the ANAs. Of particular interest for this study are those items for which most (≥50%) learners either wrongly answered (misunderstood or misinterpreted) or left out (did not attempt to answer), as these are likely to be questions learners found particularly difficult. I identified the specific questions which belonged to each of these categories.

It is important to understand why learners performed as poorly as they did in the items in question, and so in the next section, I explore possible explanations for that performance within the following three categories:

- Items not answered by more than 50% of learners
- Items wrongly answered by 50% of the learners because the questions were not understood or they were misinterpreted and
- items answered correctly by less than 10% per class.

I have also considered the third category of items answered correctly by less than 10% per class (as a special sub category of the above categories) because it is also important to know why very few learners managed to answer these questions correctly.

In the next section, I look at learner performance as shown in the 2013 ANA written scripts of items identified according to the above three criteria**.** Analysis of written scripts does not allow for Newman Error Analysis (which is interview based). However, analysis of difficulties in the above three categories will inform phase 3 which involves learner interviews to answer my research question 1b.

6.2.1 Analysis of learner performance on items not answered by more than 50% of learners in a class

Only three questions were not answered by more than 50% of learners in each of the three classes. The questions not answered were 15.2 (class A), 11 and 15.2 (class B). All questions were answered by more than 50% of learners in class C. Since non-response to items was generally low with most learners attempting most questions, these three questions were analysed for possible explanations for their avoidance by learners, particularly in class A and B. Below, I focus on the linguistic features of these questions and learners' written responses.

Item 15- Fractions

Item 15 assessed learners' knowledge of fractions in terms of comparison of different fractions, their addition and the representation of fractions on a fraction wall.

Question 15.2

Colour in ¾ of a fraction strip in the fraction wall.

Question 15.2 was not attempted at all by 50% of class A and 53% of class B learners. In my estimation, it is less likely that the act of colouring ¾ could have been a problem for the learners. It is more likely that learners' avoidance of the question could have resulted from their unfamiliarity with a 'fraction strip' and a 'fraction wall'. The phrase *fraction strip* was not present in the 2012 and 2013 ANA mathematics exemplars which were used to prepare them for their ANAs. Only the term fraction walls appeared. Fraction strip, however, appears in the learners' department-issued workbooks a number of times (Book 1 p. 19, 99, 102, 103, 104, 108 & Book 2 p. 13). A learner unfamiliar with either one of the two phrases would be less likely to understand the demands of the question in the ANA test item.

In addition, the phrase 'colour in' that was used may have been a source of confusion if learners were used to the instruction 'shade' instead. A similar example from the 2012 exemplar reads 'Shade 4/6 on the fraction wall'. The 2013 workbook, however, did use the phrase 'colour in' a few times. However, not all exercises in workbooks were completed[7]. The different words for the same instruction could challenge learners' interpretation of the questions where different words/terms for the same action are used in the different teaching and assessment instruments.

Shaftel et al. (2006) identify prepositional phrases and pronouns as important contributors to item difficulty levels. In this question, 'colour in', 'of a fraction strip' and 'in the fraction wall' are all prepositional phrases that possibly all added to the linguistic complexity of the questions.

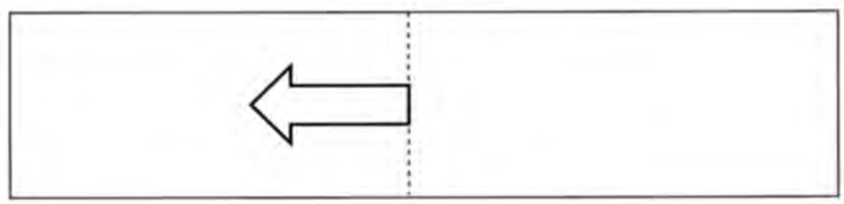
Dey and Dey (2010, p. 170) argue that most mathematical operations with whole numbers may be clearly explained through visual displays. As learners count their fingers, counters or toys, they see the numbers. When they 'add, subtract, multiply and divide their toys, they visualize these operations and that makes arithmetic

[7]The provision of workbooks is clearly central to the South African government's strategy to improve learning outcomes. The workbooks emphasise basic skill proficiency and the four basic operations: addition, subtraction, multiplication and division. Learners are encouraged to take their workbooks home so that they can do homework with the help of parents and care givers (DBE, 2012). This explains why not all work in workbooks was completed. Some learners do not do the homework and others do not finish it.

operations with whole numbers understandable and often enjoyable.' However, when it comes to fractions, it becomes increasingly abstract and decontextualized. Thus the content of the question (i.e. fractions) also possibly explains why more than 50% of learners in this study left the question unanswered.

Item 11: Space and shape

11. Draw the reflection of the arrow on the vertical dotted line.



Item 11 was not answered by 50% of learners from class B although it was correctly answered by 70% of learners in class A and 59% of learners in class C. Such discrepancy suggests that in the one class language and or concept was unfamiliar but not in the other class. Learners in class B may not have been familiar with this type of 'complete the picture' question that assesses understanding of mathematical symmetry and reflection. Additionally, this test item consisted of mainly text (language). The words 'reflection' and 'vertical' may have been foreign to the learners. These are technical terms in the mathematical register which are difficult to understand.

The 2012 and 2013 exemplars used for preparation for the ANAs posed the question differently and in a simpler way. The 2012 exemplar reads 'Draw the other part of the face to make it a symmetrical picture'. The phrase 'draw the other part of the face' is more comprehensible than 'draw the reflection on the vertical dotted line'. While the phrase 'symmetrical picture' is technical, one understands this as drawing the other part of the face. This is based on the everyday knowledge of the learners. The 2013 corresponding question in the exemplar reads 'Draw the right hand-side of the sketch to make a symmetrical 2-D shape.' Again this may be simpler language than the one used in the 2013 ANAs. Since workbooks made use of the term 'symmetrical' it was therefore, more likely a familiar term. Nowhere were the terms 'reflection' or 'vertical' used in the exemplars of the previous years. This meant that learners most likely encountered these terms for the first time in the 2013 test so possibly did not understand the instruction. These unfamiliar words and the format of the questioning possibly accounts for the item being omitted by most learners. Again, the inconsistency between the language in the workbooks, exemplars and 2013 ANAs might have been a source of confusion, causing learners to avoid this question.

6.2.2 Items wrongly answered

There were 14 questions (across 7 items) that were wrongly answered by more than 50% of the learners across the three classes. The learner responses indicate that the questions were either misinterpreted or misunderstood. Three questions (12.1, 12.2 and 18.3) appear across all the three classes as being misinterpreted or not understood by the majority of learners as indicated by the learner responses. I therefore, focus my analysis on these three questions below:

Item 12 - Measurement

12. Convert the following:

12.1 12 m 48 cm = ___________________ *cm*

12.2 80 minutes = ______ *hour* ________ *minutes*

It is possible that most learners did not understand the word 'convert' or they misinterpreted it. Some of the responses given by learners (learners are indicated in brackets) for question 12.1 were: 60cm (A1, A2, A3, A26, A33, A35, A37, A7, A31, B18, B27, C29, A34); 84cm (A6); 48,12cm (A8, B1); 51 cm (B19); 15cm (A23, B4); 510 (C20); 31cm (A29); 16cm (A39); 50cm (A40); 58cm (A5); 12cm (B17, C25); 1428 cm (C13). Incorrect responses for 12.1 largely fell into six categories: (a) answered by adding two numbers e.g. 60cm (12+48), 510cm (48+12) (b) answered by adding part of the numbers e.g. 50cm (48+2) (c) answered by switching number order e.g. 4812cm and 1428cm and 84 (d) answered by subtracting numbers e.g. 58 (60-2), 50cm(60-10) (e) answered by copying part of numbers in the question as answers e.g. 12cm and (f) answered by an unclear method e.g. 31cm and 16cm. In this last category, the responses made it difficult to say what operations the learners concerned used to arrive at them. They could have been the result of guesswork.

These responses given by learners show that the word ‘convert’ was not understood. Thus, learners read instructions as if they are implying doing something with the numbers but without drawing on the notion of conversion of units so that the amount remains the same and only the units change.

Examples of responses for 12.2 included: 40hrs 40mins (A23); 2hrs 40mins (A3); 60hrs 20mins (B18, C8); 4hrs 2mins (A20); 2hrs 60mins (A16, B19); 8hrs 0mins (A15, B30, B3, C23, C29, C27, B25); 60hrs 80mins (B14, B29); 1hr 8mins (B1, B4, B25); 40hrs 20mins (A1, A28,A5); 1hr 80mins (C33); 20hrs 2mins (C13); 4hrs 2mins (A13). These answers similarly indicate that the question was understood as ‘do something to this amount’ but answers seem to indicate that it was not clear to the learners that they needed to keep the amount the same. The equivalence of the measurements on either side of the equal sign were not paid attention to. The response 2hrs 40mins by A23 shows that the learner most likely got 80 minutes in the question by adding 40 hours and 40 minutes. Similarly, learners B18 and C8 added 60 and 20 to come up with 80. Learner A29 possibly got 80 minutes by combining 8 and 0. Others (C33, A3, A1, A28, and A5) may have got 80 minutes by multiplying numbers. This also meant the word convert was not understood. Other responses e.g. 20hrs 2mins, 2hrs 60mins could have been due to guesswork.

Perhaps learners were more familiar with the instruction ‘Complete the following’ when required to write equivalent measurement. For example in the 2013 exemplar a similar question for 2013 exemplar read: Complete: 1 year = ___________weeks (DBE, p. 10). This is simpler and could have been easier to understand had it been used in the ANAs as learners would not have had to struggle with a difficult word like ‘convert’. However, the presence of only one number also makes 1year =____weeks simpler mathematically.

Thus, item 12.1 on measurement conversion is quite mathematically challenging and requires two steps, which are:

Step 1: 12m 48cm requires 12m=1200cm, then

Step 2: 1200cm + 48cm=1248cm.

To add to that complexity, 12m is quite a large figure when converted to centimetres (1 200cm). Over and above the conversion of 12m to centimetres, learners had to add the 48cm so as to get the answer in centimetres.

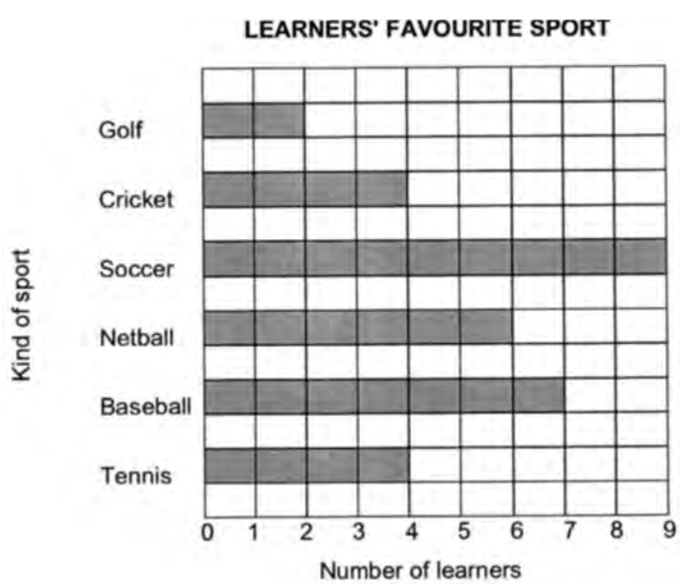
Question 12.2 which is about converting 80 minutes to hours and minutes is mathematically simpler, that is,

=60 minutes + 20 minutes = 1 hour 20 minutes,

Yet again few learners got this correct. Besides the linguistic complexity, learners probably did not know what to do in order to convert metres to centimetres or minutes to hours. This item assessed the learners' knowledge of distance and time. Responding to this item correctly learners needed to know how many centimetres there are in a metre and how many minutes there are in an hour. The interviews (which are discussed later) help to illuminate the way in which the linguistic challenges and the mathematical challenges jointly hindered learners from correctly responding to these measurement questions.

Question 18- Data

Question 18 had a graph (shown below) and three sub questions all based on the graph. (See Appendix A for full questions).



18.3 What is the difference between the number of learners who prefer soccer to cricket?

Question 18.3 was wrongly answered by most learners across the three classes. It is a long sentence, as discussed earlier, more than 8 words for Grade 4 learners learning in English as L2. The sentence length could have negatively affected learners' comprehension. The word 'difference' is additionally difficult as it takes on another meaning from its ordinary everyday use. In this context, it means 'subtract' or 'minus'. Not knowing the mathematical meaning of the term would be a source of error itself. Some answers that were given, which show an everyday interpretation of the word 'difference', include: they are most in soccer they are low in cricket (A39); the cricket has lower players (A23**);** the cricket is small and soccer is the biggest (A8); soccer is more than cricket (A20**);** soccer 9 cricket 4 (B19, B14, C25, C23, C33); 9 and 4 (B5); soccer is big cricket is small (B4); cricket not different to soccer (C3**).** Other answers seem to show a misinterpretation of the question and provided answers that suggest they understood the question as 'why is there a difference' e.g. because soccer is expensive (A25); because soccer is big than cricket (A1, A32) (A36). Thus, failure to respond correctly to the question seems largely to be due to a linguistic factor of misinterpretation of the term 'difference' in the context.

Learners might also have not known what 'prefer' means. They were likely more familiar with words like 'like' or 'love'. As in question 15.2, this question 18.3 had prepositional phrases in the sentence (uses prepositions 'between', 'of' and 'to') which is an additional source of complexity to the concepts or information to be understood. The sentence furthermore has a grammatical pattern of a long, dense noun phrase (a phrase that can function as the subject or object of a verb) such as 'numbers of learners who prefer soccer to cricket'. Such a lengthy noun phrase adds complexity to the meaning relationship in the problem. It is most probable that the errors made during solving this problem were comprehension errors which were caused by the linguistic complexity of the question.

Item 7- Converting word problems to number sentences

Item 7 appeared in two classes (A and B) as being misinterpreted or not understood by more than 50% of the learners. I therefore, discuss this item.

7. Write a number sentence for the sentence below.

The difference between 1 613 and 859 is seven hundred and fifty-four.

The responses that some learners gave showed that they did not understand what the question required them to do. Some of the responses given were: 754 (B17, A37, A28, A14); yes (A38); 911 (B24); 1613+859+54=90 000 (A12); no (A23); one hundred and thetyn and eight hundred eight hundred and fifty nine (B1); 859 (B7**);** the difference between 1613 and 859 is because the number 1613 is bigger than 889 (A19**);** the difference between 1613 and 859 is 754 (A7**)**; 900 (A6); divided by 68; 700+50+4; one thousand and 6 hundred thetyn is big (A1); 1613 is bigger than 859 (A16). These answers also revealed that many learners did not know what a number sentence is, or did not read the instruction, or that learners interpreted this as giving the answer for the sentence (754 by B17, A37, A28 and A14). Responses like those given by learners A23 (no**)** and A38 (yes) show that learners interpreted the question as requiring them to say whether the statement was true of false. Also, the question was interpreted as requiring them to perform an operation on the numbers in the number line e.g. 1613+859+54=90 000 (A12). In addition to that, as in question 18.3, some learners may not have known what the word ‘difference’ meant in this context, since it is a word with multiple meaning. Responses like ‘one thousand and 6 hundred thetyn is big’ (A1) and ‘1613 is bigger than 859’ (A16) show that learners misinterpreted the term ‘difference’ to mean dissimilar or unlike as in the everyday meaning of difference**.** Learner A19 also misinterpreted the word ‘difference’ to mean the everyday meaning and answering why it was so resulting in the learner comparing the numbers.

The way learners interpreted this term is different from how it was used in this test. This led to ambiguity in meaning. Adams, Thangata and King (2005), in their research, highlight that working with words used in mathematics that have multiple meanings adds to the difficulty. The expected answer here was 1 613 – 859 =754 yet learners like A12 added the numbers in the number sentence, while A7 just repeated the number sentence and then wrote the last number in digits, which was written in words in the question.

Learners seemingly made comprehension errors because they failed to understand the meaning of what they read in the question. Items with more language sometimes present problems to L2 learners of English because they need to be proficient in the language in order to be able to read and understand what the question requires. Learners also have to be able to read the numbers written in words to be able to translate them to figures. The exemplars and workbooks had not asked questions like 'write a number sentence' which required such translation.

The following questions appeared in only one of each of the three classes as wrongly answered by most learners.

Item 9: 9.1 and 9.2 (class A)

Item 5: 5.1 and 5.2 (class B)

Item 6: 6.1, 6.2, 6.3 and 6.4 (class C)

Item 18.1 (class B)

Item 15.5 (class C)

These are discussed in turn.

Item 9- Time

9. Look at the departures board at the airport and answer the questions that follow.

DEPARTURES		
DESTINATION	**TIME**	**FLIGHT NUMBER**
Mossel Bay	07:45	SAA 769
Knysna	10:20	BA 172
Johannesburg	20:00	SAA 372

9.1 Write down the flight number of a flight which will depart for its destination before midday.

9.2 Write down the flight number of a flight which will depart for its destination after midday.

Questions 9.1 and 9.2 were wrongly answered by more than 50% of the learners in class A. The two questions are based on a table, where destination, time, and flight numbers are written. The context of 'flight' was likely unfamiliar to learners.

Probably the use of common transport contexts like buses might have made the item more comprehensible. Unfamiliar names and words like ‘destination’, ‘departures’, ‘midday’ and ‘flight number’ possibly added to the complexity of the question. The extra wording ‘for its destination’ was unnecessary. The question could have been written simply as: ‘Write down the flight number of a flight that will arrive before 12 o’clock midday’. There was also a possibility that some learners who attempted to answer this question did not know what time midday is. Some responses to the question included: SAA 372 (A25, B17, B30) (flight number of a flight which departs at 20:00); Johannesburg 20:00 SAA372 (B7, B20); 20:00 (A28). These showed that these learners also struggled with the meaning of the word ‘before’ because the time they gave came after midday, not before.

The other responses were**:** Mossel Bay (A23); Knysna (A2); minutes (A16); 900+1000=1900 (A18); it is 07:45 (A19, A20, B11); Mapal is and Box (A24); Duben 10:20 (A20); 09:00 (B15). Mossel Bay and Knysna are not flight numbers but rather destinations. The fact that learners A23 and A2 wrote the names of these destinations as responses to question 9.1 is a clear indication that they did not understand what a flight number is and misinterpreted it to mean place. This showed lack of understanding of the demands of the question. Learners A16 and A18 did not have any idea of what the question was asking for. Their answers indicated that they were unable to access the question. Probably they could not read the question. Item 9.2 was asked in a similar way. It only differed in the use of ‘after’ where ‘before’ was used in the previous question. Again, if a learner did not know what time midday is, that learner was likely to fail at answering both questions. Some of the responses to this question were: Johannesburg (A40); BA172 (A38, A25, A14); Mossel Bay (A36); 13 (A29); 06:45 (A21); 10:20 (A20); hours (A16). Learners A21 and A20 seemingly did not understand what ‘flight number’ means nor what ‘after’ or ‘midday’ means because of the responses they gave which chose departures before midday. The same applied to learners A38, A25, and A14 who wrote ‘BA 172’, which is a flight number of a flight that would depart before midday. These responses show lack of understanding of the language used in framing the questions.

Shaftel et al. (2006) found that items with long sentences, more prepositions, pronouns and words with multiple meanings were more difficult than items with fewer or none of these features for Grade 4 mathematics learners. Syntactic features like pronouns (which, its**)** in these questions added to their degree of difficulty especially for learners not proficient in English because they introduce a (possibly ambiguous) reference to another sentence element. It might not have been clear to learners what 'its' referred to. In addition to that, the sentences have prepositions (of, for, before**)** which mark the existence of an additional phrase in the sentence and hence another concept to be understood (Shaftel et al., 2006). The item itself is long (16 words) with a lot of language which makes it difficult to understand. In this item, I concluded that learners could have made comprehension errors because of the complexity of the language used.

The 2012 mathematics ANA exemplar had exactly the same table but the question that was asked was phrased more simply and shorter. The question was: Draw a clock face to show the departure time of flight number SAA 769. The workbooks did not ask questions of this nature. They only asked learners to tell the time or represent time on clocks.

Item 5- Financial mathematics

Questions 5.1 and 5.2 were wrongly answered in class B by more than 50% of the learners. Item 5 assessed the learners' knowledge of using money to buy and sell.

Mrs Mazibe buys an apple for R1, 20 and sells it for R1, 95.

5.1 How much money does Mrs Mazibe make by selling 1 apple?

5.2 How much does Mrs Mazibe make if she buys and sells 10 apples?

The use of the word 'make' in question 5.1 is ambiguous which could have led to interpretations that were not included in the marking memo. It is not explicit that the question is asking for the profit made as it could also be asking for the price she gets for an apple. This later interpretation would have given the answer R1, 95. However, some of the responses to this question included: R120 (B25); R1, 20 (B16); R20 (B15); R1 (B19, B28); 195 120 (B13); 107/5 (B5); R512 (B4); R1, 20 + R1, 95=R2, 110 (B30). It is difficult to establish the computation processes the learners used when answering this question. Learner B16 rather gave the buying price again, while B13 gave both the buying and selling price (195 120). As some learners seemingly could not interpret what the question required them to do, they responded by doing something with the numbers, mostly adding them e.g. (R1, 20 + R1, 95=R2, 110) B30. The same learners did not also know how to write amounts of money in figures. For example, 195 120 (B13) and R2, 110 (B30) above. Some of these learners could not add money, e.g. R1, 20+ R1, 95=R2, 110 (B30). Other responses may have been random guesses e.g. R20, 107/5 and 512.

These questions consisted of long sentences (10 words for 5.1 and 12 words for 5.2) and thus too much language may have confused learners especially considering their limited proficiency in the language used. Items 5.1 and 5.2 were assessing mathematical operations, specifically if learners understood how to add or subtract amounts of money. Martiniello (2008) argues that item length in words is a well-accepted index of linguistic complexity and has been shown to generate comprehension difficulty. Learners' responses showed both transformation errors and comprehension errors. Comprehension errors relate to failure to get the meaning of what one has read. In this instance it could be either that the learners figured out what the item was asking but did not know the operation to use or they did not get the meaning of the question and therefore, failed to answer it or chose an incorrect operation.

Item 6- 4 operations

Calculate the answers for questions 6.1– 6.4.

6.1 3 456 + 2 909

6.2 5 433 – 2 104

6.3 78 × 42

6.4 654 ÷ 6

In item 6, there was minimal language. Learners seemed to know what was required as they had recognition rules which helped them to determine what the context demanded (Bernstein, 1996), but they were unable to perform the required calculation be it adding, subtracting, multiplying or dividing in these large number ranges. Additionally, most learners were not able to go through some of the stages of the calculation processes to get partial marks for these questions. Thus, their lack of competence in the 4 operations using large number ranges was the likely problem in this case rather than the language used in the question which was minimal.

The 4 operations for such high number ranges lends itself to algorithms, which are not done in the FP. Using algorithms was something learners started at Grade 4 and they were clearly still struggling with them. Since concrete counting was not possible since the numbers were too big, learners would have needed to either use a 'breaking up' method or an algorithm. Schollar (2008) and Hoadley (2007) assert that concrete counting is still dominant in the IP classes. Krauthausen and Scherer (2001) argue that weaker children have trouble generating computational strategies from finger or concrete counting. With time, children who only use counting strategies tend to obtain fewer correct results than those who use other computational strategies. In this context, learners had to use other methods which they were not fluent in. They therefore, did not score part marks for these questions.

Item 18- Data handling

Question 18.1 assessed learners' knowledge on organising and recording data. Most learners in class B answered this question incorrectly.

18.1 Complete the tally table.

KIND OF SPORT	TALLY MARKS
Golf	
Baseball	
Tennis	

Tally/frequency tables should have been familiar to the learners because the 2012, 2013 exemplars as well as the workbooks have exercises on completing tally tables and identifying the 'favourite' or most frequent item. However, instead of writing tally marks, most learners in this class wrote numbers under the column of tally marks, e.g. B3, B27, and B25. Others drew some pictures representing the number of items under that column, e.g.B26, B28, B32. An example might have given learners a clue of what was required. This item was mathematically easy but learners did not know what 'tally' meant. Although the term was used in the 2012 and 2013 exemplars and in the workbook (Book 1, p. 76, 77), it was unfamiliar to the learners who skipped the part of drawing tally lines and instead just counted. Indeed with a small number range like this, drawing tally lines is not useful as a simple count satisfies the requirement.

Item 15- Fractions

Question 15.3 was answered incorrectly by more than half of class C learners. The question assessed the learners' knowledge of fractions.

15.3 Use the fraction wall to calculate 1/4 + 2/4.

<table>
<tr><td colspan="4">1 whole</td></tr>
<tr><td colspan="2">$\frac{1}{2}$</td><td colspan="2">$\frac{1}{2}$</td></tr>
<tr><td>$\frac{1}{4}$</td><td>$\frac{1}{4}$</td><td>$\frac{1}{4}$</td><td>$\frac{1}{4}$</td></tr>
</table>

This question required the learners to use the fraction wall to calculate 1/4 + 2/4. This problem could however, be easily done without the use of a fraction wall. Using the fraction wall to calculate it most likely confused some learners who may have looked for 2/4 on the wall and failed to find it. Some responses that were given were: 1/4 + 1/2=38 (C23); 11 (C9, C27, C22, C31); 3/8 (C18, C19, C25); 5/6 (C21); 1/4 (C16); colouring (C14); 56 (C4, C5); 83; 3 (C10); 2124; 56 (C13); 38 (C26, C29); 15030 (C1). Learners C26 and C29 gave the answer '38'. As discussed earlier, fractions are particularly difficult because as learners are working with fractions, there is a tendency to apply their whole-number conceptual framework to fractions, interpreting a fraction as two whole numbers. Considering for example, the answer '38' that was given, learners probably added 1 to 2 and 4 to 4 to get 38. Those who got 11 probably added 1+4+2+4. Yet others may have added both the denominators and the numerators to come up with 3/8. The written form of fractions could have been difficult for the learners although fractions appear often in their workbooks (Book 1, p.18-20, 102-107; Book 2, p. 6-17) and were included in the 2013 exemplar.

That the question has some language in it may also have contributed to the failure in answering this question correctly. The response given by C14 **(**i.e. **'**colouring'**)** could also indicate that the question was not understood. The mathematical term 'fraction wall' may not have been familiar to learners. It was used once in the 2013 exemplar but not in the workbooks. Rather, the term 'fraction strip' was used more often in the learners' workbooks (Book 1, p. 19, 102, 103, 104, 108; Book 2, p. 13). Unfamiliar terms may have hindered learners from correctly solving the problems.

6.2.3 Items answered correctly by less than 10% per class

There were sixteen questions that were answered correctly by less than 10% of learners per class. I do not discuss some of them (5.2, 6.1, 6.3, 15.3, 12.1, 12.2 and 18.3) here because they have already been discussed in the other two categories above. The remaining items are those items that were correctly answered by less than 10% per class. These are items 2 (class C), 3.2 (class C), 13 (class A), 14 (class B and C) and 17 (class A, B and C). Since these questions were answered by less than 10% per class, they represented challenges to the learners which necessitated an investigation of the possible explanations for so few learners getting them right.

Item 2- Number sentences

The item read:

Complete:

(2 × 3) + (2 × 4) = 2 × (___+ 4)

Learners may have understood the instruction for them to complete the number sentence but most of them completed the blank with wrong answers. Only two operations, the addition and multiplication symbols were used on the question, unlike in item 6 which required all the four operations where they had to multiply, add, divide and subtract in one item. Some of the incorrect responses given for item 2 included: 5 (C17, C25, C8, C24); 15 (C2); 4 (C27); 2 (C4, C2O, C19, C29, C32, C33, C12, C3, C34, C10, C11); 1 (C31); 8 (C23); 28 (C6); 6 (C5); 32 (C22); 14 (C2). Like in other items, these responses largely fell into six categories: (a) answered by subtracting two numbers e.g. 4-2 getting the answer 2. This answer was given by the majority (34%) of the class. (b) answered by adding part of the numbers e.g. 2+3 to get 5 (c) answered by multiplying two numbers in the sentence e.g. 3×2 getting 6 or 2×4 getting 8 (d) answered by multiplying two numbers and adding them to other two multiplied numbers e.g. (2×3) + (2×4) getting 14 (e) answered by multiplying the above two sets of numbers and then multiply again by 2 getting 28 (f) unclear method e.g. 15 (C2) or 32 (C22). The specific skills of order of operations and understanding balance in an equation are skills learners would need in order to answer this question in addition to being able to add and multiply. While language in terms of words is not a factor here, the syntax of the mathematical equations must be understood for the learners to balance this equation.

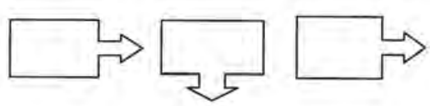
Item 3-Geometric patterns

Question 3.2 was answered correctly by less than 10% of learners in class C. It assessed the learners' knowledge of representing geometric patterns in diagrammatic form.

3. Complete each of the following patterns:

3.1 4 900; 4 925; 4 950; ________; 5 000; ________.

3.2



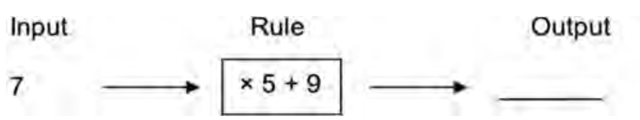
________________.

In item 3.2 some learners actually struggled to draw the diagrams. A simpler diagram could have served them better. Fifteen learners (44%) left the question unanswered. Only four learners answered the question correctly. Five learners (C34, C20, C6, C26 and C13) attempted to draw a geometric shape though unsuccessfully. Some answers for 3.2 given include: 4950 (C30); 1600 (C2); down (C21); 116 (C27); 28 (C31); 4851 (C33); 1128 (C12) 104 (C22); 49911 (C3); 12 (C23). It is likely that the learners who wrote figures instead of drawing a shape may have misunderstood the question and seen 3.2 as a continuation of 3.1. Learner C30 answered by copying one of the numbers in 3.1. Learner C21 may have had an idea that the arrow of the shape to be drawn should face downwards, thus the answer 'down'. He could not draw the diagram perhaps because the shape was not easy to draw. The other learners used unclear methods or seemingly resorted to guess work.

Item 13- Input and output values

Question 13 was answered correctly by less than 10% of learners in class A. It assessed whether the learners could determine the output values for a given input values for the flow diagram. Thirty-four out of forty (85%) learners could not correctly complete the flow diagram.

13. Complete the following flow diagram:



Incorrect responses given by learners included: 14 (A19, A3, A1,A33, A21, A30, A37, A23, A36, A11); 9+5 (A7, A14); 96 (A31); 19 (A26); 70 (A10); 6X9 (A24); 57 (A40); 18 (A20, A6); 5 (A28); 6 (C30); 11 (A8); 5X9 (A29); answer (A2, A4); fent (A9); 10 (A15, A27); 9 (A35, A34, A13); 10X18 (A12); 43 (A42); 35 (A18); 1 (A38). The answers given here also fell into five categories:

1) Firstly there were answers which showed that learners had no clue about what was to be done e.g. answer (A2, A4)**;** fent (A9) and randomly guessing answers (96, 70, 57, 18, 6, 11, 10, 43 and 1).
2) Secondly, some answers emerged from the addition of part of the numbers e.g. 9+5 getting 14**.** Thirty percent of the answers were found this way. Nothing else was done except the addition of the two numbers in the box.
3) Thirdly, some answers came as a result of multiplying part of the numbers in the flow diagram e.g. 5x9 and 35.
4) Fourthly**,** some answers like 9 and 5 emerged because the learners just wrote some of the numbers that appeared in the flow diagram. Dempster (2007) notes that if learners struggle to comprehend a question they may simply pick a word or number from the question and write it as the answer. This could be the case with the answers written, e.g. 9 and 5.
5) Lastly, some unclear methods were used to get answers e.g. 10x18. It is not clear where the 10 and the 18 came from. The answers are not just incorrect

but do not make sense, neither do they conform to a particular mathematical computation. The question was not very clear on what was to be done. The terms used, 'input', 'rule' and 'output' may have confused the learners. Learners may have lacked process skills and therefore, failed to know the procedure needed to carry out an operation. It was not very clear from the question what learners needed to do. The 2013 exemplar and even the workbooks did not ask this type of question. Therefore, it was most probably unfamiliar to the learners.

Item 14- Capacity

This item covers the learning strand measurement. Responding to this item correctly would indicate that learners know how to convert millilitres to litres and vice-versa. Less than 10% of class B and C answered this question correctly.

Poppy buys a 2 ℓ bottle of milk. She uses 500 mℓ of the milk to bake a cake.

How much milk is left in the bottle?

_______________________________________ *mℓ*

Some interesting answers given from both classes include: 3ml (B29, C9); 200 (B27); 150 (B26, B10); 500 (B30, B16); 2l (B3, C6, C2); 2kg (B8); 25 (C26); R6, 50 (C33) ½ (B14, B19, C10 B24, C16).

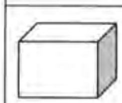
From the answers given above, it is clear that learners did not know what *l* stands for or what a litre is. In addition to that, they did not understand how to convert millilitres to litres. Learner B27 possibly tried to convert 2 litres to millilitres but got 200 instead of 2000. Learners (B14, B19, C10, B24, and C16) who wrote ½ and may have thought of 500ml being half of a litre and then came up with the answer ½ but they did not answer the question. Those who wrote 2*l* answered the question by simply copying 2*l* on the question. Probably learner C26, who got the answer 25**,** got it by dividing 500 by 2 and failed to add another zero to make it 250. There is no clue as to how learners B29 and C9 got their answers. They may have applied guess work. Learners B26 and B10 may have answered by converting 2 litres to millilitres and then subtracting 500, which is a sensible method of working out the answer, but failed to come up with 1 500 as the correct answer. Rather, they came up with 150. Learner C33 may have used his/her knowledge of the world to determine the amount of the milk bought. Whatever the likely reasons for failure, it was clear that for most learners the question was not understood.

The use of the word ‘left’ may also have confused learners because of its multiple meanings. To add to these complexities, the question is written in a passive form, which makes it more difficult to understand. Furthermore, this item has four prepositions. Multiple meaning words, prepositions and pronouns were identified in Shaftel at al.’s (2006) research as important contributors to item difficulty levels. Therefore, although learners might not have been able to convert litres into millilitres and then subtract 500 from 2000 millilitres, another problem that they might have encountered was the linguistic complexity of the item. Such an item was not asked in the 2013 exemplar and learners may have found it unfamiliar.

Item 17- Properties of 2-D shapes

Item number 17 was correctly answered by less than 10% of learners from all the three classes.

17. Complete the table

OBJECT	NAME OF OBJECT	SHAPE(S) OF THE FACES
	________________	Rectangles
	Triangular prism	Triangles and ______________

Many learners failed to name the objects given and also to name the shape(s) of the faces of the objects. Examples of responses given included: for part one: name of object (C5); box (C9, B20); name (C14); rectangles (B2, B8, C10, B7); square (A31, A4, A40, A17, A17, A26, B4, C24, C17, C19, A28); fauntz (A33); triangle (A33, B31); **7** (B23); 4 (B28); hexagon (B25, B10, B3, B32); ¼ (B6); 3 (A29); quadrilateral (A20). C4 drew a rectangle on part one**.**

For part two**:** pencil (C11); faces (C14); prism (C5, C10, C25), rectangle (A22), triangle (B25, C18, A33, C15); hexagon (A40); prism (A10, A23, B24, C32, A28, C27); mantn (A9); five (A35B23, B8, A33); 3 (B28); squar**e** (A21, B20); 1/5 (B6); 10 (A29); triangular prism (A38). Some learners drew shapes in the spaces provided e.g. B3 and C4 drew a circle, C8 drew a triangle to answer part two of the question.

There is a clear indication that these learners still struggled with identifying and naming shapes. For part one, the answer was 'rectangular prism' and for part two it was 'rectangles'. The incorrect responses for item 17 largely fell into four categories as well. Firstly, there were those answered by giving the names of any shapes they knew, e.g. rectangle, triangle, hexagon and quadrilateral, most examples given fell into this category. Secondly, there were some answered by copying some words from the table, e.g. name of object (C5) faces (C14). Thirdly, there were some answered by counting the sides of the shapes, although they failed to count correctly e.g. 10 (A29), 4 (B28); five (A35, B23, B8, A33) and 3 (B28). The fourth category is for those responses that came up as a result of not knowing what to do and as result learners wrote letters that did not form readable words, e.g. fauntz (A33) mantn (A9). Some wrote fractions (e.g. ¼ and 1/5 (B6). Such incorrect answers may be attributed to learners' inability to identify shapes, both the 2-D and 3-D. Lemke (2003) argues that learners need to know the domain-specific terminology of mathematics, that is, the specialized vocabulary (for example triangle, quadrilateral), as well as make sense of visual displays and diagrams such as the ones in item 17.

6.3 Chapter summary

The chapter presented and analysed findings for phase 2. Three classes of learners' responses and performance on the 2013 mathematics ANA tests were analysed. From the analysis of the test results, it emerged that only 10 (25%) of Santa Anna primary learners attained the 50% basic requirement and only one learner from Biko primary got close to that basic requirement (44%). This attests to the difficulty the learners in both schools experienced in writing the test.

The analysis of the test questions revealed that for many of these questions the language used was either unfamiliar or unnecessarily complex for Grade 4 learners using English as an additional language. This was compounded by the inclusion in the ANAs of linguistic forms learners would not have encountered in their workbooks or exemplars which were meant to prepare the learners for the assessments.

It was apparent from this part of the study that the linguistic complexity of items had a marked impact on the learners' poor performance in the test. Of the thirty-two questions that were analysed, the poor performance in thirty of them could be attributed to linguistic complexity. Twenty-six questions were made problematic by the length and complex grammatical patterns of the sentences. Some of these questions are questions 1 (and all its parts), 5.1, 5.2, 7, 8, 9.1, 9.2, 11, 13, 14, 15, 1, 15.2, 15.3, 15, 4, 18.1, 18, 2 and 18.3.

In addition to this, ten questions were made demanding by the use of unfamiliar words, for example, questions 15.3, 18.1, 9.1, 9.2, 18.3, 12.1 12.2 and 11. In five questions, familiar words were used in unfamiliar ways, rendering the questions difficult. Questions 1.4, 1.6, 7, 8 and 18.3 were of this nature. Six questions, questions 7, 5, 13, 9.1, 9.2 and 11 made use of unfamiliar styles of questioning. That is, the way they were asked in the 2013 ANA test had not been used before either in the workbooks or in the exemplars. In addition, the analysis showed that learners struggle with several mathematical skills even when the language was minimal.

Thus it was important to understand the causes of poor performance in these mathematics assessments and the way in which linguistic factors intertwined with mathematical difficulties. One way to do this was through interviewing the learners who made the errors to find out where they went wrong.

The findings from this analysis set up the foundation for the Newman's Error Analysis (learner task-based interviews) protocols (and selection of a sample of 26 learners) to gather evidence of comprehension difficulties for participating Grade 4 isiXhosa- speaking learners using English as LoLT in school. The next chapter,

Chapter 7 focuses on the learner interviews. In this section, learners' experiences of these questions from individual interviews conducted with the learners are analysed.

CHAPTER 7: ANALYSIS AND FINDINGS OF LEARNER INTERVIEWS (PHASE 3)

7.1 Introduction

This study sought to understand the linguistic challenges of the 2013 Grade 4 mathematics ANAs as well as the difficulties encountered by learners as they solved mathematical problems. In this section, the findings that emerged from the learner task-based interviews provide insight into the difficulties experienced by learners as they solved mathematical problems. In the previous section, test items and learners' responses to items, as well as learners' performance in the 2013 ANA test items were analysed. From the previous section's analysis of the test results, it emerged that only 10 (25%) of Santa Anna primary learners attained at least 50% (considered the basic requirement) and only one learner from Biko primary got close to that basic requirement with a score of 44%. This attests to the difficulty the learners in both schools experienced in writing the test. There was therefore, need to understand this poor performance in the assessment, with a particular interest on the role language played in influencing learners' participation and performance. This necessitated interviewing learners on a selection of items that registered the poorest performance, as I indicated in the methodology section. The interviews were conducted after school. Because the interviews could not be conducted on all the questions (to avoid overwhelming and fatiguing the learners), questions in which more than half of the learners in the three classes underperformed were selected for the interviews. Not all learners could be interviewed (there were 106 learners from the three classes). I therefore, interviewed nine learners from class A, eight from class B and nine from class C. I had selected nine learners from class B as well but one learner chose not to participate. I selected three top performers, three middle performers and three lower performers for interviews from each class, as was indicated in the sampling procedure in Chapter 4.

This study proceeds to explore the hypothesis that, for many of the ANA questions, the language used was either unfamiliar or unnecessarily complex for Grade 4 learners using English as an additional language. The hypothesis was confirmed by the analysis of the linguistic complexity of the ANA test items (see Chapter 5), which revealed that 28 out of 38 questions (73.7%) had an LCI of more than 10 which indicates that the language was indeed complex (even for first language English learners). The task- based interviews concentrated on error analysis and was conducted on the twenty-six selected learners' responses from the two schools. The interviews sought to explore the following research questions:

- What difficulties do learners experience as they solve particular mathematical problems?
- Which of these difficulties can be attributed to linguistic factors?

As discussed in the literature review, learners have trouble solving mathematical problems and these present in different ways. According to Newman (1977), these include:

- failing to read questions
- failing to comprehend questions
- failing to identify the proper mathematical operations to use
- failing to carry out correct procedures when solving problems
- failing to provide an acceptable written form of the answer.

Newman (1977) also found that in the process of problem solving, learners normally make careless errors and give incorrect answers because of a lack of motivation to answer to their ability level. The learner interviews were conducted with these difficulties in mind in an attempt to ascertain the cause of individual learner's difficulties. The findings from these interviews are presented below.

All the questions in the interviews were asked in English, with isiXhosa as a back-up in the event learners failed to understand a word or a question in English. The interviews were 'task-based' interviews where the stimulus tasks were the 15 selected 2013 ANA questions. Interview time ranged from thirty minutes to one hour thirty minutes, depending on how fast or how much mediation was required by individual learners. Probing questions followed the presentation of each ANA question based on learner responses. Audio recordings of the interviews were made to capture the instances of difficulty like hesitations and silences evident in learner responses which would have been difficult to document otherwise.

As with the points made by Newman, the following types of difficulties were detected during the learners' interviews: reading, comprehension, transformation, process skills, encoding difficulties with an additional category of difficulties engendered by carelessness.

7.1.1 The style and format of the interviews

As in Casey's (1978) study, this study modified and adapted the Newman Error Analysis to suit the present research. The interview explored learners' demonstration of their competence in all five skills on the selected items. Learners were helped at 'break down' points, for example, helping them to read a word that they could not read. Newman (1977) calls such 'break down' points errors, but in this study, I refer to them as difficulties because if a learner indicated that they did not understand what a 'square' is or what 'multiply' meant, they would not have made an error but rather pointed to a difficulty in understanding a word or concept meaning.

An understanding and appreciation of the findings this chapter presents is dependent on a clear understanding of the process that led to those findings. Thus, it is imperative to devote this sub-section to detailing that process which was briefly outlined in the methodology section. The discussion of the process logically follows on from the analysis of the previous chapter since the choice of ANA items used for interviews emanates from the findings of that chapter.

During the interviews, learners were taken through a process of reading the questions, interpreting them, and solving the problems once difficulties were noted and mediated. Care was taken not to correct errors during the interview, but rather to focus on the difficulties learners experienced in order to provide basic mediation that would enable movement to subsequent stages of the problem solving process. The interview thus involved questioning and probing to follow-up on the learners' responses in order to establish understanding of the 15 identified questions (from Chapter 5). See Appendices F and G for the full interview schedule and the interview questions.

Each interview began with an introduction by myself as the researcher and my translator. That was followed by clarification of the purpose of the interview, which was to understand how learners made sense of the ANA questions. Thereafter, learners were asked to verbally confirm their willingness to participate. As indicated in the ethics section, prior to the interviews, permission had been obtained from all relevant persons and authorities (teachers, principal, parents, and department of education). Each learner was given a pencil to write with and a sheet with the 15 questions (see Appendix F for sheet) on which the interview was based and where they would also write the answers.

Each learner interview had several mediatory questions inserted at the different and largely sequential stages (and/or skills) of reading, comprehension, transformation, processing, and encoding. This order emerged in the majority of questions which required learners to demonstrate their ability to read the question before the subsequent skills of comprehension, transformation, processing and encoding. Not all of the five skills were applicable for all 15 items as some questions did not require some of the skills. The probing questions at each stage generally followed the same format. The format for the probing in relation to each stage of the interview is described below:

Stage 1: Reading

Learners were first asked to read each question aloud. If the learner failed to read a word or some words, that was noted as a reading problem. Failing to read a word was exhibited by either mispronouncing a word, hesitating to read a word, remaining silent, or outright admission of the inability to read a word. If a learner was unable to read the words or sentence, those were subsequently read for them.

Stage 2: Comprehension

For this stage, learners were asked to indicate if there were words that they did not understand in the ANA question. If there were, then that was noted as a comprehension difficulty. Learners were asked to say which words or sentences they did not understand. Learners were given an explanation of the word or translation. Learners were then asked to say what the question asked them to do. Where learners failed to say what the questions required them to do or kept silent, that was noted as a comprehension problem. There was, therefore, comprehension at both the word level and the sentence level which learners were supposed to demonstrate. Learners were then provided with the meaning of the word or sentence.

Stage 3: Transformation

If a learner seemingly understood the question but failed to identify the mathematical operation or sequence of operations to successfully pursue the problem, this was noted as a transformation difficulty. Learners were then subsequently probed/steered toward the operation or skill required to solve the problem.

Stage 4: Process skills

Where the learner was able to choose the correct operation but failed to carry out the mathematical calculation correctly, I noted that as a process skill difficulty. Similarly, where learners failed to identify the appropriate mathematical operation and were prompted on the operation but could not execute it, I noted that as a process skills difficulty.

Stage 5: Encoding

Sometimes a learner was able to carry out the correct procedure in solving a problem but failed to provide a mathematically acceptable written form of the answer. Such difficulties were noted as encoding difficulties.

Additional difficulty: Careless errors

In mathematics, careless errors or slips sometimes occur (Newman, 1977). These were also noted in addition to the Newman's five 'break point' stages but were not included as part of the five difficulties because, while they cause an error to the final solution, they do not necessarily cause difficulties for the learner in working through the problem. Such careless errors were not prevalent across interviewees as only one learner (learner A28) exhibited an error attributable to carelessness.

7.1.2 Some challenges to the interview formats and categorization of questions

There were cases where some learners (e.g. learners C28, B12 and B31) struggled to read many words in the questions and as a result failed to comprehend both the individual sentences and the question as a whole. In such cases of severe limitations in reading and comprehension, even the interviewer's mediation (and in some cases even when the mathematical operation was provided) did not enable learners to successfully participate in the subsequent stages and skills. In such cases, it was not clear whether learners would have managed to complete the operation correctly (processing skills) had they only been provided with the required processing skill outside of the context of the question. I elaborate on this issue with an example.

In question 5.1 where some learners did not realize that the question required them to solve R1.95 - R1.20 to find a profit, I suggested verbally to them that they subtract the amounts. If they were then unable to perform the subtraction, that was then additionally recorded as a process skill difficulty. It was however, possible that learner demonstration of this skill would already have been affected by their lack of reading and comprehension skills which would possibly have affected their confidence in continuing with this calculation. Thus, there was no certainty that had they been given R1.95 - R1.20 in numeric form from the start, they would still have had difficulty with, or been unable to solve, the decimal subtraction in the context of money.

The use of this adapted NEA interview focused on determining whether learners' difficulties were caused by lack of proficiency in the English language, the language of the questions, or by lack of content-knowledge of mathematics. The remainder of this chapter presents the findings from the analysis of those interviews in relation to the determination of the source of learner difficulties.

Initially, all learner interviews were analysed in terms of the frequency of the types of difficulties each learner encountered across the 15 question on which the interviews were based. As already indicated, I explicitly mediated the reading and comprehension of questions and thereafter the required transformation in order to establish whether learners were then subsequently successful in demonstrating the required processing and encoding skills. Focusing on difficulties and using prompts when learners experienced difficulties, revealed a wealth of information. More so than that emanating from the analysis of the frequency of difficulties learners experienced as evidenced from the analysis of their written scripts in Chapter 5 where results of all learners across all three classes were analysed.

The data for the learner interviews was analysed both quantitatively and qualitatively. Quantitatively, the data is organized and presented in tables, summarizing the findings, displaying evidence and describing with descriptive statistics the profile of findings. The qualitative analysis presents what the interviewed learners said along with how they acted and engaged during the interview process. Thus where expressions or gestures were deemed relevant, these were noted.

From this initial reading and analysis of all learner interviews, I noted that learner difficulties with the language in which questions are couched often differed in relation to the types of questions being asked. This led me to group the 15 ANA question items that I used in the interviews into four categories as follows:

- *word problems* couched in everyday contexts and terminology (e.g. buying and selling)
- questions requiring use of *data representations* (e.g. time tables and bar graphs)
- questions requiring use of *mathematical representation* (e.g. fraction wall and flow diagram)
- *instructions to demonstrate skills* (e.g. convert this measurement; draw the other side; write a number sentence)

7.1.3 Developing categories of questions for structuring analysis of question types

The language demands of these four sets of question types vary in the amount and type of language used; some using minimal language with simple instructions and others having complex instructions, as well as differing in the range of demands in terms of mathematical register. The categorisation therefore, supported my analysis as I was able to foreground a range of difficulties that seemed prevalent in each of the categories. It also allowed me to note both differences and similarities in difficulties between the four categories. I provide the categories with their questions below. I also provide the LCIs for the questions in each category.

7.1.3.1 Category 1: Word problems

The first set 'word problems', comprised questions 5.1, 5.2 and 14.

5.1. Mrs Mazibe buys an apple for R1, 20 and sells it for R1, 95.

How much money does Mrs Mazibe make by selling 1 apple?

____ *(1)*

5.2. How much does Mrs Mazibe make if she buys and sells 10 apples?

14. Poppy buys a 2 ℓ bottle of milk. She uses 500 mℓ of the milk to bake a cake.

How much milk is left in the bottle?

_____________________________________ *mℓ*

This set of word problems generally used simple everyday language and terms such as buying, selling and baking, with little or no mathematics specific vocabulary. The words used in these questions are predominantly short and all words have less than 7 letters. The LCI for each of these is, 15.5, 17 and 11 respectively, giving a range of 6 (11-17). The average LCI for the three questions was 14.5. Remember in Chapter 5 the entire LCI range was 0- 32 and the average LCI across questions was 14.49. Thus the LCI for the three questions were slightly above average and this shows that they were not very complex in terms of language. This was largely as a result of the use of relatively short words and the absence of words belonging to the mathematical register, with high ambiguity and no passive sentences.

7.1.3.2 Category 2: Data representation

The second category, consisting of questions 9.1, 9.2, 18.1, 18.2 and 18.3, related to the representation of data and information in tabular and graphic form.

9. Look at the departures board at the airport and answer the questions that follow.

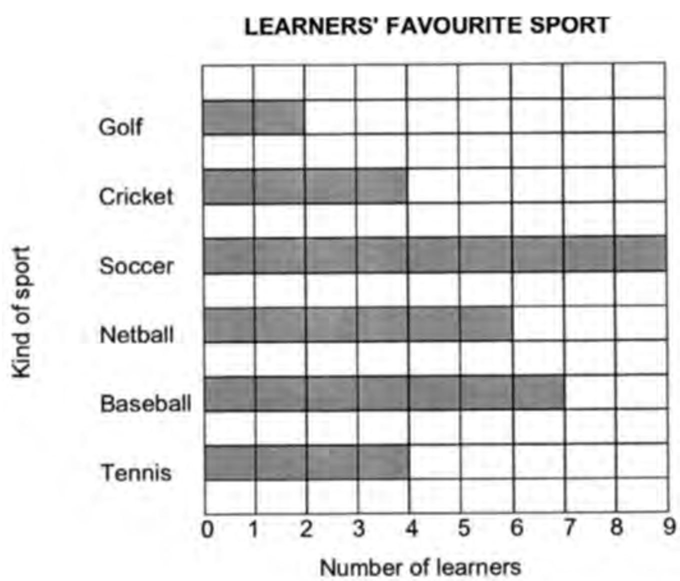
DEPARTURES		
DESTINATION	TIME	FLIGHT NUMBER
Mossel Bay	07:45	SAA 769
Knysna	10:20	BA 172
Johannesburg	20:00	SAA 372

9.1 Write down the flight number of a flight which will depart for its destination before midday.

____

*9.2 Write down the flight number of a flight which will depart for its destination after midday.*____

18. This bar graph shows the most popular kind of sport amongst the learners in Grade 4.



18.1 Complete the tally table

KIND OF SPORT	TALLY MARKS
Golf	
Baseball	
Tennis	

18.2 Which is the learners' favourite kind of sport

____

18.3 What is the difference between the number of learners who prefer soccer to cricket?

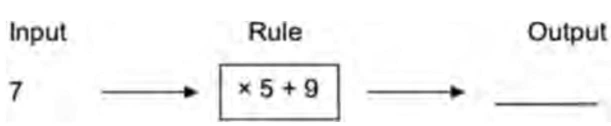
____

Some questions like questions 9.1 and 9.2 had simple instructions with no mathematics specific vocabulary although some words used like 'destination' and 'departure' were quite likely unfamiliar to learners and difficult to read due to their length. The presence of many words with 7 letters or more in these questions implied that there were many difficult words for Grade 4 English L2 learners. There was thus a high LCI in most of these questions. The LCIs for questions 9.1, 9.2, 18.1, 18.2 and 18.3 were 32, 29, 22.5, 14 and 27 respectively, giving a range of 18 (14 to 32) and an average of LCI of 24.9.

7.1.3.3 Category 3: Mathematical representation

The third category, consisting of questions 13, 15.1, 15.2 and 15.3 related to mathematical representation.

13. Complete the following flow diagram:



15. Use the fraction wall to answer the questions that follow.

<table>
<tr><td colspan="4">1 whole</td></tr>
<tr><td colspan="2">$\frac{1}{2}$</td><td colspan="2">$\frac{1}{2}$</td></tr>
<tr><td>$\frac{1}{4}$</td><td>$\frac{1}{4}$</td><td>$\frac{1}{4}$</td><td>$\frac{1}{4}$</td></tr>
</table>

15.1 Write the symbol <, > or = between the fractions to make a correct statement.

½ ___________ 2/4

15.2 Colour in ¾ of a fraction strip in the fraction wall.

15.3 Use the fraction wall to calculate ¼ +2/4.

Although in this category of questions simple instructions are used (e.g. 'Complete the following …' or 'Use the … to calculate ...'), the questions are full of mathematics specific vocabulary, e.g. 'tally marks', 'frequency', 'fraction wall' and 'fraction strip' implying that there were many difficult words for Grade 4 English first additional language learners. As with category 2 questions, the LCIs for these questions were relatively high, with a mean average of 17.25. For questions 13, 15.1, 15.2 and 15.3, the LCI's were 16, 19, 21 and 13 respectively and thus the LCI range for these was 8 (21-13) which was slightly higher than the range in category 1 and lower than the range in category 2. The length of the questions also resulted in many linguistic features, resulting in a high aggregate number of features that added to the complexity in items.

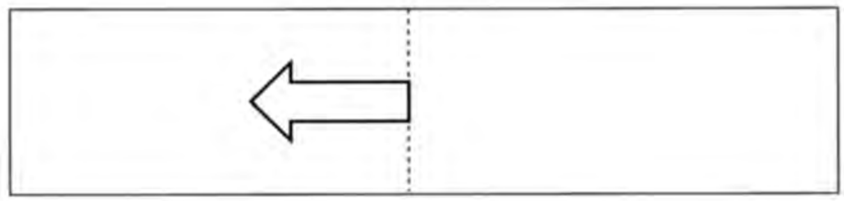
7.1.3.4 Category 4: Instructions to demonstrate skills

The last set of questions, namely question 7, 11 and 12.1 instruct learners to demonstrate a skill without reference to everyday contexts.

7. Write a number sentence for the sentence below.

The difference between 1 613 and 859 is seven hundred and fifty-four.

11. Draw the reflection of the arrow on the vertical dotted line.



12. Convert the following:

12.1 12 m 48 cm = ___________________ *cm*

Question 7 and 11 have complex worded instructions where several mathematical words have been used. These include ‘Draw the reflection of the arrow on the vertical dotted line’ and ‘Write a number sentence for the sentence below: The difference between ….’ The terms ‘reflection’, ‘vertical’, ‘difference’ and ‘number sentence’ would very likely be beyond the learners’ comprehension because they are terms within the mathematics register (consisting of more than 7 letters each). Furthermore, those words are potentially ambiguous. For example, the words ‘difference’ and ‘sentence’ which assume different meanings in everyday language use. Although in these questions neither transformation nor process skills were required, learners had to demonstrate their mathematical skills according to their interpretation of the instructions.

While question 12.1’s instruction used few words (unlike the instructions in questions 7 and 11 above), it included the mathematical term ‘convert’. This word seemed particularly challenging because even while some learners understood that ‘convert’ means change, they did not understand it as changing only the units while keeping the amounts the same. Thus, many misconstrued ‘convert’ to mean ‘change to anything’. On this question, learners had to demonstrate their mathematical skills of converting measurements.

Aside from question 11, the LCIs for the questions in this category were relatively low (as in the case of category 1 questions) with a mean average of 13.7 and a range of 13. The LCIs for questions 7, 11 and 12.1 were 16, 19 and 6 respectively. Question 12.1 had among the lowest LCI because of its minimal language usage.

In the next section I analyse all the learner interview responses within each of the four categories of questions identified above. This allowed me to determine the nature of learner difficulties across categories and to note similarities and differences in difficulties across the categories.

7.2. Findings in relation to the four categories of questions across 26 interviewed learners

7.2.1 Findings, category 1: Word problems

Recall from above, the questions in this category are as follows:

5.1. Mrs Mazibe buys an apple for R1, 20 and sells it for R1, 95.
How much money does Mrs Mazibe make by selling 1 apple?
____ *(1)*
5.2 How much does Mrs Mazibe make if she buys and sells 10 apples?

14. Poppy buys a 2 ℓ bottle of milk. She uses 500 mℓ of the milk to bake a cake.
How much milk is left in the bottle?
___________________________________ *mℓ*

Table 15 presents data for each of the three word problem questions in terms of each particular skill (i.e. reading, comprehension, transformation, process skills and encoding) that the 26 interviewed learners were able to demonstrate during the interviews. The number of questions for which each learner demonstrated a particular skill is given in the table (i.e. either 3; 2; 1; or 0 out of the three questions) followed by the question reference in brackets [] for which the skills were not demonstrated. That is, the questions in which each learner had difficulty demonstrating a particular skill. Since there are three questions in this category, a 3 would indicate that a learner was able to demonstrate that skill on all three questions under a skill. This would mean the learner had no difficulty with all questions in this category. For example, learner A27 did not have any difficulty with the skills of reading and comprehension for all the three questions. On the other hand, the same learner experienced transformation difficulties on all the three questions (i.e. a 0 in the table for A27 for this skill) and only managed the process skill required on one of the three questions (i.e. a 1 out of 3 with [5.1, 5.2] indicates that learner A27 experienced process skills difficulties on those two questions.

As mentioned above, mediatory prompts were used for each of the five skills to enable learners to demonstrate their competence in the subsequent skills required by a question. All questions in this category required all five skills.

Table 15: Learner demonstrated competences and difficulties across the five skills for the word problem questions

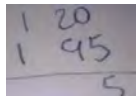
Learner [L]	Reading [max score:3]	Comprehension [max score:3]	Transformation [max score:3]	Process skills [max score:3]	Encoding [max score:3]
A27	3	3	0[5.1, 5.2, 14]	1[5.1, 5.2]	1[5.1,5.2]
A23	2[5.1]	2[5.1]	1[5.2, 14]	2[5.2]	1[5.2,14]
A28	3	2[5.1]	3	0[5.1, 5.2, 14]	1[5.1,5.2]
A22	3	2[5.1]	2[5.2]	1[5.2, 14]	2[5.2]
A4	3	2[5.1]	3	2[5.2]	2[5.2]
A17	3	3	3	2[5.2]	3
A26	3	2[5.1]	1[5.1, 5.2]	2[5.1]	3
A3	3	2[5.1]	3	1[5.1, 14]	3
A5	3	1[5.1, 14]	1[5.1, 5.2]	0[5.1,5.2, 14]	1[5.2,14]
B29	3	0[5.1, 5.2,14]	0[5.1,5.2,14]	1[5.2,14]	0[5.1,5.2,14]
B27	1[5.1,5.2]	1[5.1,5.2]	1[5.1,5.2]	1[5.1,5,2]	0[5.1,5.2,14]
B26	3	1[5.1,5.2]	1[5.1,5.2]	1[5.1,14]	1[5.2,14]
B19	3	2[5.2]	1[5.1,5.2]	0[5.1,5.2,14]	1[5.1,5.2]
B31	1[5.1,14]	0[5.1,5.2,14]	0[5.1,5.2,14]	1[5.2,14]	0[5.1,5.2,14]
B11	2[14]	1[5.2,14]	0[5.1,5.2,14]	1[5.1,5.2]	1[5.2,14]
B2	0[5.1,5.2,14]	0[5.1,5.2,14]	1[5.1,5.2]	0[5.1,5.2,14]	0[5.1,5.2,14]
B13	2[14]	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]
C17	3	3	3	2[14]	2[14]
C16	3	0[5.1,5.2,14]	1[5.1,5.2]	2[14]	2[5.1]
C21	3	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]
C8	3	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]
C28	3	0[5.1,5.2,14]	1[5.1,5.2]	0[5.1,5.2,14]	0[5.1,5.2,14]
C33	2[5.2]	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]
C24	3	1[5.1,14]	0[5.1,5.2,14]	1[5.1,14]	0[5.1,5.2,14]
C11	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]
C12	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]	0[5.1,5.2,14]
Mean Ave	2.35	1.01	1	0.81	0.92
Mode	3	0	0	0	0

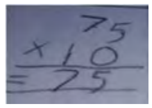
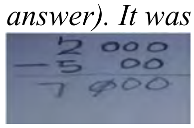
Table 15 shows the competences of the 26 learners interviewed in the 3 classes for the three 'word problem' questions. All three questions required reading, comprehension, transformation, process and encoding skills. During the interview, mediatory prompts were given by the researcher (and translator if required) at each stage to assess whether, given access to the previous skill, learners could demonstrate the subsequent skills. For some learners, this prompting worked as they were then able to engage with the subsequent steps. For example, learner A23 was initially unable to read or comprehend question 5.1 but with sustained prompts managed to demonstrate the transformation, processing and encoding skills for question 5.1. For many others however, the mediation did not result in subsequent skill demonstration and so, for some learners, processing and encoding skills could not be validly assessed. For this reason, many learners who received low scores for reading and comprehension skills have zeros in the encoding section in table 13.

Table 15 illuminates that the reading skill has the highest mean average (i.e. 2.35 out of 3). However, the comprehension category drops to a mean of 1.01 out of 3. This perhaps suggests a 'rote' type reading skill, rather than reading for meaning. The mean for the subsequent categories further declines and given that the categories are largely sequential, it is unsurprising to see low scores in the later categories.

To give a sense of how the interviews unfolded for these questions, I provide an extract from learner A28's (a girl I have named Chulu) interview:

1	Interviewer	Can you please read the question to me, question 5.1
2	Chulu (Pseudonym)	(*reading*) Mrs Mazibe buys an apple for one rand twenty and sells it for one rand ninety five. How much money does Mrs Mazibe make by selling one apple?
3	Interviewer	Are there words that you don't understand?
4	Chulu	(*does not respond*)
5	Translator	Uyayiva? (Do you understand?)
6	Chulu	No
7	Interviewer	OK. What do you think the question is asking you to do?
8	Chulu	It's asking me that how … how, how much money does Mrs, Mrs Mazibe (*gets stuck and keeps quiet*)
9	Interviewer	OK. How are you going to find the answer?
10	Chulu	To minus at one hundred and twenty
11	Interviewer	To?
12	Chulu	One hundred and … Yoh! one rand twenty
13	Interviewer	OK. Can you please work it out here (*pointing to the space*

		on the question paper)
14	Chulu	(*writing, places one two zero on top of one nine five and starts subtracting like this*: 
15	Interviewer	Which number do you think is bigger than the other?
16	Chulu	This one (*pointing to 195*)
17	Interviewer	Do you think it is possible to subtract One rand ninety-five from one rand twenty? Remember one rand twenty is smaller than one rand ninety-five?
18	Chulu	(*counting fingers (2, 4, 6, 8) and working, got 45 after subtracting 120 from 195*)
19	Chulu	I can't do it teacher
20	Interviewer	OK. Would you like to show me how you subtracted? Can you please show me here?
21	Chulu	(*pointing*) I subtract zero to five then I got 5 cents
22	Interviewer	Ok. You subtracted zero from five. Five minus zero is five then, what did you do next?
23	Chulu	I say nine minus two
24	Interviewer	And what is nine minus two?
25	Chulu	It is four
26	Interviewer	You can count your fingers
27	Chulu	(*counting*) two, four, six, eight (gets stuck)
28	Chulu	(*Counts*) it's 7
29	Interviewer	Uhuh. OK. You can write your answer here (pointing to the sheet)
30	Chulu	(*writes one rand seventy five cents*)
Q5.2		
31	Interviewer	OK. Can you now read the next question
32	Chulu	(*Reading*) How much does Mrs Mazibe make if she sells ten apples?
33	Interviewer	Uhuh. Any words that you don't understand?
34	Chulu	No
35	Interviewer	OK. Do you understand what the question is asking you to do?
36	Chulu	How much Mrs Mazi (*touches her mouth*), how much does Mrs, Mrs Mazibe … Mazibe make if she … if she (*looks at the question*) buys and sells ten apples (*pauses looking unsure what to do*)
37	Interviewer	At first she bought one apple and sold it for one rand ninety-five and got a profit of seventy-five cents. Now she wants to sell 10 apples. How do you think are you going to get the answer? What do you think?
38	Chulu	(*remains quiet*)
39	Interviewer	Now she sells ten apples. How much is she going to get? How you would get the answer?
40	Chulu	I, I … double the seventy-five

41	Interviewer	You are right. You can speak.
42	Chulu	I multiply seventy-five by ten
43	Interviewer	Uhuh. Good
44	Chulu	(*working*) I say five multiply by zero it's five and then seven multiply by one it's seven and the answer is seventy-five 75 It was written like this: 
Q14		
45	Interviewer	OK. Number 14. Can you please read the question to me?
46	Chulu	(*Reads*) Poppy buys a two litre bottle of milk. She uses five hundred millilitres of the milk to bake … to bake a cake. How much milk is left in the bottle? (*pauses briefly then answers*) one litre fifteen millilitres
47	Interviewer	Ok. Can you tell me, how did you get fifteen ml?
48	Chulu	Because one litre is one hundred millilitres
49	Interviewer	You are almost right but one litre is one thousand ml, not one hundred millilitre. Do you now want to try and work out the answer?
50	Chulu	(*without working*) My answer is one thousand … one thousand five hundred
51	Interviewer	Could you please work it out so that I see how you are getting the answer and that someone did not tell you the answer
53	Chulu	(*Laughs and starts working. Subtracts five hundred from two thousand but the five hundred is not correctly placed according to the standard place value algorithm since the 5 is placed under 2 instead of under 0, getting 700 as her answer). It was written like this:* 
54	Interviewer	OK. When you subtract you put five hundred under that two thousand (pointing to the place under the zero digit representing hundreds)
55	Chulu	(*Works out and gets one thousand five hundred* by *writing the standard algorithm method with 'borrowing'*). It's one thousand five hundred
56	Interviewer	OK. Very good. Can you please write it down? You may write it here (*pointing to the space provided*)
57	Chulu	(Wrote one thousand five hundred on the provided on the sheet)

The extract above demonstrates the prompts used at the various stages of the interview and shows how at 'break down' points reflective of learner difficulties, mediatory prompts and or direct suggestions are given to allow learners the opportunity to demonstrate the subsequent skills required by the questions. The above extract shows that Chulu was able to read all the questions without difficulty.

For question 5.1, Chulu said she understood the question and could identify subtraction as the appropriate operation. She managed the first three skills of reading, comprehension and transformation. Her difficulty or 'break down point' on this question came with the processing skill of decimal subtraction in the context of money. When she tried to subtract, she wrote 120 on top of 195 indicating inappropriate format of the standard algorithm which places larger numbers above smaller ones. However, when she was asked which number was bigger, she knew that it was 1.95 although she still struggled with the processing skills even when told to put 1.95 on top. Following this prompt, she got 45c instead of 75c from her calculation. She said 9 minus 2 is equal to 4 indicating some careless error or guess work. This manifested a process skills difficulty with decimal subtraction. She was however, aware of her error and with some prompting and encouragement to use her fingers to subtract and confirm her answer, she eventually got the right answer. However, the answer she wrote in the space provided was wrong (instead of writing 75c she wrote R1.75). This was considered a careless error rather than an encoding error.

On question 5.2 Chulu once again managed the reading and, with some mediatory input, seemingly comprehended the question sufficiently to appropriately identify multiplication as the required operation (i.e. transformation) but once again she struggled with the processing skills for 75 x 10. Here, rather than using mental calculation, she again relied on the use of a standard algorithm but made placement errors in the execution of the algorithm.

In question 14, Chulu managed the reading, comprehension and transformation skills required. However, due to an incorrect processing skill of conversion of litres to millilitres, she initially made a processing error. (She erroneously stated that 1*l* equals 100ml). However, with correction on this aspect of the transformation, she was able to subtract 500ml from 2000 ml mentally without the need for paper and pencil. However, when prompted to show her working on the answer sheet, she once again made a placement error when trying to represent this in terms of the vertical algorithm for subtraction, [i.e. she subtracted 500 from 2000 but the 5 was placed under 2 instead of under the 0 which led to a wrong answer of 700]. It was apparent in all the questions that the learner struggled with the processing skill of subtraction when using the algorithm although she understood the requirements of the question and could solve it mentally.

Each of the learner interview responses were analysed in a similar fashion to the way described with Chulu (learner A28) above. Below, I provide a summary of the analysis across learner interviews on the three word problem questions in category 1.

Themes emerging from analysis of learner competences and difficulties as indicated in Table 15 across the 26 learners in the three classes for category 1 (word problems)

Themes emerging in relation to the five skills/stages assessed in word problems are discussed below.

Theme 1: Reading skills were generally stronger than the subsequent skills across the three classes for these word problems and were generally stronger than for other categories of questions

Performance in reading on the whole was stronger than on the subsequent skills across all three classes. The modal score for reading skills across all 26 learners was 3, indicating that most learners (17 out of 26) were able to read all three questions (additionally the modal scores for each class A, B and C was 3). [The modal scores on the other four skills was 0; 0; 0; 0]. The strongest reading skills were demonstrated in class A where 8 out of 9 learners were able to read all of the three questions. In class C, 6 out of 9 learners managed the reading while in class B, only 3 out of 8 learners were able to read all three questions.

Overall, the reading skills demonstrated across questions for all 26 learners were similar with six learners having problems with question 5.1, five learners with question 5.2 and six learners with question 14. Three of the six learners who demonstrated difficulty with reading question 14 (i.e. B11, B2, B13) had difficulty reading the word 'uses' and the other half (i.e. B11, C11, C12) failed to read the word 'buys'. This explains why later in the interview process these and other learners failed to interpret the mathematical meaning of 'uses', leading to misunderstanding the requirements of the question.

Three of the six learners who demonstrated difficulty with reading question 5.1 (i.e. B27, C12, B31) had difficulty reading the word 'selling' and the two out of six learners (i.e. C11, C12) struggled to read the word 'buys'. The other two learners (B2, C12) could not read the word 'does'. Later again in the interview process, the same learners confessed to not understanding the meanings of these words.

Similarly, for question 5.2, two (B27, C12) out of the five learners who had difficulty reading this question struggled reading the word 'buys' and the other three learners (i.e. B2, C33, C12) had difficulty reading the word 'does'. As in question 5.1, some learners (C11 and C12) could not read the word 'make'. Interestingly, learner C12 who experienced difficulty in reading the word 'does' in question 5.1 could not read the same word again in question 5.1 even though the word had been read to them. Words like 'does' and 'make' were probably not easy for learners to read because their pronunciation do not correspond with their sounds.

Possible reasons why learners had fewer difficulties with reading questions in this category of questions (compared with the other four categories discussed below) could be because the questions were embedded in everyday familiar words and did not include words with a high mathematical register. Wolf and Leon (2009) posit that the overall amount of mathematics register in word problem items often cause difficulty for learners learning mathematics in English. The absence of such mathematics specific words in these questions most likely made the reading of the questions easier.

Theme 2: Everyday comprehension of terms used does not necessarily signify comprehension of the mathematical intention behind its use in an assessment context.

The mean average across the 26 learners for the comprehension of the three questions in this category was 1.08 (that is, on average learners were able to comprehend 1.08 of the three questions) while the modal average was 2. The modal average, however, differed across the classes with modes of 2, 1 and 0 across classes A, B and C respectively. Thus, comprehension skills were weaker than reading skills and much weaker for classes B and C who started learning in English in Grade 4.

As indicated above, transformation skills are closely linked to comprehension skills. Identifying the appropriate mathematical transformation requires comprehension of the mathematical demands of the terms used in the question within the assessment context. As indicated in the sample interview transcript, where learners struggled to comprehend the question, an explanation was given in order to assist learners to demonstrate their transformation skills where comprehension was established.

The least understood question in this category was question 5.1 (not understood by 21 learners), followed by question 5.2 (not understood by 15 learners) and question 14 (not understood by 14 learners). For question 5.1 and 5.2, while the learners demonstrated that they comprehended the context of the question in that they could say what the question was asking them to do, the errors they made showed that they did not understand the mathematical requirements of the question. Examples are learners A27, A5 and C28 who, despite saying they understood question 5.1, went on to add R1.20 to R1.95 instead of subtracting R1.20 from R1.95. Only 7 out of 26 (about a quarter) learners managed to execute the transformation to a subtraction operation for question 5.1. On question 5.1 (and 5.2 following on from it), many learners did not understand the word 'make' as to mean the money that she got *after deducting* her expenses.

Thus, although learners purported to be able to read and comprehend questions, it was interesting to note that only 5 comprehended the mathematical demands of the questions to the extent of appropriately transforming the question into a valid mathematical operation. Most learners understood the words used and the context of the questions, but that understanding was not necessarily in relation to its mathematical intention within the assessment context. I expand on this with an example which indicates the strong interdependence between comprehension and transformation and demonstrates that everyday comprehension may not necessarily cohere with the mathematically intended use of the everyday term within the assessment context.

Example of a learner response to 5.1

5.1 Learner B29 reads:

"*Mrs Mazibe buys an apple for R1, 20 and sells it for R1, 95.*

How much money does Mrs Mazibe make by selling 1 apple?"

She then says 'the question required me to addition these two things and work out what the answer is'. She then wrote 1.20 + 1.95 and got 3.15. The learner's response thus shows some comprehension of the R1.95 as money she makes (or gets) but this understanding without considering the deduction of expenses is insufficient to lead to the appropriate mathematical operation.

The above example illuminates the way in which the word 'make' in this assessment context (which is intended to signify the mathematical concept of *profit* and hence to imply the amount obtained after *subtracting* initial costs from amount of money received from selling – as indicated by the marking memorandum) is interpreted by the learner differently. Most students understand the notion of 'making' money to involve getting money through various means but few understand it in terms of the concept of profit and thus would not necessarily connect this term to the need for transforming the information into a subtraction operation where expenses are deducted. Thus, the concept of profit is embedded in the term 'make' in this assessment in a way which is not necessarily visible to learners. Although the term 'make' may have made the question easier to read, as it is quite familiar in literacy readers (compared to the more technical term 'profit'), it obscured the mathematical demands of subtracting costs required by the question.

Only 13 out of 26 (half) learners managed to do the appropriate transformation for question 14 which was: *Poppy buys a 2 ℓ bottle of milk. She uses 500 mℓ of the milk to* *bake a cake. How much milk is left in the bottle?* The other half of the learners did not understand the mathematical meaning of the question. For example, learner C33 said she would get the answer by adding four five hundreds, learner C24 said she would divide 2000 by 500 and learner B21 said he would add 2000 to 500. On the other hand, some learners (e. g. B29, B13, C33 and others) stated that they did not know what to do in order to get the answer.

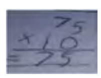
Thus, similar to the case of the interpretation of the word 'make' in 5.1 and 5.2 explained above, the word 'uses' in the statement 'She *uses* 500 ml of the milk', while understood as using or having that 500ml quantity of milk was not necessarily comprehended as being taken from the existing amount of 2 litres. The word 'the', while easy to read, was not read by all to imply reference to *the* 2 litres of milk referred to in the previous sentence and was thus another source of complication in this context. From this, it was evident that it is not only the longer words (more than 7 letters) which create linguistic complication, but also shorter and highly familiar words which take on slightly new contextual meanings. Thus shorter words with fewer syllables, shorter sentences, and active verb tenses may not be easier to read (Connaster, 1999, cited in Oakland & Lane 2004, p. 16).

Theme 3: Dependency on algorithms presents difficulties even for simple processes

Processing skills and encoding skills are closely intertwined as learners usually need to perform a process (such as converting rands to cents and vice versa) in order to provide the appropriately encoded answer. I therefore, discuss these together in relation to this theme.

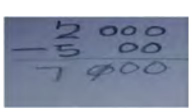
Demonstration of processing skills was weaker than that of reading, comprehension and transformation skills and significantly weaker for classes B and C who also had weaker skills in reading and comprehension. The modal score across all 26 learners was 0 and almost half of the learners (11 out of 26) were unable to employ requisite process skills for all three questions. [The modal scores on the three classes was 2; 1; 0;]. The strongest process skills were demonstrated in class A where 4 out of the 9 learners successfully managed the process skills for 2 out of 3 questions. In class C, 2 out of the 9 learners managed the process skill for 2 out of 3 questions while in class B, none of the learners was able to manage the process skills for 2 of the 3 questions.

As indicated above, process skills are closely tied to encoding skills and coming up with the appropriate encoding requires the correct processing of the mathematical problem. The processing difficulties were mostly with decimal subtraction (required in the context of money) and large number subtraction (required in the context of 2 000 ml-500 ml). The learners' greatest difficulties were experienced when they used algorithms for operations rather than performing calculations mentally. For example, for question 5.1, learner (A27), when prompted to subtract 1.20 from 1.95, wrote 1.20-1.95 (vertically) and got 1.25. This was a placement error which led to a wrong answer, and hence wrong encoding. Thus, instead of subtracting 1.20 from 1.95 mentally, which may have been easier, she resorted to an algorithm. However, due to faulty number placement and the misalignment of numbers, the algorithm resulted in processing difficulty.

In question 5.2, learner A33 was prompted to work out 75 times 10. Instead of doing it mentally, he wrote: 

Again we see that he was trying to use an algorithm in order to solve the problem. Because he did not know how to use the algorithm appropriately, he faulted by writing 75 instead of 750. Had the learner done this mentally he possibly could have come up with the correct answer, if he knew the times pattern of 10. The absence of encoding this answer in the context of money as 75c or R0. 75 indicates perhaps unawareness of the importance of encoding answers in relation to the context. Learner A28's answer '5' and not '5c' is an encoding error.

When some learners were prompted to subtract 500 from 2 000 they struggled to do the subtraction. For example, learner A28 wrote:



Instead of arriving at 1 500 as the answer, she came up with 700. These examples illuminate the way in which learners struggle with processing skills for operations if they choose to use an algorithm instead of solving the problem mentally. Although the learner knew the correct operation to use, she struggled with the process skills.

Overall, with regard to processing skills, the question in this category that was done more successfully than any other was question 5.1, with 8 out of 26 learners being able to execute the process skills correctly, while question 5.2 had the least number of learners (6) who were able to work it out. Ten learners failed to successfully complete the process skills for all the three questions. This suggests that although learners lacked comprehension of the mathematical language which was embedded in the everyday language used in the questions, they experienced even greater difficulty with processing skills, especially when using algorithms.

The mean average across the 26 learners for the encoding of the three questions was 0. 92 (that is on average learners were able to encode just under one of the three questions) while the modal average was 0. The modal average however, differed in class A with modes of 1, 0 and 0 respectively across classes A, B and C. Therefore, demonstration of encoding skills was the weakest of all five skills and significantly weaker for classes B and C. Only 3 learners (A17, A26 and A3) provided the correct encoding of answers in all three questions. Twelve learners did not manage encoding in all of the three questions. For some of the learners, the zeros were as a result of not reaching that stage of encoding since they failed to complete the process skills. For some they managed the processing skills (as in the examples given above) but failed to subtract or multiply the numbers and hence arrived at the wrong answers. Therefore, they failed to encode. Overall, on the encoding skill, the question that was encoded better than any other was question 5.1, with 10 learners being able to encode correctly, while question 5.2 had the least number of learners (5) who were able to encode it correctly.

Looking at the overall analysis of the questions in this category, most learners performed well on comprehension and transformation (12 and 14 learners respectively) in question 14 where the everyday comprehension of terms used was linked to comprehension of the mathematical intention or demand of the question.

The best performance in reading was on question 5.2 possibly because it had fewer words to read compared with questions 5.1 and 14.

The worst performances were in comprehension of 5.1, transformation of question 5.2 and encoding of question 5.2. As discussed above, the comprehension difficulty was because learners did not understand the mathematical meanings of the everyday language used in the questions, for example, the use of the words 'make' and 'use'. The following section discusses the second category of questions which have to do with representation of data and information in tabular and graphic form.

7.2.2 Findings for category 2: Data representation

Recall from above that the questions in this category are as follows:

9. Look at the departures board at the airport and answer the questions that follow.

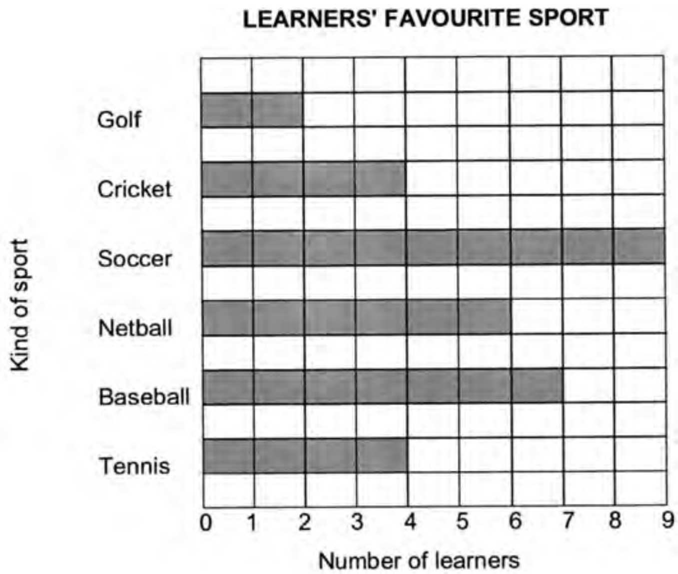
DEPARTURES		
DESTINATION	TIME	FLIGHT NUMBER
Mossel Bay	07:45	SAA 769
Knysna	10:20	BA 172
Johannesburg	20:00	SAA 372

9.1 Write down the flight number of a flight which will depart for its destination before midday.

____

9.2 Write down the flight number of a flight which will depart for its destination after midday.

18. This bar graph shows the most popular kind of sport amongst the learners in Grade 4



18.1 Complete the tally table

KIND OF SPORT	TALLY MARKS
Golf	
Baseball	
Tennis	

18.2 Which is the learners' favourite kind of sport

____

18.3 What is the difference between the number of learners who prefer soccer to cricket?

Table 16 presents data on the five questions that test the skills of reading, comprehension, transformation, processing skills and encoding that the 26 learners were able to demonstrate during the interviews. As with Table 15, the number of questions each learner demonstrated a particular skill for is given in the table (i.e. either 5; 4; 3; 1; or 0 out of the five questions) followed by the questions in which they had difficulty demonstrating a skill. Hence, a 5 indicates that a learner was able to demonstrate a particular skill (e.g. reading) on all the five questions and had no difficulties in this skill. In questions 9.1, 9.2, 18.1 and 18.2, no transformation or process skills were needed and therefore, a 1 under the transformation and process skills indicates that the learner was able to demonstrate the skill on question 18.3 without any difficulties.

Table 16: Learner demonstrated competences and difficulties across the five skills for the data presentation questions

Learner	**Reading [max score: 5]**	**Comprehension [max score: 5]**	**Transformation [max score:1]**	**Process skills [max score:1]**	**Encoding [max score:5]**
A27	5	2 [9.1, 18.1, 18.3]	1	1	5
A22	5	4 [9.1]	1	1	5
A3	4 [9.1]	4 [9.1]	1	1	5
A4	5	4 [18.3]	0 [18.3]	1	5
A5	5	3 [9.1, 18.3]	1	1	5
A23	2 [9.1, 9.2,18.1]	3 [9.1,18.3]	1	0 [18.3]	3 [18.1,18.3]
A28	5	3 [9.1,18.3]	1	0 [18.3]	5
A17	5	4 [9.1]	1	1	5
A26	5	3 [9.1,9.2]	1	1	5
B29	5	1 [9.1,9.2,18.1,18.3]	1	0 [18.3]	4 [18.3]
B26	5	3 [9.1,18.3]	0 [18.3]	1	5
B11	3 [9.1,18.1]	1 [9.1,9,2,18.1,18.3]	0 [18.3]	1	5
B27	1 [9.1,9.2,18.1,18.2]	1 [9.1,9.2,18.1,18.2]	1	1	1 [9.2,18.1,18.2,18.3]
B2	1 [9.1,9.2,18.1,18.3]	1 [9.1,9.2,18.1,18.3]	1	1	5
B19	4 [9.1]	1 [9.1,9.2,18.1,18.3]	0 [18.3]	1	5
B31	0 [9.1,9.2,18.1,18.2,18.3]	0 [9.1,9.2,18.1,18.2,18.3]	0 [18.3]	1	3 [18.1,18.2]
B13	2 [9.1,9.2,18.1]	0 [9.1,9.2,18.1,18.2,18.3]	1	1	5
C33	3 [9.1,18.1]	2 [9.1,18.1,18.2]	1	1	5
C21	3 [9.1,18.1]	2 [9.1,18.1,18.3]	1	1	5
C17	5	4 [9.1]	1	1	5
C11	0 [9.1,9.2,18.1,18.2,18.3]	0 [9.1,9.2,18.1,18.2,18.3]	1	1	3 [9.1,9.2]
C8	4 [9.1]	2 [9.1,9.2,18.1]	1	1	3 [9.2,18.1]
C28	3 [9.1,18.1]	2 [9.1,9.2,18.1]	0 [18.3]	1	2 [9.1,9.2,18.1]
C24	4 [9.1]	2 [9.1,18.1,18.3]	1	1	5
C12	0 [9.1,9.2,18.1,18.2,18.3]	0 [9.1,9.2,18.1,18.2,18.3]	1	1	5
C16	4 [9.1]	3 [9.1,18.3]	1	0 [18.3]	5
Mean	3.38	2.1	0.76	0.84	4.39
Mode	5	2 & 3	1	1	5

Table 16 shows competences for the 26 learners for the five questions requiring use of data representations. All the questions required reading, comprehension and encoding skills. Questions 9.1, 9.2, 18.1 and 18.2 did not need transformation and processing skills. For questions 9.1 and 9.2, learners only had to interpret or make sense of the time on the table without making any calculations. Questions 18.1 and 18.2 required learners to interpret the information on the graph. No calculations were required. As in the previous category of questions during the interview, the interviewer gave mediatory prompts at each stage in order to assess learners' ability to demonstrate subsequent skills if the earlier ones were supplied. For example, learner A3 failed to read and comprehend question 9.1 but with the prompts, managed to exhibit the subsequent transformation, processing and encoding skills required. As in the previous category of questions, for some learners (e.g. learner B29) despite the mediation provided on a question, they still could not exhibit the subsequent skills of processing and encoding. However, in this category, the encoding frequencies are higher than the category 1 in spite of the values for prior skills being low.

As in category 1, in order to provide the reader with a sense of how the interviews proceeded for these 5 questions, I provide an exemplar extract from one interview with learner B13, a girl I have named Tino. The interview transcript is as follows:

1	Interviewer	Can you please read the question to me?
2	Tino (Pseudonym)	(*Reads*) Look at the … (*pauses for seconds*)
3	Interviewer	Can you please continue reading? What is that word?
4	Tino	(No response)
5	Interviewer	It is 'departures'
6	Tino	(*Continues reading*) look at the departures bond at the
7	Interviewer	This word is 'board' (pointing to the word)
8	Tino	(*continues reading*) board at the arapot … arapot
9	Interviewer	It's 'Airport'
10	Tino	(*Continues reading*) airport and answer the question the, that follow.
11	Interviewer	Uhuh (*reads for the learner*). Look at the departures board at the airport and answer the questions that

		follow. (Clarifies) When you go to the airport, you see a board like this. Can you please read this word? (*Points to the word 'departures'*).
12	Tino	(*remains silent*)
13	Interviewer	Right. It is the same as this (pointing to the other word 'departures')
14	Tino	Depatowo
15	Interviewer	It's 'Departures'
16	Tino	Departures
17	Interviewer	Yes. Can you please read this one? (*pointing to the word 'destination'*)
18	Tino	dens-denst … (*could not read)*
19	Interviewer	It's 'Destination'. What about this one (*points to the words flight number*)
20	Tino	Flight number
21	Interviewer	Good. So this board is showing where flights are going and where they are coming from and the time that they are leaving the airport. So destination is the place where they are going. So (*pointing to flight names*) this plane is going to Mossel Bay, this one to Knysna, this one is going to Johannesburg. It's going to Johannesburg at twenty hundred hours. This one is going to Mossel Bay at seven forty-five and the flight number of the flight number that is going to Mossel Bay at seven forty-five is SAA seven sixty-nine. This is the flight number and that is the name of the flight. Ok. Do you remember what destination means?
22	Tino	(*No respons*e)
23	Interviewer	The place where it is going. To depart is to leave a place going somewhere. Right?
24	Tino	(*looks lost*)
25	Translator	Uthi to depart Ukusuka kukushiya indawo usiya

		kwenye. (*Depart is moving from one place to another)* Destination isiphelo sohamba kulopho uya khona (*destination is where you are going*)
26	Interviewer	OK. Do you get it now? Let's look at this table. It is just the same as that one but this one is made simple. We said destination means going to. They leave at these times, then these are the flight numbers, the number of the planes. Now, can you read the question?
27	Tino	Write down the flight number of the flight which would depet…
28	Interviewer	Depart. Depart, you remember what it means?
29	Tino	(No response)
30	Interviewer	It means 'Leave'
	Tino	Leave (*continues reading*) depart for it di … (*pauses*)
31	Interviewer	Destination. Destination, where it is going
32	Tino	(*continues reading)* destination before myd, myd …
33	Interviewer	Midday
34	Tino	Midday
35	Interviewer	Uhuh. Midday. Do you know what midday means?
36	Tino	(*No response*)
37	Interviewer	Twelve o'clock. Then, afternoon. After twelve o'clock you then go to past twelve then one then two. So midday is the middle of the day. So now do you understand what the question wants you to do?
38	Tino	AH ah No
39	Translator	Uthi bala pantsi iflight number ezihamba zifike pamko 12 imidday. Bhala pantsi iflight number. (It says '*write down the flight number of the flight that departs after 12 midday. Write the flight number'*)
40	Tino	Ndibhale inumber eyi *one na*? (*Should I write one number?*)
41	Translator	Ungayibala ibe yi*one* ukuba uyafuna *(you can write the*

		one you want)
42	Tino	(*writes the answer SAA769*)
43	Interviewer	OK. Good. Now can you to me read the next question?
44	Q9.2	
Q14	Tino	(*Reads*) Write down the flight number of a flight which would depend …
45	Interviewer	Depart
46	Tino	(*continues reading*) depart for each, it destination after mad, midday
47	Interviewer	Ok. Can you now write it down here (*pointing to the space provided on the answer sheet*)
48	Translator	Uyawuqonda na umbuzo? (*Do you understand the question?*)
49	Tino	Ah ah (*nodding to say No)*
50	Translator	Uthi Bala phantsi uflight number yenqwelo ntaka ezawuphuma emva kwemini (*It says 'write down the flight number of the flight that departs after 12'*)
51	Tino	(*writes a wrong flight number BA172*)
52	Interviewer	OK. Ten twenty This is twenty past ten. It's still before twelve, before midday. So we want a flight that departs after twelve midday.
53	Tino	(*Wrote SAA372, the correct answer*).
54	Interviewer	OK. Good.
55	Q18.1	
56	Interviewer	Please read question 18.1 to me.
57	Tino	This bar graph shows the most popular kinds of sport … (*gets stuck)*
58	Interviewer	Amongst
59	Tino	Amongst the grade four learners
60	Interviewer	Learners in grade four do these sports, can you read the names of the sports?
61	Tino	Galf

62	Interviewer	Golf
63	Tino	Golf, cricket, soccer, bat
64	Interviewer	Baseball
65	Tino	Baseball, tennis
66	Interviewer	Right. Can you read this question? (*points at question 18.1)*
67	Tino	Complete the table
68	Interviewer	Can you please complete this table? You are using this graph to complete this table. So you are looking at golf, then you will see how many learners do golf.
69	Tino	(*starts writing twos*)
70	Interviewer	Ok. Look here. Do you know what tallies are?
71	Tino	(*shakes head to say No*)
72	Interviewer	Tally marks are like this *(draws tallies on the paper)*… these marks, so you are not writing numbers you are writing tally marks. Can you try and do that
73	Tino	(writes 2s after golf, like this): 
74	Interviewer	OK, Let me show you. Tally marks are like this (*shows her again*)
75	Tino	(*draws the tally marks*)
76	Interviewer	Yes, then for baseball?
77	Tino	(*draws 7 tallies but does not cross the fifth one*)
78	Interviewer	Ok. Go to the next but next time you could cross the four with the fifth tally like this (*showing her how it is done*)
79	Tino	(*draws tally marks for tennis*)
80	Interviewer	That’s right. Good!
	Q18.2	

81	Interviewer	Can you please read to me the next question?
82	Tino	Which is the learner's favourite kind of sport?
83	Interviewer	Do you understand this question?
84	Tino	(*nods to say No*)
85	Translator	Awu understandi? (*You don't understand?)*
86	Tino	Aha
Q5.2	Interviewer	Uyawabona lamasports egolf, cricket ntoni ntoni .Eyipi yona isport yethandwayo nabafundi (*Between these sports: golf, cricket etc. which one do learners like most?*)
87	Tino	Soccer
88	Interviewer	Good. Ok. Can you please read the last question?
89	Q18.3	
90	Tino	(*Reads*) What is the difference between the numbers of learners who prefer soccer to cricket?
91	Interviewer	Is there any word you don't understand there?
92	Tino	This one *(pointing at the word 'prefer'*)
93	Interviewer	To prefer is to like. To like something and not the other thing. They are saying: what is the difference between the number of people who like cricket and those who like soccer. What is the question asking you to do? Could you try and work it out on the paper.
94	Tino	(*looks confused*)
95	Interviewer	Ok. The question is saying: More learners like soccer instead of cricket; do you see the number of learners who like soccer? How many are they?
96	Tino	(*no response*)
97	Interviewer	How many learners like soccer?
98	Tino	Nine
99	Interviewer	Good. How many learners like cricket?
100	Tino	Four
	Interviewer	Right. So what is the difference between those who like

		soccer and those who like cricket? What is the difference?
101	Tino	(*no response*)
102	Interviewer	The difference is the number you get when you minus or subtract a number. Understand? What is the difference between the number of learners who like soccer and those who like cricket?
103	Tino	Cricket
104	Translator	Uyabuza … kwekucala idifference iphuma nqcaumainasa. Uyabuza ke kuthi ingaki ledifference kubantwana badlali soccer bangu9 nabantwana labathanda icricket bayi 4, so bayafuna mahluko; nine minus four (*She is asking, at first, difference is when you subtract. She is asking for the difference between 9 soccer players and 4 cricket players*)
105	Tino	Five
106	Translator	Uhuh
107	Interviewer	Yes, good. Can you write it down?
108	Tino	Writes 5 down

This extract illuminates difficulties several learners experienced as they tried to solve the problems and the prompts used at various points where learners failed to demonstrate a skill. It also reveals the way in which translation to isiXhosa was used for several learners who seemingly struggled with the comprehension of questions in English.

In terms of the analysis of Tino's responses to the data presentation questions, the extract shows that Tino was able to read only 2 questions out of 5. Additionally, Tino did not understand all of the five questions and required both translation and mediatory prompts.

On question 9.1, her first difficulty was on the first skill of reading. She was unable to read the words 'departures', 'board', 'airport', 'destination' and 'midday'. Failing to read five words in one question compromised her comprehension of the question because she did not understand the question until the words were explained. As mentioned earlier, according to Nagy and Scott (2000), for a reader to comprehend a text, approximately 90 to 95 percent of the words in a given text should be known to the reader. Known words are words that are frequently used (high-frequency words) and are thus likely to be known by learners since they are frequently exposed to them. On the other hand, if the text is full of low-frequency words, it is likely to be difficult to read and comprehend. The words that Tino could not read are low frequency words that she was not exposed to in school readers or in everyday conversation. Hence, her second 'break down point' was comprehension of the words as well as the question. Explaining these words and rewording the question alone did not assist because the learner still did not understand and thus it was translated into isiXhosa.

The fact that Tino asked whether she should write one flight number was evidence that she understood that there were two flights that would depart before midday. This question did not need any transformation and process skills. Learners only had to identify the flight that would depart before midday and copy this flight number. The difficulties that Tino experienced were with reading and understanding the question. Once the question was translated, she was able to identify the flight correctly and write the answer in the correct format by giving the flight number.

Likewise on question 9.2, Tino was again unable to read some of the words (i.e. 'depart' and 'destination'). Tino said that she did not understand the question, which was then translated for her. She therefore, had two 'break down points' for question 9.2 which related to reading and comprehension skills. Despite the translation (and mediatory prompts), she failed to identify the correct flight number of a flight that would depart for its destination after midday. Instead of writing SAA372, she wrote BA172, which was not the correct flight though her answer was appropriately encoded (or in this case copied). When prompted further she then got it right.

On these two questions, Tino's major difficulties were reading and comprehension, pointing to a language problem. Tino struggled to read in both questions although the words 'departures' and 'destination', which she struggled to read in both questions are not mathematics specific vocabulary, they were unfamiliar words. Both words are more than 7-letters long and therefore possibly too difficult for a Grade 4 learner who had only started learning in English about seven months before the test.

For question 18.1, Tino was only able to read the words ‘amongst’ and ‘golf’ with some mediatory input. She did not know what tally marks were. In spite of an example of tally marks given, she went on to write twos after golf (instead of drawing two tallies to represent two learners who played it). With mediatory prompts, she then managed to draw tally marks for the subsequent questions. Since tally marks had seemingly not been taught or learnt by Tino, she experienced difficulties in reading and in comprehension in this question.

Tino managed the reading of question 18.2 but did not comprehend what it required her to do. When the question was translated to isiXhosa and with further prompts, she managed to come up with the correct response. Here again, her difficulty was primarily with comprehension of the language used to ask the question.

On question 18.3, Tino managed the reading but she did not understand the meaning of the word ‘prefer’. With some mediatory input, she struggled to understand the question. Also the word ‘difference’ which is part of the mathematical register is used differently in everyday language. When asked what ‘difference’ means, she did not respond. When asked ‘What is the difference between the number of learners who like soccer and those who like cricket?’ she answered ‘cricket’, a clear indication that she did not understand the question. Only when the question was translated and the transformation of subtraction was suggested to her was she able to manage the processing and encoding skills. Thus, in this question, Tino’s hurdles were comprehension of words and the question, which hindered her from identifying the appropriate operation to use.

The exemplar analysis of Tino’s transcript above indicates that Tino’s major difficulties were linguistic, particularly reading and comprehension. Both unfamiliar words and mathematics vocabulary made it difficult for her to demonstrate reading and comprehension skills.

Below I provide a summary of the key themes emerging from the analysis across the 26 learner interviews on the five data presentation questions in category 2.

Themes emerging from the analysis of learner competences and difficulties as indicated in Table 16 across the 26 learners in the three classes

Themes emerging in relation to the five skills/stages assessed in data presentation problems are discussed below:

Theme 1: Reading skills were generally weaker than the subsequent skills across the classes for this category of data presentation problems and were generally weaker in class B and class C than in class A

In contrast to the relative strength of reading skills in category 1 questions, reading performance on the whole was weaker than the other skills of transformation, processing and encoding across all the three classes. The mean average across the 26 learners for the reading of the five questions was 3.38 (that is on average learners were able to read only just over three of the five questions). Although the modal score across all 26 learners was 5, only ten learners were able to read all five questions in this category. The modal scores for each class A, B and C was 5, 5 and 1 (two modes for class B) and 4 respectively. [The modal scores on the other four skills respectively was 2 and 3 (bi-modal for comprehension); 1; 1; 5]. Recall that 1 was the maximum score for transformation and processing as only question 18.3 required these skills in this category. The strongest reading skills were demonstrated in class A where 7 out of 9 of the learners were able to read all the three questions. In class B, 2 out of 8 learners managed the reading while in class C only 1 out of 8 learners was able to read all the five questions indicating weaker reading skills for classes B and C. Class A learners managed better on the reading skill most likely because they had been exposed to English language reading from Grade 1.

Overall, on the reading skill, the question that was read better than the others was question 18.3 with 22 out of 26 learners correctly reading it, while question 18.2, 9.2 and 18.1 had 21, 19 and 16 of the 22 learners managing the reading respectively.

Question 9.1 had only 10 learners who were able to read it and this means it was the question in this category which most (16) learners could not read. Learners (e.g. A3, A23, B11, B27, B2, B31, C33, C21, C11, C8, C28) who failed to read question 9.1 and 9.2 failed to read the words ‘departures’ and ‘destination’. This explains why later in the interview process these and other learners could not understand the meaning and requirements of the question.

Ten learners failed to read question 18.1. In this question, 8 out of these 10 learners were unable to read the word ‘amongst’, 7 out of the 10 learners did not manage to read the word ‘graph’, 6 out of the 10 learners could not read the word ‘kind’ and 7 out of the 10 learners could not read the word ‘popular’. Other words that could not be read by some learners included ‘tally’, ‘bar’ and ‘golf’. Learners could not read the words ‘amongst’ and ‘popular’ possibly because they are 7-letter words, and thus can be challenging for Grade 4 level learners who are not proficient in English. Words like ‘tally’ and ‘bar’ were not easy for learners to recognise possibly because they are mathematics register words which they had not come across in everyday language or in readers and are thus unfamiliar to them.

Learners B27, B31, C11 and C12 could not read the words ‘favourite’, ‘learner’ and ‘kind’ in question 18.2. Words like ‘favourite’ and ‘learner’ are long, more than 7-letter words, which are considered difficult for Grade 4 English L2 learners. All the three words were difficult to read possibly because there is no correspondence between the spelling form and their pronunciation.

On question 18.3, 3 out of 5 of the learners who failed to read this question could not read the word ‘prefer’ and 2 of the 5 learners could not read the word ‘difference’. The word ‘prefer’ could have been unfamiliar to the learners since ‘like’ is more commonly used instead of ‘prefer’. As for the word ‘difference’, its length might have made it difficult to read.

A possible reason why learners had more difficulties with reading in this category of questions (compared with the other three categories) could be because the questions were embedded with long words and words that learners are unfamiliar with, as well as mathematical specific vocabulary. Wolf and Leon (2009) in their study on improving validity of English language learners' assessments observed that the amount of academic vocabulary in word problem items was most predictive of item difficulty for learners learning mathematics in English when English is an additional language. Martiniello (2008) also argues that problems with understanding words is related to their frequency of use. Learners are likely to know high-frequency words "since repeated exposure to words in multiple contexts is a good predictor of word acquisition" (McKeown, Beck, Omanson & Pople, 1985, cited in Martiniello, 2008, p. 335). The reading difficulties were more profound in classes B and C no doubt due to their unfamiliarity with the language compared with class A.

Theme 2: The use of long, unfamiliar words as well as ambiguous mathematical specific vocabulary compromised the comprehension of questions particularly for Grade 4 learners not proficient in English

Since comprehension skills are closely connected to transformation skills and identifying the appropriate mathematical operation to use to solve a problem requires comprehension of the mathematical demands of the question, those two skills will be discussed together under this theme. In this category of questions, only one question (18.3) required transformation skills. In the other questions, learners only needed to interpret the tables and graphs.

Comprehension on the whole was poor with no learner in the sample of 26 learners understanding all 5 questions. The mean average across the 26 learners for the comprehension of the five questions was 2.1 (that is on average learners were able to comprehend 2.1 of the 5 questions) while the modes were 2 and 3 (bi-modal). The modal average differed across the classes with modes of 3 and 4 for class A; 1 for class B and 2 for class C. Therefore, comprehension skills were weaker than reading skills and significantly weaker for classes B and C.

Although class A's reading skill was better than classes B and C's, class A's comprehension skills in this category of questions was poor. Only 4 out of 9 of the learners understood four of the five questions. Class B's performance in comprehension was particularly weak as 5 out of the 8 learners interviewed understood only one question. Similarly, in class C, only one learner was able to comprehend four questions and 5 out of the 9 learners could only comprehend two questions.

Under the comprehension skill, the least understood questions in this category were questions 9.1 (only 1 out of the 26 learners understood it) and question 18.3 (only 8 out of 26 of the learners understood it). The question that most learners grasped was question 18.2 which was understood by 20 out of 26 learners. The comprehension of question 18.2 (the one understood by most learners) could be attributed to the fact that the question was relatively short with simple everyday language and possibly easy to understand (its LCI was 14). Furthermore, learners simply had to look at the graph and identify the sport with the most learners doing it.

This was contrary to question 9.1 which was understood by only one learner. The misunderstanding of the question could be attributed to the long sentence (16 words, excluding the words in the table), although the question did not have mathematical specific vocabulary, the non-mathematical words used (destination and departures) were unfamiliar and confused the learners. In addition, question 9.1 contained the highest number of prepositional phrases (5). These include ‘at the departures’, ‘at the airport’, ‘of a flight’. As discussed earlier in chapter 5, prepositional phrases potentially confound English language learners because they mark the existence of an additional phrase in the sentence and hence another concept to be understood (Shaftel et al, 2006). Graves and Graves’ (2003) observation that long and complex sentences may also contribute to making texts difficult to read, held true in the study. In most cases shorter texts are easier to understand and remember.

Question 18.3 was one of the least comprehended questions, not understood by 18 out of 26 of the learners. The main cause of this difficulty was the word ‘difference’ which most learners took to mean ‘unlike’ or ‘dissimilar’. When learners were asked what difference means they gave an everyday meaning. For example, learner B29 said ‘difference is a thing which is not the same’. ‘Difference’ is an ambiguous word and ambiguous words have multiple meanings where assignment of the unintended meaning compromise the comprehension of the item’s demands and inevitably the response given (Sibanda & Graven, 2015).

As mentioned earlier, in this category of questions, only question 18.3 required transformation skills where learners had to identify an operation to find 'the difference between the number of learners who prefer soccer to cricket'. Learners' performance in the transformation skills in this category was better compared to other categories although some were only able to identify the operation to use after some mediatory prompts. The modal score for transformation across all 26 learners was 1 (i.e. the maximum for this category) indicating that most of the learners (20 out of 26) were able to do the transformation skills for this one question after linguistic mediation was provided.

Six learners, A4, B26, B11, B19, B31 and C28 were unable to choose the operation to find ''the difference between the number of learners who prefer soccer to cricket'. Several learners seemed to randomly choose one of the four operations rather than linking their choice of operation to what was being asked. For example, when learner A4 was asked how he would get the answer, he said 'I must take the soccer children and multiply by cricket children so that we can get the answer'. Another example, learner B26 was able to identify the number of learners who liked soccer and those who liked cricket but did not know how to work out the answer. He said he would 'add the numbers'. Similarly, learner C28 after identifying the numbers said she would say '4+9'. From these three examples, it is clear that these learners could not identify the appropriate operation to use to get 'the difference' between the number of learners who liked soccer and those who liked cricket. Failure to choose the correct operation could be attributed to the fact that they did not know the mathematical meaning of the word 'difference' even after translation or an explanation was given. If they knew that word 'difference' meant the extent of the difference in the quantities i.e. 'subtract', they possibly could have done the correct transformation. Therefore, in this question again, we see language difficulties compromising the comprehension of the question which led to transformation skill difficulties.

Theme 3: Encoding skills were broadly strong, as well as processing skills for the one question in this category that required the process skill

Here I will also discuss processing and encoding skills together since they are linked. Question 18.3 was the only question in this category which required process skills. Processing and encoding skills were strong for question 18.3 across all the three classes. The modal score for processing skills across all 26 learners was 1 indicating that most of the learners (22 out of the 26) managed the process skills for this question (the modal scores for each class A, B and C was also 1) partly because the numbers were small and easy to subtract.

Of the four learners (A23, A28, B29 and C16) struggled with process skills, learners C16 and B23 knew that they had to subtract 4 from 9 but when they did this they answered 6 instead of 5. Learner A28 said she would say 'four minus nine' instead of 'nine minus four'. The above examples point to processing difficulties for these learners even with simple single digit number computations.

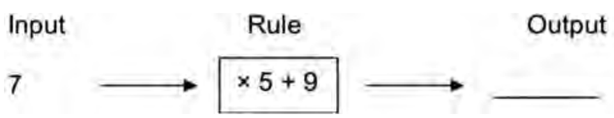
The overall performance in encoding was good in that 19 out of 26 of the learners managed to encode all 5 questions in this category. The questions that were wrongly encoded by most learners were questions 9.2 and 18.1 with 4 learners not managing to encode them. Of interest is learner B27 who had difficulties with the same questions from reading, to comprehending to encoding. Even the provision of the operation to use did not assist him.

Considering the overall analysis of this category of questions, the best performance for this category was exhibited in processing skills, with 22 out of 26 learners managing processing for all 5 questions, followed by transformation, in which 20 out of 26 learners could manage transformation, then encoding with 19 out of 26 learners correctly encoding all the questions and then reading in which 10 out of 26 learners could read all five questions. The worst performances were in comprehension. No learner could comprehend all 5 questions. Reading skills were generally weaker than the subsequent skills of transformation, processing and encoding skills across the three classes for this category and were generally weaker in class B and class C. In terms of comprehension and transformation, the use of long, unfamiliar words as well as ambiguous mathematical specific vocabulary compromised the comprehension of questions by Grade 4 learners. Processing and encoding skills were generally stronger than the skills of reading, comprehension and transformation across the three classes for the data presentation problems as well as other categories of questions and were stronger in class B and class C as well.

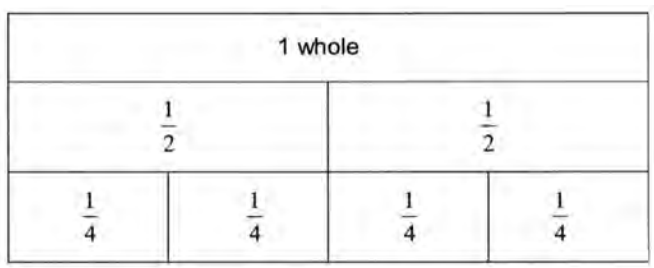
7.2.3 Findings, category 3: Mathematical representation

Recall section 6.4.3.3, the questions in this set are as follows:

13. Complete the following flow diagram:



15. Use the fraction wall to answer the questions that follow.



15.1 Write the symbol <, > or = between the fractions to make a correct statement.

½ ___________ 2/4

15.2 Colour in ¾ of a fraction strip in the fraction wall.

15.3 Use the fraction wall to calculate ¼ +2/4.

Table 17 presents data for each of the four questions for the five skills that learners were able to demonstrate during the interviews. As discussed earlier, mediatory prompts were used at each stage to enable learners to proceed to the next stage.

Table 17: Learner demonstrated competences across the five skills for the mathematical representation category questions

Learner	Reading [max score: 4]	Comprehension [max score: 4]	Transformation [max score: 3]	Process skills [max score: 4]	Encoding [max score: 4}
A27	4	2 [13,15.1]	2 [13]	2 [13, 15.1]	3 [13]
A22	4	4	3	3 [13]	4
A3	4	3 [13]	2 [13]	3 [15.1]	4
A4	3 [15.1]	4	3	4	4
A5	4	3 [13]	2[13]	2 [13, 15.1]	4
A23	3 [15.2]	3 [15.3]	2 [13]	3 [13]	4
A28	4	2 [13,15.3]	2[13]	3 [13]	4
A17	4	4	3	4	4
A26	4	4	3	4	4
B29	4	1 [13,15.1,15.2]	1 [1,15.1]	3 [13,15.1]	2 [13,15.1]
B26	3 [13]	2 [13,15.2]	2 [15.1]	2 [13, 15.1]	3 [15.1]
B11	1 [13,15.1,15.3]	3 [15.2]	2 [15.1]	3 [15.1]	3 [15.1]
B27	2 [13,15.1]	3 [13]	1 [15.1,15.2]	1 [13,15.1,15.2]	1 [13,15.1,15.2]
B2	0 [13,15.1,15.2,15.3]	2 [13,15.1]	1 [13,15.1]	3 [13,15.1]	3 [15.1]
B19	3 [15.1]	1 [13,15.1,15.2]	2 [15.1]	3 [15.1]	3 [15.1]
B31	1 [13,15.1,15.3]	0 [13,15.1,15.2,15.3]	0 [13,15.1,15.2]	1 [13,15.1,15.2]	2 [15.1,15.2]
B13	2 [13,15.3]	2 [13,15.1]	0 [13,15.1,15.2]	0 [13,15.1,15.2,15,3]	2 [15.1,15.2]
C33	2 [13,15.1]	1 [15.1,15.2,15.3]	2 [15.1]	2 [13, 15.1]	3 [15.1]
C21	1 [13,15.1,15.3]	2 [13,15.2]	1 [13,15.1]	2 [13, 15.1]	2 [13,15.1]
C17	4	4	3	4	4
C11	0 [13,15.1,15.2,15.3]	1 [13,15.1,15.2]	0 [13,15.1,15.2]	1 [13,15.1,15.2]	2 [15.1,15.2]
C8	2 [13,15.2]	0 [13,15.1,15.2,15.3]	1 [15.1,15.2]	1 [13,15.1,15.2]	2 [13,15.1]
C28	1 [13,15.1,15.2]	2 [13,15.2]	1 [15.1,15.2]	0 [13,15.1,15.2,15.3]	2 [15.1,15.2]
C24	3 [15.1]	2 [13,15.1]	2 [15.1]	3 [15.1]	4
C12	0 [13,15.1,15.2,15.3]	0 [13,15.1,15.2,15.3]	2 [15.1]	1 [15.1, 15.2,15.3]	2 [15.1,15.3]
C16	4	3 [13]	2 [15.1]	3 [15.1]	4
Mean Ave	2.58	2.23	1.73	2.35	3.04
Mode	4	2	2	3	4

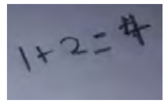
Table 17 shows the competences for the 26 learners in the 3 classes for the four 'mathematical representation' questions. All the questions required reading, comprehension, process and encoding skills. Question 15.3 did not require transformation skills because the operation was provided. For learners like A22, A5, C24 and C16, mediatory prompts provided access to subsequent skills because although they experienced some difficulties in transformation and process skills, they managed to do the appropriate encoding. Class A, barring one learner, were all able to come up with appropriate responses for all four questions even though some of the learners had experienced some difficulties in different skills. For other learners, for example, B27 and C8, the mediatory prompts given did not help them and so encoding could not be achieved.

Following is an extract from one interview with learner C28. The transcript provides the reader with a sense of how the interview with a boy I have named Amos unfolded.

1	Interviewer	OK. Can you please read to me question 13?
2	Amos(Pseudonym)	(*reads*) Complete the following digramu
3	Interviewer	Diagram
4	Amos	Diagram
5	Interviewer	Yes. Is there any word that you don't understand?
6	Amos	Uhh input, rule, output
7	Interviewer	OK. Let's start with diagram. This is the diagram (pointing), the drawings that we have here. Input is the number that you are given first, then we have a rule that you use so that you can get an answer and output is the answer. So we have got the number that we are given first, you work it out according to the rule, and then you get the answer. Can you now work out these numbers so that you can get the output, the answer?
8	Amos	OK. (*Works out the problem*). It's fifteen
9	Interviewer	Ok. Can you tell me how you worked it out? How did you get the fifteen?
10	Amos	I said five plus nine

11	Interviewer	OK. And what is five plus nine?
12	Amos	(*counts his fingers*) fourteen
13	Interviewer	Good. Then what do you do with the seven?
14	Amos	(*sighs*)
15	Interviewer	What do you do next, in order to get the answer?
15	Amos	seven times five
19	Interviewer	Ok. Good. What is seven times five
20	Amos	(*Stuck. Tries to count on his fingers but he can't. Doesn't know what to do*)
21	Interviewer	OK. Seven times five is thirty five. Can you count (counting fingers together) five, ten, fifteen, twenty, twenty-five, thirty, thirty-five. OK. Thirty-five plus nine. What is thirty-five plus nine?
22	Amos	*(counts his fingers)* forty-four
23	Interviewer	Yes. Good. That is the answer. Can you write it down? OK. Next. Let's go to the next one.
	Q15.1	
	Interviewer	Please read question 15.1 to me.
24	Amos	(*reads*) Write a (*pauses*) syball
25	Interviewer	a symbol
26	Amos	symbol (*doesn't read the symbols*) between the fractions
27	Interviewer	Can you tell me what these symbols are?
28	Amos	wise, bigwise, between
29	Interviewer	Come again please
30	Amos	Small
31	Interviewer	Ok. These are 'bigger than' 'smaller than' and 'equal to'. Now can you write a symbol between those fractions so that you make the statement correct.
32	Amos	(wrote < to mean that *half* is smaller than *two quarters* instead of writing *equals*)
33	Interviewer	OK. Here you are saying half is bigger than two quarters. This is half and this is two quarters (pointing to the

		fraction wall). *Quarter*, *quarter*. Now, which one do you think is bigger than the other?
34	Amos	Two over four
35	Interviewer	OK. Can you look here? They are equal. Here is the half and these two quarters put together they are equal to half. You understand? Alright. Let's go to 15.2.
	Q15.2	
36	Amos	(*Reads*) Colour, colour in three quarters of a fraction strip, strip in the fraction wall.
37	Interviewer	Colour in the three quarters of a fraction strip in the fraction wall. Do you know what a fraction strip is?
38	Amos	*(shakes his head to say No)*
39	Interviewer	OK. The question says shade three quarters of piece or row of the picture. Can you now shade three quarters on the fraction wall?
40	Amos	(*did not know what to shade*)
41	Interviewer	Can you do that?
42	Amos	No
43	Interviewer	OK. This is one quarter. (*pointing to a quarter*) We have a quarter here. Can you now show me three quarters on the fraction wall?
44	Amos	(*Points to 3 one quarters*)
45	Interviewer	Yes. This is the part that you shade. OK. Now can you read to me question 15.3.
	Q15.3	
46	Amos	Use the fraction wall to calculate (*pauses*) … to calculate … (*pauses again*)
47	Interviewer	(Reads) Use the fraction wall to calculate quarter plus three quarters.
48	Amos	(*counts on his fingers*)
49	Interviewer	Can you show me what you do to calculate the answer?
50	Amos	say one plus two

51	Interviewer	OK. Good. Write it down.
52	Amos	(*wrote 1+2=4*) 
53	Interviewer	One plus two. What is one plus two? You wrote four
54	Amos	It is four
55	Interviewer	Is it four? Can you work it again?
56	Amos	(*counts on his fingers*) three
57	Interviewer	Yes. Three over four. Very good.

The extract above presents the prompts used at various stages of the interview and shows the difficulties that Amos experienced. In terms of Amos' responses to the questions in this category, the transcript shows that Amos was able to read 3 out of 4 questions without difficulty.

On question 13, Amos could not read correctly and he said he did not understand the question. When the question was explained to him, he could not manage the processing skills. When he added 5 to 9 he got 15 instead of 14. He also could not calculate 7 times 5 although he had chosen the right operation to use. When he was prompted, he managed to get the correct response.

In question 15.1, Amos could not read and said he did not understand the question. He also did not know the names of the symbols given (i.e. >, <, =). When asked to write a symbol between fractions to make the statement correct, he wrote a wrong symbol (<) because he did not know which of the two fractions was bigger than the other. He could not use the fraction wall to compare the fractions. He also could not identify 2/4 on the fraction wall which he could get by adding ¼ to the other ¼ to get 2/4. Even when he was shown 2/4 on the fraction wall, he still could not see that ½ and 2/4 were equal. This indicated a process skills difficulty with comparison of fractions.

For question 15.2, Amos said he understood what the question required him to do. He knew that he had to add the numerators of the fractions but he failed to add them correctly. He said 2 plus 1 was 4. This was a processing difficulty.

The extract illuminates that in the four questions, the learner's difficulties were in all four skills. Below I provide a summary of the analysis across learner interviews on the four questions in category 3.

Themes emerging from analysis of learner competences and difficulties as indicated in Table 17 across the 26 learners in the three classes

Themes emerging in relation to the four skills assessed in mathematical presentation problems are discussed below.

Theme 1: Reading skills were stronger in class A than in classes B and class C but were generally weaker than the encoding skills for this category of data presentation problems

Performance in reading was, on the whole, not very good as less than half of the learners were able to read all four questions and 6 out of the 26 learners were able to read only less than half (2) of the questions. In class A however, the reading performance was better since 7 out of 9 learners in this class were able to read all four questions. The modal score for reading skills across all the 26 learners was 4, with 10 out of 26 learners able to read all four questions. On the other hand, class B had only 1 out of 8 learners who was able to read all four questions, while 2 out of 9 of the learners in class C were able to read all four questions in this category.

Overall, the reading skill demonstrated across questions for all 26 learners were similar with 20 learners managing to read question 15.2 and 19 learners able to read question 15.3 without difficulty. Questions 13 and 15.1 were both difficult for the learners to read. Only 14 learners could not read both questions. Twelve learners who demonstrated difficulty with reading question 13 could not read the word 'diagram'. 'Diagram' is a mathematical vocabulary which Grade 4 learners may not be familiar with. Later in the interview process, some of the learners who could not read the word ‘diagram’ said they did not know what the word meant. Five learners (B11, B2, B31, B13, and C11) had difficulty reading the word ‘calculate’, and three learners (B11, B2, and C11) struggled to read the word ‘statement’. These words are more than 7 letter words which made them potentially difficulty for learners learning mathematics in English.

Theme 2: Comprehension of questions for this category was better than comprehension of questions for the other three categories of questions

The mean average across the 26 learners for the comprehension of the four questions in this category was 2.23 (that is on average learners were able to comprehend 2.23 of the four questions) while the modal average was 2. The modal average however, differed across the classes with modes of 4, 2 and 2 respectively across classes A, B and C. Thus, more learners (5) showed comprehension of all questions in this category than in the other three categories which had 3, 0 and 0 learners understanding all the questions in the categories.

Under the comprehension skill, the least understood questions were questions 13 (which was not understood by 16 learners), question 15.1 and 15.2 (each not understood by 11 learners). The misunderstanding of question 13 (understood by the least learners) could be ascribed to the mathematical vocabulary that was used in the question. These were ‘diagram’, ‘input’, ‘output’ and ‘rule’. The words ‘input’, ‘rule’ and ‘output’ while easy to read, were also the other source of complication in this context. There were however, no clues in the question of what ‘input’, ‘rule’ and ‘output’ meant. Their presence in the question did not assist in making the question clearer. For example, learners A4, C21, C28 and B2 said they did not know what these words meant. Therefore, it is not only the long words that cause problems but also the short unfamiliar words. These words are not among the high-frequency words that are likely to be known by Grade 4 learners. In addition to this linguistic complication, the learner needed to know the rule or formula in order to work out the problem.

The lack of comprehension of question 15.1 by learners was not necessarily due to a language problem but possibly stemmed from lack of mathematical content knowledge. Learners who did not know that to get 2/4 they had to add two 1/4s were not able to see 2/4 on the fraction wall. On the other hand, some learners (e.g. C33, C21, and B26) did not understand the meaning of the symbols and hence did not know how to use them.

As in question 15.1, question 15.2 was not understood by 11 learners. Learners' lack of comprehension could be attributed to failure to identify ¾ on the fraction wall since it was not written on the wall. In addition to that, a number of learners, for example, C28, C21, and B29 said they did not know what a fraction strip was. In Chapter 5, question 15.2 was not attempted at all by 50% of class A learners and by 53% of class B learners. This indicates that these learners did not understand the question. Although colouring ¾ may not have been a problem for the learners, learners may have refrained from answering this question because they were not familiar with a fraction strip and a fraction wall. In the interviews, 11 out of 26 of the learners said they did not understand the question. According to Shaftel et al. (2006) prepositional phrases and pronouns are important contributors to item difficulty levels. In this question, 'colour in', 'of a fraction strip' and 'in the fraction wall' are all prepositional phrases that most likely jointly contributed to the complexity in the language, hence creating difficulty for learners.

Question 15.3 was understood by 20 learners, with only six learners not understanding it. Since the operation to use to solve this problem was provided in the question, it was easy to interpret what the question required them to do. Only a few learners had difficulties understanding what 'calculate' means.

On the whole, this category of questions had the most number of learners (5) understanding all questions compared to the other three categories that had less learners understanding all the questions in the categories.

Theme 3: The lack of knowledge of fractions (addition and comparison of fractions) hindered learners from demonstrating appropriate transformation and processing skills

Here, I discuss process skills and transformation skills together in relation to this theme. Learners often need to perform a process skill after choosing an appropriate operation.
Transformation skills for this category were generally weak with only 5 out of 26 learners managing the transformation skills required for the three questions in this category. The modal score across all the 26 learners was 2 and the average score was 1.73 indicating that on average, learners were able to do transformation skills on 1.73 of the three questions. The question that was transformed better than the others was question 15.2, with 20 learners being able to do the correct transformation, while question 15.1 had the least number of learners (10) who were able to do the correct transformation.

Similarly, learners showed poor processing skills even when they were prompted to move to the next stage of problem solving. The modal score for all the 26 learners for the process skills of the four questions in this category was 3. Only 4 learners out of 26 were able to do process skills for all four questions. The question that they answered best was question 15.3, with 23 learners managing the process skills, while question 15.1 had the least number of learners (7) able to process it. Two learners failed to do process skills for all four questions.

Some learners' difficulties included not knowing the symbols <, > and = in the question. For example, learner C28 with the transcript above said that the symbols were called 'wise, bigwise, between'. This led to the wrong choice of operation and hence incorrect processing. Had the learners been conversant with the symbols in this question, they would have known how to use them. Secondly, the lack of knowledge of fractions (addition and comparison) was also an obstacle to the successful resolution of the mathematical problem. Learners did not know that they get 2/4 by adding a ¼ and a ¼ on the fraction wall. They did not see 2/4 on the fraction wall and as a result did not know the operation to use or how to get it.

Question 15.3 was easily processed by many learners. This could be attributed to the fact that the transformation (operation) was provided for them. Also, the numbers that they had to add were small (i.e. 1 and 2) and consequently easy to add. Moreover, the question required them to add fractions with the same denominator. This was an easy task for most of them as most confirmed that they only had to add the numerators and do nothing to the denominators.

In contrast, only 7 learners were able to do process skills on question 15.1. This was because learners could not identify 2/4 on the fraction wall. They did not know that they needed to add the two ¼s in order to get 2/4. Hence in this question learners' difficulties were more attributed to mathematical computation than to language.

Theme 4: Encoding skills were generally stronger than the preceding skills for these mathematical presentation problems and were generally strongest in class A

Performance in encoding on the whole was stronger than the preceding skills across all the three classes in this category of questions. The mean average across the 26 learners for the encoding of the four questions was 3.04 (that is on average learners were able to encode 3.04 of the four questions). The modal score for encoding skills across all 26 learners was 4 indicating that the four questions were encoded correctly by 11 out of 26 learners. In the preceding skills, 10 learners managed to read all four questions, five learners could comprehend all the questions, five learners were able to do transformation skills for all three questions and only four learners managed to do process skills for all four questions in this category. This indicates that in this category of questions, encoding skills were stronger than the preceding skills possibly because the encoding required was relatively simple.

In class A, 8 out of 9 learners managed the encoding skills for all four questions in this category. Although some learners experienced difficulties with processing skills in questions 13 and 15.1 (for example, learners A22, A3, A5, A23, C16 and C24), they however, managed to do encoding skills for these questions with the aid of prompts.

The question that was encoded best was question 15.3, with 25 learners being able to encode it, while question 15.1 had the least number of learners (12) who were able to encode it.

For some learners, (for example, B29, A27, B26, C8 and C28) questions like 15.1 and 15.2 for which they could not perform the correct process skills, they correspondingly could not do encoding. This was because they failed to work out the right answers even when they were prompted. Dey and Dey (2010) argue that mathematical operations with whole numbers can be explained with visual displays when they are added or subtracted, visualising the operations until it becomes easy to understand. This is different from fractions whose mathematical operations are abstract and decontextualized and difficult to understand. Hence in these fraction problems learners struggled even when mediatory prompts were used.

Considering the overall analysis of the four questions, question 15.3 was done well in comprehension, process skills and encoding. The reason could be that the operation to use was provided. They only had to work out the answer.

Most learners (20) performed well on transformation skill (question 15.2) while the best performance in reading was on question 15.2 as well. This good performance in reading could be ascribed to question 15.2 having many short words familiar to Grade 4 learners (e.g. in, of, a, the, wall). The only long word ‘fraction’ was repeated twice, and the question was also relatively short, with only 9 words.

The worst performances were in the comprehension of question 13 (16 learners did not comprehend the question), transformation for question 15.1 (16 learners could not do transformation), and encoding for question 15.1 again (14 learners could not encode). As discussed earlier, the lack of comprehension for question 13 (the one understood by least learners) could be ascribed to the mathematical vocabulary in the question. These were ‘diagram’, ‘input’, ‘output’ and ‘rule’. The words ‘input’, ‘rule’ and ‘output’ while easy to read, were also the other source of complication in this context.

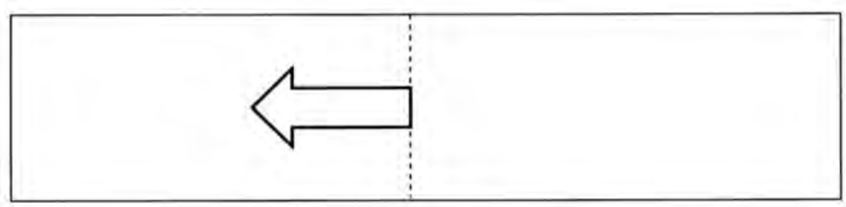
Next, I discuss the questions that instructed learners to demonstrate direct skills.

7.2.4. Findings, category 4: Instructions to demonstrate direct skills

Recorded in section 7.1.3.4 the questions for instructions to demonstrate skills are as follows:

7. Write a number sentence for the sentence below.
The difference between 1 613 and 859 is seven hundred and fifty-four.

11. Draw the reflection of the arrow on the vertical dotted line.



12. Convert the following:
12.1   12 m 48 cm = ___________________ cm

Table 17 presents data for each of the three questions in terms of each particular skill (i.e. reading, comprehension, transformation, process skills and encoding) that the 26 interviewed learners were able to demonstrate in the questions that required demonstration of skills. Mediatory prompts were also used at different stages of the skills demonstration.

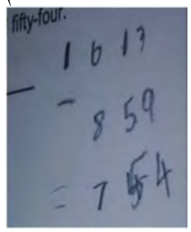
Table 18: Learner demonstrated competences and difficulties across the three skills for the instructions to demonstrate direct skills.

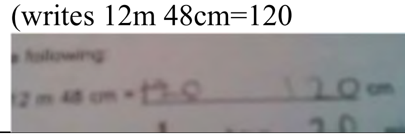
Learner	Reading [max score: 3]	Comprehension [max score:3]	Transformation [max score: 2]	Process skills [max score: 1]	Encoding [max score:3]
A27	3	0 [7,11, 12.1]	0 [7, 12.1]	0 [12.1]	1 [7, 12.1]
A22	3	2 [12.1]	0 [12.1]	0 [12.1]	3
A3	3	0 [7, 11, 12.1]	1 [12.1]	0 [12.1]	3
A4	3	0 [7, 11, 12.1]	1 [7]	0 [12.1]	2 [12.1]
A5	3	2 [7]	0 [7, 12.1]	0 [12.1]	1 [7, 12.1]
A23	3	0 [7,11, 12.1]	0 [7, 12.1]	0 [12.1]	1 [11, 12.1]
A28	3	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	1 [7, 12.1]
A17	3	1 [11, 12.1]	2	1	3
A26	2 [11]	1 [7, 12.1]	1 [12.1]	0 [12.1]	3
B29	3	0 [7,11, 12.1]	0 [7, 12.1]	0 [12.1]	1 [7, 12.1]
B26	3	0 [7, 11, 12.1]	1 [12.1]	0 [12.1]	2 [12.1]
B11	2 [11]	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	2 [7]
B27	2 [7]	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	1 [11, 12.1]
B2	0 [7, 11, 12.1]	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	1 [7, 12.1]
B19	2 [11]	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	1 [7, 12.1]
B31	0 [7, 11, 12.1]	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	1 [7, 12.1]
B13	0 [7, 11, 12.1]	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	2 [12.1]
C33	2 [11]	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	2 [12.1]
C2	1 [7, 11]	0 [7, 11, 12.1]	1 [12.1]	0 [12.1]	1 [7, 12.1]
C17	3	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	1 [7, 12.1]
C11	0 [7, 11, 12.1]	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	1 [7, 12.1]
C8	2 [7]	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	1 [7, 12.1]
C28	0 [7,11, 12.1]	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	1 [7, 12.1]
C24	3	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	0 [7, 11, 12.1]
C12	0 [7, 11, 12.1]	0 [7. 11, 12.1]	1 [12.1]	0 [12.1]	2 [12.1]
C16	3	0 [7, 11, 12.1]	0 [7, 12.1]	0 [12.1]	2 [12.1]
Mean	1.88	0.23	0.30	0.04	1.53
Mode	3	0	0	0	1

Table 18 shows the competences for the 26 learners in the 3 classes for the three 'direct skills' instruction questions. All the questions required reading, comprehension and encoding skills. Only two questions, question 7 and 12.1 required transformation skills, and only one question, question 12.1 required process skills. As with tables 15, 16 and 17 the question numbers in brackets [ ] following the frequencies, indicate those questions where learners had difficulties in demonstrating the skill. Mediatory prompts were also done at 'break down' points.

What follows is an extract from one learner's interview in order to provide the reader with a sense of how the interviews unfolded. The interview transcript is for learner C17, a boy I have named Peter:

1	Interviewer	Ok. Let's look at the next question, question 7. Can you read it to me?
2	Peter (Pseudonym)	(*Reads*) Write a number sentence for the sentence below. The difference between 1 613 and 859 is seven hundred and fifty-four.
3	Interviewer	Ok. What do you think that question is asking you to do?
4	Peter	I don't … ah …
5	Interviewer	Which word don't you understand? Is there a word you don't understand? Do you know what a number sentence is?
6	Peter	No
7	Interviewer	Ok. A number sentence is like this: two plus three is equal to five (2+3=5). That will be a number sentence. Does that make sense? Ok. Do you know what difference means?
8	Peter	Yes
9	Interviewer	What does it mean?
10	Peter	Like this watch is different to the paper
11	Interviewer	OK. This watch if different from this paper. Good. That is a good difference in everyday language, but if I say what is the difference between seven and five?
12	Peter	Seven is more than five
13	Interviewer	OK. Because seven is two bigger than five. That's alright. It's two bigger. So the difference between 5 and seven is two. OK. That could be a way of explaining 'difference' between seven and five. So do you think you could write me a sentence that shows that the difference between this and this is this (*pointing to the numbers in the sentence)?* Do you think you could? Do you think you are able to answer it? Try.
14	Peter	(*pauses for seconds to think*)
15	Interviewer	Ok. If we say the difference between, read it for me. Read the question to me.
16	Peter	The difference between one thousand six hundred and thirteen is seven hundred and fifty-four.
17	Interviewer	How do you think you could write that in a number sentence, something like a sentence with only

		numbers, pluses, minus and equals? Could you write that using only numbers, pluses, minus and equals?
18	Peter	*(writes it vertically like this):* 
19	Interviewer	Ok. Very good. Next time when you write a number sentence you write it like this (*writes on the space provided*) writing numbers and symbols. Ok. Good. Let's go on to the next question. Read the question to me.
Q11		
20	Peter	(*Reads*) Draw the reflection of the arrow on the vertical dotted line
21	Interviewer	Is there a word that you don't understand?
22	Peter	(Points to the word 'reflection')
23	Interviewer	Reflection?
24	Peter	And verti … vertical
25	Interviewer	OK. Vertical is like when I look in a mirror, the reflection is that other part, the other side, do you see what I mean?
26	Peter	Yes
27	Interviewer	(*Draws on the paper an example of a reflection of a butterfly*). So if I look at a butterfly for instance, if there is my mirror and there is part of the butterfly, then the other part of the butterfly will be looking like this (*drawing the reflection of a butterfly*). Is that right? The 'reflection'. Alright.
28	Peter	Yes
29	Interviewer	Then 'vertical'. A vertical line is just a straight line standing up. A horizontal line is a line that goes flat. A vertical line is a line that goes up. Do you think you can answer that question now?
30	Peter	Here? (*pointing to the space provided*)
31	Interviewer	Yes. Draw it as best as you can.
32	Peter	(Draws the reflection)
33	Interviewer	Very good. That's fantastic. Can we go on to the next question?
Q12.1		
34	Interviewer	Can you read the question to me?
35	Peter	(Reads) Convert the following
36	Interviewer	OK. Is there anything there that you don't

		understand? Any word you don't understand?
37	Peter	No
38	Interviewer	You understand the word 'convert'? What does it mean?
39	Peter	When you change
40	Interviewer	Ok. Can you do that for me?
41	Peter	(Tries to write but gets stuck) when I…..I….I add
42	Interviewer	OK. Show me what you think you will do
43	Peter	I add twelve and forty eight
44	Interviewer	OK. You want to add but are these the same the twelve meters and the forty eight centimetres? Because what you wanting to do is you want to change but keep it the same. I can say a, a, a … You are ten years old alright?
45	Peter	Yes
46	Interviewer	I can say you are ten years old so convert your years to months and in months there are twelve months in a year, am I right?.
47	Peter	Yes
48	Interviewer	So I can say your age is ten years or your age is one hundred and twenty months. So that is conversion but I have kept your age the same. I am just talking about your age in years or months. So that 1 week is 7 days. Does that make sense? They are equal. So can you convert this to cm so that they are equal?
49	Peter	(writes 12m 48cm=120 
50	Interviewer	Twelve meters will be equal to how many centimetres?
51	Peter	Ah … 120
52	Interviewer	Yah, almost right because one meter is equal to hundred centimetres. So it will actually be one thousand two hundred in centimetres. Ok, that's conversion.

The extract above demonstrates the prompts used at the various stages of the interview and shows how at 'break down' points, mediatory prompts or direct suggestions are given in order to allow learners the opportunity to demonstrate the subsequent skills required by the questions.

According to the analysis of the responses to the questions that required demonstration of direct skills, Peter was able to read all the three questions without difficulty.

On question 7, Peter's 'break down point' was that he said he did not understand what the question was asking him to do. He also did not know what a number sentence was. It was explained to him and he was able to continue. Although Peter understood and knew the meaning of the word 'difference', he only understood its everyday use but not the mathematical context. For example, when he was asked what 'difference' means, he said it means 'this watch is different to the paper' and thus he took it to mean 'unlike' or 'dissimilar'. This example demonstrates how ambiguous words may bring complexity and can confound learners who are not proficient in the English language. There were two mathematics specific terms ('number sentence' and 'difference') in the question and this added to the linguistic complexity of the question and may have affected the learner's comprehension of the question. When mediatory prompts were used, he had an idea of what he was supposed to do, (writing numbers with minus and equals) although he wrote the number sentence vertically instead of horizontally.

On question 11, the learner could read the question correctly but he had difficulty with understanding the words 'reflection' and 'vertical'. These are mathematics specific words which add to the question's linguistic complexity. When these words were explained to him, he was able to demonstrate the skill of drawing the reflection of the arrow as the question demanded.

Question 12.1 Peter managed to read and said he understood that the word 'convert' means 'change'. He however, did not understand it as changing metres to centimetres while maintaining the same amount. For him, he would change 12m 48cm by adding 48 to 12. Changing for him thus probably meant doing something to the numbers in order to get a different number. His difficulty in this question was thus with transformation. He also said that 1m is equal to 10cm and hence he wrote 12m=120 cm (thus a processing error).

It is apparent that in questions 7 and 11, Peter struggled with comprehension of the language used in the questions, i.e. 'reflection', 'vertical', 'difference' and 'number sentence'. This mathematics vocabulary added complexity to the language and compromised the comprehension of the questions. In question 12.1 his 'break down point' was on transformation.

Themes emerging from the analysis of learner competences and difficulties as indicated in Table 18 across the 26 learners in the three classes

The themes that emerged are discussed below:

Theme 1: Reading skills in general were stronger than the subsequent skills in this category, but were weak in classes B and C

Reading performance was stronger than the other skills in this category of questions. Half or 13 out of 26 learners were able to read all three questions in this category. In the other skills, for example, no learner was able to comprehend all three questions, only two learners could do transformation skills for all the questions, only one learner managed to do process skills for all three questions, and four learners were able to correctly encode the three questions. This shows that learner performance in reading was better than their performance in the other four skills in this category of questions.

In class A, where the best reading performance was shown, 8 out of 9 of the learners were able to read all three questions. In contrast, in class B and class C the performance in reading was so weak that only 2 out of 8 and 3 out of 9 learners respectively cleared that hurdle successfully. The mean score for the reading skill in class B was 1.5, implying that on average learners were able to read 1.5 of the three questions while in class C the mean score for the reading skill was 1.56, meaning that on average, learners were able to read 1.56 of the three questions.

The question where the learners performed the best in readings was question 12.1, with 20 learners getting it correct, while for questions 7 and 11 there were 17 and 15 learners respectively able to read them. All of the 11 learners who failed to read question 11 failed to read the word 'vertical' and 8 out of 11 learners failed to read the word 'reflection'. A few (6) learners could not read the word 'dotted'. Later during the interview process, these six learners plus some others said they did not understand the meaning of these words, leading to the misunderstanding of the requirements of the question. The reason could be because the words belong to the vocabulary of mathematics (i.e. ‘reflection’, ‘vertical’ and ‘dotted’) which they were unfamiliar with. Learners rarely encounter such words in everyday language. In addition, the words ‘reflection’ and ‘vertical’ are long (more than 7 letters) considering the level of the learners and their English language proficiency. Again class A’s reading skills were clearly superior.

Theme 2: Comprehension skills in this category of questions were weak, leading to poor transformation and process skills

Performance in comprehension on the whole was very poor as 22 out of 26 of the learners did not understand even one question in this category. Only two learners (A22 and A5) were able to comprehend 2 of the 3 questions. The average across the 26 learners for the comprehension of the three questions in this category was 0.23 (that is on average learners were able to comprehend 0.23 of the three questions) while the modal average was 0. The modal average was the same (0) across the classes.

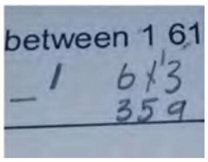
The least understood questions were questions 12.1 (not being understood by 25 learners), followed by question 7 (not understood by 24 learners) then question 11 (not understood by 23 learners). The lack of comprehension on question 12.1 (the one misunderstood by most learners) could be attributed to the use of the word ‘convert’ which was unfamiliar to them, possibly the use of ‘change’ could have resulted in a better understanding. Although this question was among those with the lowest LCI (Chapter 5) because it had a minimal number of words, it was the question that most learners failed to understand. While they could comprehend that by saying ‘convert’ the question was asking them to ‘change’ 12m 48cm into cm, the errors they made showed that they did not understand the mathematical requirements of the question, that is, to change 12m 48cm to cm so that the amounts remained the same.

Examples of learners who did not understand this question are learners C17, B2 and A22. Learner C17 said that he understood 'convert' to mean change but it was clear that he did not understand it as keeping the amount the same. Learner B2 wrote 48m 12cm, which he got by simply switching the positions of the numbers. Learner A22 wrote 12cm as the answer, possibly trying to maintain the 12m. Learners did not understand that this called for them to multiply 12 by 1 000 and then add 48 to get the cm but understood this change as playing around with the numbers in some way which left them different. Although learners were confused by the term 'convert', they also lacked mathematical content since many did not know how many centimetres there are in 1 metre (e.g. learners C17, C11, B26, C28, A27, and A22). Despite an example of conversion being given (1 week=7 days), they could not convert the metres to centimetres because they did not know the number of centimetres in 1 metre. However, for some learners, the prompting worked as they were able to engage with the subsequent steps of processing skill and got the right encoding (for example, learners A22, A3, A26, A17 and B11). For those where mediation did not result in access, processing and encoding skills were not attained.

The word 'difference' in questions 7, while we understand it as the answer you get after subtracting, was not necessarily understood by learners to mean that. Some learners understood it to mean 'dissimilar' or different things. For example, learner C17 said difference means 'watch is different to the paper', learner B29 said difference means 'thing that is not the same' and learner B11 said it means 'something different'. Learner B19's response was 'It's like when we have a bicycle and someone has a car, that's the difference'. Here learners only understood 'difference' in everyday language. The word 'difference' is an ambiguous word with multiple meanings where assignment of the unintended meaning compromised the comprehension of the item's demands and inevitably the response given. As discussed in Chapter 5, we note that ambiguous words can be confusing to learners who are not proficient in the English language.

Some learners understood 'difference' to mean 'add' as many learners tried to add the numbers. For example, learners C16, B11, C28, A27 and A28. This also was a result of the ambiguity of the word 'difference'.

The other term that was not understood by learners in this question was ‘number sentence’. The majority of the learners said they were unaware of what was required. Learners like C24 and B19 understood ‘number sentence’ as writing the numbers in words (in a sentence). The word was understood in an everyday language, not mathematically. Others wrote one number under the other e.g. C12, B29 and B27 like this:



Since learners had not understood the question, their intention was to work out the answer yet the answer had been provided.

Overall, on the comprehension skill, question 7 was not understood due to the mathematics specific words that were used, i.e. ‘difference’ and ‘number sentence’. Here, language use is manifestly compromising the comprehension of the question by learners.

Theme 3: Process skills were the worst performed skills in this category of questions and were generally weaker than the other three categories

On the whole, performance in processing was weaker than in the other skills across all three classes and the demonstration of processing skills for this category was the worst of all the four categories of questions. The modal score for processing skills across all the 26 learners was 0 indicating that most learners (25 out of 26) were unable to do processing for question 12.1 (additionally the modal scores for each of the classes was 0). [The modal scores on the other four skills were 3; 0; 0; 1]. All classes showed poor demonstration of processing skills.

Of the three questions, question 12.1 was the only question that required processing skills yet learners struggled even when they were given the figures to work with in order to solve the problem. They did not know that 1m=100cm and since they did not know this, it was not possible for them to go ahead with the problem solving. For example, learners A23, B26, C11, C8, C28 and C 24 all said they did not know how many centimetres make up a metre. Learner A28 said 1m=2cm, A26 said 1m=10cm, A22 and A3 said 1m=1000cm and A27 said 1m=48cm.

In addition to that, when they were told that 1m=100cm, some for example, learners A4 and A5 still failed to multiply 12 by 100 and then add 48 in order to get the answer in centimetres. Learner A5 said 'I can't count' and got 48 after multiplying 48 by 12. Clearly, learners struggled with mathematical computation, even when they were told what to do.

Overall, question 12.1 was badly done on the processing skills. Only one learner could do process skills for the question. This shows that although learners lacked comprehension of the mathematical term 'convert' which was used in the questions, they also had difficulty in processing skills of conversion even after 'convert' was explained.

Theme 4: Mediatory prompts in processing skills in question 12.1 did not improve performance in encoding of the problem

While mediatory prompts were provided on question 12.1 to help learners to proceed to subsequent stages of the problem, most of the learners (21 out of 26) could not come up with the correct encoding. Although the overall performance on the encoding skill of the three questions was poor, question 12.1 was the worst. Only 5 out of 26 learners correctly encoded this question. This failure to encode was attributed to the fact that many learners failed to do process skills for the same question.

Considering the overall analysis of the three questions in this category, question 12.1 was better read (20 learners being able to read it) and question 11 was comprehended better than the others (3 learners comprehended it). The question in which better transformation skills were employed was question 7 (with 7 learners showing correct transformation skill) and the strongest encoding skills were evident in question 11 (23 learners being able to encode).

The lowest performances in comprehension, transformation and encoding were displayed in question 12.1 (25 learners did not comprehend the question, 24 learners could not do transformation skill and 21 learners could not encode). The lowest performance in reading was in question 11. This was exacerbated by the use of the words ‘difference’ and the use of mathematics vocabulary like ‘vertical’, ‘reflection’ and ‘convert’. In addition to limited language proficiency, learners lacked mathematical content.

7.2.5 Summary of the findings of learner interviews

During the task-based interviews, difficulties were detected across all skills namely: reading difficulty, comprehension difficulty, transformation difficulty, process skills difficulty, encoding difficulty and difficulties engendered by carelessness. Mediatory prompts used during the interviews enabled some learners to demonstrate subsequent skills that they did not have the opportunity to demonstrate in the written ANAs and thus revealed important new information which was not revealed by the written ANAs.

The 15 ANA question items were grouped into four categories and the following themes emerged in the categories:

Category 1, Word problems summary of findings

Theme 1: Reading skills were generally stronger than the subsequent skills across the three classes for these word problems and were generally stronger than for other categories of questions.

Theme 2: Everyday comprehension of terms used does not necessarily signify comprehension of the mathematical intention behind its use in an assessment context.

Theme 3: Processing skills revealed that the greatest difficulties for learners with word problems resulted largely from dependency on algorithms for operations that might be better performed mentally.

Category 2, Data representation summary of findings

Theme 1: Reading skills were generally weaker than the subsequent skills across the classes for this category of data presentation problems and were generally weaker in class B and class C.

Theme 2: The use of long, unfamiliar words as well as ambiguous mathematical specific vocabulary compromised the comprehension of questions particularly by Grade 4 learners not proficient in English.

Theme 3: In this category, processing and encoding skills were strong for the one question where they were required.

Category 3, Mathematical representation summary of findings

Theme 1: Reading skills were stronger in class A than in classes B and class C but were generally weaker than the encoding skills for this category of data presentation problems

Theme 2: Comprehension of questions for this category was better than comprehension of questions for the other three categories.

Theme 3: The lack of knowledge of fractions (addition and comparison) hindered learners from doing appropriate transformation and processing skills.

Theme 4: Encoding skills were generally stronger than the preceding skills for these mathematical presentation problems and were generally strongest in class A.

Category 4, Instructions to demonstrate direct skills summary of findings

Theme 1: Reading skills in general were stronger than the subsequent skills in this category, but were weak in classes B and C.

Theme 2: Comprehension skills in this category of questions were weak, leading to poor transformation and process skills.

Theme 3: Process skills were the worst performed skills in this category of questions and were generally weaker than the other three categories.

Theme 4: Mediatory prompts in process skills in question 12.1 did not improve performance in encoding of the problem.

The following table provides a summary of the broad analysis of all the 26 learner interview responses across the four categories of interview questions in order to encapsulate the frequently occurring learner difficulties.

Table 19: Summary of the findings of the difficulties experienced by learners in the four categories

Question categories	Frequently occurring difficulties
category 1: word problems Qs 5.1, 5.2, 14	More difficulties related to language as most learners misunderstood the mathematical meaning of everyday words like ‘uses’ and ‘make’ and as a result failed to choose the right operations to use.
category 2: Data presentation Qs 9.1, 9.2, 18.1, 18.2, 18.3	More difficulties related to language as many learners struggled to read and comprehend the questions. The questions had many unfamiliar words like ‘destination’, ‘departures’ and mathematical vocabulary like ‘difference’, ‘tally’, ‘bar graph’ as well as questions with many prepositional phrases (which causes complexity in sentences) like questions 9.1 and 9.2.
category 3: Mathematical representation Qs 13, 15.1, 15.2, 15.3	More difficulties related to mathematical processing than language. Most learners showed very poor processing skills due to difficulties in adding and comparing fractions as well as poor transformation on question 13.
category 4: Instructions to demonstrate direct skills	More difficulties related to language as many learners could not understand the meanings of key words like ‘convert’, reflection’, ‘vertical’, ‘difference’ and ‘number sentence’. On question 12.1 the difficulties were also partly mathematical because although the majority of learners had managed the reading skill in this question, they however, did not know that 1m is equal to 100cm and hence could not do the required conversion.

From the analysis done in this section, it is evident that learners’ attempts to successfully solve the mathematical ANA questions were compromised largely by their lack of comprehension of the questions. Reading and comprehension skills were stronger in class A than in classes B and C. Difficulties in demonstrating different skills was due to the fact that most learners failed to read and understand many words in the questions. Their lack of English proficiency contributed to their difficulties. In addition to the language problem, the learners’ lack of mathematical content knowledge also hampered them from successfully solving the mathematical problems.

Therefore, in as much as language could be key in the learners' underachievement, lack of mathematical content knowledge also had a role to play.

In the next section I provide deeper qualitative analysis and thicker description of the nature of learner difficulties that emerged across the categories of questions and I do so by providing case study data of selected learners to illuminate each theme in depth.

7.3 In depth analysis of the nature of selected learner difficulties that emerged across the question categories

The largely quantitative analysis above aimed mainly at organizing the data, summarizing the findings, providing evidence and describing the profile of findings across all of the 26 interviewed learners. The qualitative analysis that follows is intended to portray a full account (Maxwell, 2013) of the interviewed learners' experiences in the interview process. Patton (2002, p. 114) argues that the thick description is a way to get "behind the numbers" that are recorded in a quantitative analysis in order to see the richness of real social experience.

The following questions were used to establish the experiences of the Grade 4 learners as they went through the task-based interviews.

- What difficulties do learners experience as they solve mathematics problems?
- Which of these difficulties can be attributed to linguistic factors?

Three groups of learners emerged in relation to difficulties experienced. There were cases where some learners really struggled to read many words in the questions and as a result failed to comprehend the words, sentences and the questions as a whole but managed after mediation. In some cases learners struggled so much with reading and comprehension that even with the aid of interviewer mediation, they were still not able to participate in the subsequent stages and skills of transformation, process skills and encoding. In other cases, learners managed the reading and other skills of questions with little or no need for mediation.

In order to illuminate the varied experiences of learners in these different groups, I discuss selected learner experiences with examples of the range of learner difficulties. That is, I share examples from learners who had the least difficulties with various skills and needed the least mediation to examples of learners who experienced the greatest difficulties and who needed extensive mediation. The selected learner interviews are discussed under the following three key difficulties experienced across the learners in learner interviews.

1. Learners' difficulties in reading
2. Learners' difficulties in comprehension
3. Learners' difficulties in transformation, process skills and encoding

For each difficulty I draw on six learners to provide an opportunity for deeper analysis. The six learners were selected as follows: 1) two learners who required little or no mediation; 2) two learners who required moderate mediation; 3) two learners who required extensive mediation. In key difficulty 3, I discuss transformation, process skills and encoding skills together because they are closely related. For each difficulty, I have chosen learners from the range described above. In this analysis all learners have been assigned pseudonyms.

7.3.1 Learners' difficulties in reading

Under this difficulty, I first discuss the difficulties of learners who demonstrated good reading skills and therefore needed little mediation.

7.3.1.1 Learners requiring little or no mediation in reading

This sub-section uses excerpts of two learners who demonstrated reading skills with the least mediation. These were John (A26) and Mary (A3).

Reading skill was strongest in class A. Words like 'vertical' and 'departures' were the words that the selected learners could not read. John and Mary only needed mediation in reading these words. As discussed earlier, failure to read a word was evidenced by either mispronouncing a word, hesitating to read a word, being silent or learner's outright admission of their inability to read it. I share some excerpts that demonstrate John and Mary's difficulties in reading certain words despite their relative strength in reading.

John's excerpt:

Interviewer: Please read question 11 to me
John: Draw the reflection of the arrow and the … the vertices dotted line
Interviewer: What is this word? (Pointing to 'vertical')
John: Vertices
Interviewer: It is 'vertical'

John read the word 'vertical' as 'vertices' so he mispronounced the word although he read the word confidently. That was the only word he could not read in all the 15 questions that he read. The word was later read for him. He could have confused the words 'vertical' and 'vertices', both of which are part of the mathematical register. We hardly look at all the letters of a word when we read because we read words not letters. Where two words are made up of the same letters in different combinations, such misreading can occur. It could also be lack of mastery with the phonics in reading. Phonics refers to "the understanding that there is a predictable relationship between phonemes (the sound of spoken language) and graphemes (the letter that present those sounds in written language (DoE 2010, p. 27). It involves understanding the relationship between spoken sounds and written letters, such as knowing that the letter 'c' makes the /k/ sound when followed by the letters *o* or *a*, for example, in the word 'vertical'.

Mary also needed minimum mediation as she failed to read only one word, 'departures'. The following is an excerpt that demonstrates Mary's reading the word.

Mary's excerpt:

Interviewer: Please read the following words
Mary: time, destination, (*skips the word 'departures'*), flight number
Interviewer: Can you please read this one (*pointing to the word 'departures'*)?
Mary: (*Remains silent for some time*)
Interviewer: That word is 'departures'

Mary skipped reading the word 'departures' and then remained silent when she was asked to read it. She could not automatically recognize this word and thus could not read it. The word 'departures' is not an easy word to read because not all letters of the word have a one-to-one correspondence with the sound. It is different from a word like, 'jump' where each letter relates to a sound. An attempt to sound out the letters of the word 'departures' would even lead to its misreading. The difficulty in reading such words emanates from the fact that in English, a letter may represent many different sounds, for example, letter *e* may represent sound /i/ or /e/. In the word 'departure' the first *e* represented the sound /i/ while in the word 'desk' the letter *e* represents the sound /e/. In addition to this difficulty, the first *r* is silent. These inconsistencies make this word difficult to read.

Most, if not all, African languages have transparent orthographies where words are pronounced as they look, and children learn to read fluently more easily. IsiXhosa, the learners' HL is consistent in its phoneme-grapheme representation, and so the sound – symbol system correspondences are relatively transparent (Saigh & Schmitt, 2012, p. 26). In contrast, English has some consistent phoneme-grapheme representations but it also has inconsistent and more complex representations (Saigh & Schmitt, 2012). The sound –symbol correspondences are relatively opaque compared to isiXhosa.

The two excerpts above illustrated the experiences of two learners from class A. Their reading skills on the whole were strong and they needed minimum mediation in reading. Next I discuss the two learners who experienced reading difficulties and needed moderate mediation.

7.3.1.2 Learners requiring moderate mediation in reading

Moderate mediation was given to learners who were unable to read a word or words in half of the questions and the words were read for them by the interviewer. The 'moderation' of the mediation is both in quantity terms (how often the mediation was given) and also qualitative (how intensive the moderation was given). I provide three excerpts to demonstrate the difficulties experienced by learners Rose (C28) and Clara (B13).

Rose's excerpt a:

Interviewer: Please read the question to me.

Rose: Look at the di … depart ... uhh … di, di

Interviewer: departures

Rose: Uh, uh … but

Interviewer: departures board

Rose: departures board at the … at the ar … airport and answer the questions that follow

Interviewer: Please continue reading the question

Rose: Write down the fight, the fit, the flit number

Interviewer: flight

Rose: the flight number of a flight which will de … depart of for its dirty … d … desination

Interviewer: destination

Rose: destination before mi, mi … miday

Interviewer: midday

In this question Rose could not read the words ‘departures’, ‘board’, ‘flight’, ‘destination ‘ and ‘midday’. Words like ‘departures’, ‘airport’ are not easy to read because they contain letter combinations that are more commonly pronounced in a different way and also because of their 'phonic unreliability’. The following excerpt illustrates another question in which she struggled to read.

Rose’s excerpt b:

Researcher: May you please read question 11 to me.

Rose: Draw the reflection of the arrow on the … on the ertical … dot line

Researcher: Ok. Draw the reflection of the arrow on the vertical dotted line

Rose: Draw the reflection of the arrow on the vert ... vertical dotted line

Rose could not read the words ‘vertical’ and ‘dotted’. This could be seen through mispronunciation of the words. In the following example, another learner, Clara could not read the words ‘popular’, ‘kind’, and ‘amongst’.

Clara’s excerpt:

Interviewer: Please read the question to me

Clara: This …This is a bar graph shows, shows the most pop …pop ula ki … ki … nd … kids

Interviewer: kind

Clara: kind of kids

Interviewer: This bar graph shows the most popular kind of

Clara: This bar graph shows the most popular kind of sports am ...am ... ong ... amo

Interviewer: amongst

Clara: amongst the learners in Grade 4

The excerpts above show that in some cases Clara failed to read as many as four or five words in one question. The two learners could not recognize words automatically and as a result they could not pay attention to their meaning. Gough (1984) notes that the more easily a learner recognizes a word, the faster he or she can read, therefore, two indicators of word recognition are accuracy and speed. Rose and Clara lacked both accuracy and speed. Next, I discuss the experiences of learners who struggled with reading and as a result much mediation had to be used.

7.3.1.3 Learners requiring extensive mediation in reading

Some learners' reading skills were so weak that they failed to read several words or more, in every question. Although I will not share all the reading difficulties encountered by the following two learners in the 15 questions, it is important to note that these learners needed reading mediation on every question. This will enable us later to understand the reading level these learners are at. Following are the excerpts of interviews with two boys, Bongani (B2) and Benny (C11):

Bongani's excerpt a:

Interviewer: Can you please read the question to me Bongani?

Bongani: Mrs … Ma, Mazime, Mazibe booys … buys an apple for one rand twenty and sells it from one rand ninety-five

Interviewer: for one rand ninety-five cents

Bongani: How much ma … money do.ors

Interviewer: does

Bongani: does Mazi … Mazibe make buy

Interviewer: by

Bongani: by selling one a … apple

Bongani could not manage to read the word 'does' in questions 5.1 and again struggled with this word in question 5.2 although the interviewer had told him how the word is read. Following is another example of Bongani's difficulties in reading.

Bongani's excerpt b

Interviewer: Can you please read question 7 to me?

Bongani: Write a number distance

Interviewer: sentence

Bongani: sentence for the sentence blow

Interviewer: below

Bongani's failure to read the words 'does', 'by', 'sentence' and 'below' was exhibited by mispronouncing the words and hesitations. He read slowly because he was unable to recognize most of the words instantly. On question 9.1, Bongani could not read the words 'departures', 'airport', 'answer', 'destination', and 'midday'. On question 15.1 he was not able to read 'use', 'wall', 'symbol', 'correct' and 'statement', and on question 18.1 he could not read the words 'bar', 'graph', 'amongst' and 'baseball'. These are some of the questions in which Bongani failed to read more than one word in a question. Most of the words were those whose sound did not correspond with letters as well as those whose letters are silent.

The next excerpts are of Benny (C11) and show his struggle to read and the mediation he received.

Benny's excerpt a:

Interviewer: Can you please read the question to me Benny?

Benny: Mrs Mazibe bu ,,.. b ... u (*pauses for some seconds)*

Interviewer: If you do not know the word leave it

Benny: Mrs Mazibe … an apple for one rand twenty and sells it for one rand ninety-five.

Interviewer: That word you have left is 'buys'. Mrs Mazibe buys an apple for one rand twenty and sells it for one rand ninety-five cents.

In this question, Benny could not read the word 'buys'. When he first attempted to read it, he pronounced the sound /u/ in isiXhosa, not in English. When he was asked to leave out the words he could not read, he left out the word 'buys'. 'Buys' is a simple word which can be easily read by making the sounds of the letters /b/+/u/+/y/+/s/. These sounds are taught in Grade 1. The fact that Benny could not read this word is an indication that he had not mastered the correspondence between the sound (auditory) and the letter in English. No wonder he was sounding the word in isiXhosa. Knowledge of phonics (sound system of letters) provides the foundation for word recognition abilities (Shanahan, 2008). Through phonics, learners are able to learn the relationship between sound and letters. Phonics also gives learners essential 'word attack skill' (the ability to take a previously unknown word) and 'spelling skill', then sound it out and make meaning of it (DoE, 2010, p. 27). From the above example, it was apparent that Benny's reading exhibited very limited knowledge of word sounds which in turn compromised his meaning making from the reading.

Another example of Benny struggling to read is given below.

Benny's excerpt b

Interviewer: Benny, please read the question to me

Benny: Draw the re ... repet ... re ... refish … reflix

Interviewer: reflection

Benny: reflection of the a, a ... arr ... arrow on the v ... ve ... veksheken

Interviewer: vertical

Benny: vertical (*pauses, can't read the word 'dotted*)

Interviewer: dotted

Benny: dotted line

Benny demonstrated very poor reading skill on question 11. Firstly, he could not read the word 'reflection' as he could not even sound the letters, let alone try to pronounce the word. Secondly, he hesitated to read the word 'arrow' and mispronounced it (pronounced with a high tone, as in the word 'parole'). On the word 'vertical', he just failed to read it, sounding some letters which were not even in the word. Thus, he could not recognize the word 'vertical' as well as 'dotted'. The word 'dotted' could simply be read through sounding the letters. Jennings, Caldwell and Lerner (2006) note that in order for learners to be able to read, they should be able to recognize sight words (words that are recognized immediately, without further analysis), for example, 'reflection' and 'vertical' which do not need to be sounded in order to be read. Such words make up 75 percent of most reading tasks (DoE, 2010) and they are key to basal reading. They help learners to remember the forms and recognize the words as soon as they see them and enhance reading speed (DoE, 2010). Fourie (2008) argues that the ability to recognize words is critical for mastery of written words and also for fluent reading. Without the skill of recognizing words, learners cannot arrive at an understanding of what they are reading. In Benny's case, inability to readily recognize the sight words instantly, took him longer to finish reading the question which put pressure on his short term memory to retain the first words and their meaning at the end of the sentence. Walpole and Mckenna (2007, p. 48) note that the ability to recognize words in print consists of both "routine skills and meta-cognitive strategies". Routine skills involve matching written representations of words with their sounds and spellings in memory, while meta-cognitive strategies are basic, one of which is word recognition

According to Rault-Smith (2009), learners entering Grade 4 should be early fluent and independent readers and the DoE (2007a, p. 10-11) prescribe characteristics of an early fluent reader as one who:

- uses different 'cueing' systems, such as phonics (sounding out), language knowledge (familiar sentence structures), and general knowledge in order to make meaning
- recognizes most familiar words on sight (approximately 200 words)
- reads fluently at least 60 words per minute

- uses punctuation to enhance comprehension and stops at full stops
- begins to understand implied meaning
- reads texts with longer, more complex sentence structures
- reads silently for an extended period

This is what was expected of the Grade 4 learners I interviewed but most of them, including Benny and Bongani, could not meet these expectations. In terms of their reading level, they were expected to read '158 words per minute' (DoE, 2007b, p. 25) yet Benny and Bongani took a minute to read a question of 11 words. This confirms Phala's (2013) research which established that most Grade 4 learners read below the expected criteria, and lack the necessary reading skills. Phala (2013) also observed that learners read slowly because they are not able to recognize most of the words instantly.

Instead of reading at 'independence level', learners were reading at 'frustration reading level'. Independent level is when a reader can read and understand a text on his or her own. For such a text, a reader should be able to recognize 98-100% words in the text (Stange, 2013). A reader should be able to read the text fluently without much hesitation which compromises the flow of reading. When a reader is reading aloud, there should not be any omissions, additions, repetitions, false starts, fillers - such things which are permissible in speech - and words should be correctly pronounced. It has been suggested that no more than 1 in 20 words (5%) should be difficult for the reader (Betts, cited in Stange, 2013). Many of the learners who were interviewed were not even reading at the instructional reading level. Learners read at instructional level when the text is accessible to learners with the teacher's help. Here at least 90% of words should be known (Armbruster, Lehr & Osborn, 2003). Rather, in this study, many learners (especially in classes B and C) were reading at frustration level. This is when more than 10% of the words (more than 1 in 10) in a text are difficult (Betts, cited in Stange, 2013). Bongani and Benny are good examples of learners who were reading at frustration level because in a question of eleven words, they could not read three to four words.

Jennings et al. (2006) divide word recognition strategies into sight words, i.e. those words that promote reading fluency, and phonics, structural analysis and context, those that promote reading accuracy. Reading fluency refers to the “ability to read text accurately, quickly and with expression and comprehension whereas reading accuracy means reading words correctly without any error” (DoE, 2007b), p. 17). Both these reading competences were not sufficiently met by most of the learners who were interviewed in this study. This explains learners’ poor comprehension as revealed earlier in the quantitative analysis. Rault-Smith (2009) argues that learners entering Grade 4 should be reading fluently and independently while the DoE (2007b), p. 10) expects them to “access information, become critical readers, analyse information from texts, generalize information, construct new knowledge and understand abstract concepts”. The latter expectation would be impossible where learners could not demonstrate mastery of the former. The latter requirement is consistent with the notion of learning to read, learners transition to Grade 4 within the South African context.

Pretorius and Ribbens (2005) observe that the transition from learning to read during the FP to reading to learn in the IP is evident when learners can read expository (informative) text and critically analyse a variety of texts. Reading fluency is a pre-requisite to the attainment of this ideal and from the learners ‘interviews, it was apparent that at Grade 4, most of them still needed to learn to read. Without well-developed reading and language skills, learners would not “develop mathematical thinking skills such as generalizing, explaining, describing, observing, inferring, specializing, creating, justifying, representing, refuting and predicting” (DoE, 2002, cited in Bohlman & Pretorius, 2008, p. 44) as was seen earlier in the quantitative analysis and as shall be shown later in the discussion.

Next, I discuss the experiences of learners in comprehension of the task-based questions.

7.3.2 Learners’ difficulties in comprehension

Under this theme, I first discuss the experiences of learners who demonstrated their comprehension skills without too much trouble and required little mediation, then those for whom moderate mediation was given and lastly those that needed extensive mediation.

7.3.2.1 Learners requiring little mediation in comprehension

There were a few learners who did not struggle much with comprehension of words in several questions and the questions as a whole. For example, Abigail (A22) and Elliot (C17) could not understand only 3 of the 15 questions. Of interest is that these two learners, who had the strongest comprehension skills in their classes, were also able to read all the questions fluently. This confirms the DoE's (2007b) assertion that reading fluency, 'which is reading a text accurately, quickly and with expression', leads to comprehension. Children with a strong reading background, who read with high fluency and comprehension, experience automatic and accurate fluency of understanding as they read (Wixon & Lipson, 1997). Following are two excerpts showing Abigail's experience when she failed to comprehend a few words from the same questions.

Abigail' excerpt a:

Interviewer: Can you please read the question to me?
Abigail: Mrs Mazibe buys an apple for one rand twenty and sells it for one rand ninety-five. How much money does Mrs Mazibe make by selling one apple?
Interviewer: Abigail, is there any word that you don't understand in the question you have read?
Abigail: No
Interviewer: Ok. Tell me what the question is asking you to do
Abigail: (reads silently the question for the second and third time)
Interviewer: What is the question asking you to do?
Abigail: (*Does not respond*)
Interviewer: Do you understand it?
Abigail: (for some seconds, opens her mouth but could not say anything)
Interviewer: Ok. The question is asking you to find how much profit or extra money Mrs Mazibe makes after selling the apple for one rand ninety-five cents. She bought it

for one rand twenty and sold it for one rand ninety-five. So how much profit or how much more money will she get? How are you going to get the answer?
Abigail: I subtract

Abigail was the first person to be interviewed in her class. She was anxious and actually did not know what to expect from this task-based interview. Although she had been assured that no marks were to be awarded for this task-based interview, and encouraged to relax and respond without fear, she still remained anxious for some time. The first question, 5.1 was a question with very simple everyday language which I expected her to comprehend easily. She, however, did not understand what she was required to do possibly due to anxiety; a phenomenon that is among the most "critical affective determining success and/or failure in language learning" (Krashen, 1987, p. 31). "Anxious students are likely to experience mental blocks, negative self-talk and ruminate over a poor performance which affects their ability to process information in learning contexts" (MacIntyre & Gardner 1991, cited in Atasheneh & Izadi, 2012, p. 178). Anxiety possibly explains Abigail's failure to comprehend the question, as it was the first question asked, and she was the first person to be interviewed.

Abigail's excerpt b

Interviewer: From the question, is there any word that you don't understand?
Abigail: This one (*pointing to 'departures'*)
Interviewer: departures
Abigail: Yes
Interviewer: Departing is leaving a place going somewhere. When you leave school and go home, that is to depart school. So 'departure' is the act if leaving
Abigail: ok
Interviewer: Can you please continue reading the question?
Abigail: Write down the flight number of a flight which will depart for its destination before midday.
Interviewer: Good. Do you understand what the question requires you to do?
Abigail: (*Re-reads the question twice*)

Interviewer: Do you understand it?

Abigail: No, I don't

Interviewer: In other words, the question wants you to write the flight number of a flight that leaves before 12 o'clock, which is midday. Can you try and write it down?

Abigail: Writes down BA172, a correct answer

Interviewer: Good

From Abigail's excerpt b above, Abigail could not say what the question required her to do. When she was asked whether she understood the question, she did not answer implying that she had not. Although she had understood all the words in the questions, she had not understood the content of the question. This implies comprehension of words in a text does not always guarantee comprehension of the text. She however, understood the question when it was reworded as she could come up with the right transformation.

Abigail said she did not understand the word 'departures'. When the word was explained to her, she still could not say what the question required her to do. Abigail most likely lacked a background knowledge of the context of the question (in this case, aviation language like 'departures', 'destination' and 'flight numbers'). Duke and Pearson (2002) note that for comprehension to take place, thoughtful readers use relevant prior knowledge to predict when they are reading. Reading comprehension comes from the interaction between the words in the text and the knowledge that the reader brings to the text during reading (National Education Evaluation and Development Unit, 2013). The use of prior knowledge helps learners bring knowledge from life experiences to their reading, form predictions based on this prior knowledge and then engage more deeply with the text. Prior knowledge includes background knowledge and literacy-related knowledge (National Education Evaluation and Development Unit, 2013). Abigail, whose school was located in a poor township most likely hailed from a similarly poor family background devoid of knowledge of middle and upper class experiences and the attendant literacy-related knowledge. This confirms Bohlman and Pretorius' (2008) idea that learners need to access information and understand the context and content before they can even begin to apply any of the mathematical skills they have learnt. Comprehension is what reading is all about (Pretorius & Lephalala, 2011).

In addition to the lack of background knowledge and literacy-related knowledge, the word 'departures' is a low frequency word which most learners at Grade 4 are likely to be unfamiliar with. Because low frequency words are not found in many texts, they are more difficult for students to acquire (Nagy & Scott, 2000). MacLeod and Kampe (1996) argue that the degree of automaticity of processing words decreases as their frequency in the language decreases. Therefore, when a child reads, high frequency words are recalled and processed automatically, whereas low frequency words not.
Next, I discuss the comprehension experiences of two learners who demonstrated their skills with moderate mediation.

7.3.2.2 Learners requiring moderate mediation in comprehension

As in the case of reading, learners who received moderate mediation were those who failed to understand about half of the questions and then demonstrated the subsequent skill after mediation. In this sub-theme, I discuss the excerpts of a girl, Anathi (A27) and a boy, Buhle (A23).

Anathi's excerpt:

Interviewer: Can you please read the question to me Anathi?
Anathi: Write a number sentence of the sentence below. The difference between 1 613 and 859 is even hundred and fifty-four.
Interviewer: Good. Is there a word or words that you do not understand?
Anathi: No
Interviewer: You understand all the words. Good. So what is the question asking you to do?
Anathi: It's asking me what is the difference between 1 613 and 859
Interviewer: So what are you going to write here (pointing to the space provided on the paper)? What are you going to write? What is the question asking you to do?
Anathi: It wants me to write what is the difference between 1 613 and 859

Interviewer: Ok. The question is asking you to write a number sentence, this sentence here (pointing to the sentence on the paper). The difference between 1 613 and 859 is seven hundred and fifty-four. Do you know what difference means in this question?

Anathi: Yes

Interviewer: OK. Can you tell me what it means?

Anathi: difference means ah, ah … difference ah what is different numbers, numbers are different.

Interviewer: OK. Difference is the answer that you get when you subtract a number. For example, five minus three is equal to two. Two is the difference. So when you subtract a number the answer that you get is the difference. So the question wants you to write a number sentence for this (pointing to the sentence). So can you try and write it?

Anathi: (*wrote the sentence in words*)

Interviewer: When you write a number sentence, you do not write it in words. You write it in numbers and symbols such as plus, minus and equals. So you do not write words in a number sentence. Can you now write the number sentence?

Anathi: (*Looks confused*)

Interviewer: A number sentence is something like 10-5=5 (ten minus five is equal to five). Do you understand now what a number sentence is?

Anathi: Yes

Interviewer: OK. Now can you write it down?

Anathi: (*wrote a number sentence in numbers this time-1613+859-754)* (one thousand six hundred and thirteen plus eight hundred and fifty nine minus seven hundred and fifty four) instead of 1 613-859=754

The excerpt above illuminates the difficulties Anathi went through as she attempted to comprehend what the question required her to do. Firstly, she said that she understood all the words in the question but it was evident in her response that she did not understand what the question required her to do. The question required her to write a number sentence but she said it required her to 'write what is the difference between 1 613 and 859'. She did not have to look for the 'difference' because the difference was provided.

Secondly, she did not know what the word 'difference' means. She defined 'difference' as 'what is different numbers, numbers are different'. As discussed in the quantitative analysis, this same learner took 'difference' in the everyday context to mean 'dissimilar'.

Thirdly, Anathi did not also know what a 'number sentence' is. She had an idea of a sentence as a string of words, which is why, when she was asked to write a number sentence, she wrote this: 1613+859-754. She did not understand a 'number sentence' includes symbols like – or + and = as well as numbers in figures. The correct interpretation of mathematical information and concepts is dependent on learners' ability to comprehend and express their understanding coherently (Bohlman & Pretorius, 2008).

Bohlman and Pretorius (2008) note that:

> Mathematics discourse is characterized by precision, requiring close attention to detail. Mathematics texts are also hierarchical and cumulative, such that understanding each statement is necessary for understanding subsequent statements. Overlooking or misunderstanding a particular step has severe consequences for overall comprehension (p. 43-44).

This is confirmed by Anathi's inability to solve the given problem because she failed to pay attention to the details. Boero, Douek and Ferrari (2002, cited in Bohlman & Pretorius, 2008, pp. 43-44) also posit that "only if students reach a sufficient level of familiarity with the use of natural language in … mathematical activities they can perform in a satisfactory way". The interviewees needed to be familiar with the mathematics language, which may be used differently in everyday settings. Next, is an excerpt of Buhle, who also struggled with the mathematical discourse which was unfamiliar to him, to the extent that he could not perform well in the word problems that contained mathematical terms.

Buhle's excerpt:

Interviewer: Buhle, can you please read question 11 to me?

Buhler: Draw the refraction … reflection of the arrow on the ver … vertical do-tted line

Interviewer: Ok. Any words that you do not understand?

Buhle: very ... vertical

Interviewer: vertical. Ok. A vertical line is a line that goes down or up, like that line on the chalk board (*pointing to a vertical line on the chalk board*). Do you see it?

Buhle: Yes

Interviewer: Do you see that it is dotted because it has been draw using dots. That is why it is called dotted line. Can you show me a vertical dotted line on your paper?

Buhle: Yes. This one. (*Pointing to the line*).

Interviewer: Good. So what is the question asking you to do?

Buhle: Ah ….ah to draw a reflesh of the arrow

Interviewer: It's 'reflection'. What is a reflection?

Buhle: (*remains quiet*)

Interviewer: It is the right hand side of that shape which looks the same as that shape (*pointing to the shape*)

Buhle: We must draw an arrow?

The words that Buhle struggled to read were the same words that did not understand. He failed to recognize the words 'vertical' and 'reflection' and thus, could not read them fluently. Fourie (2008) notes that the ability to recognize words is critical for mastery of printed words and also for fluent reading, which then leads to comprehension. Bohlman and Pretorius (2008) also note that mathematics learning is highly dependent on literacy. In order to learn and understand, one needs to be able to read. Because Buhle struggled to read the words 'reflection' and 'vertical', he also was unlikely to know what they meant. It was discussed in the quantitative analysis that the possible reasons why these words were difficult for learners was that they are mathematics specific vocabulary, which were not familiar to learners. Learners rarely encounter them in everyday language.

The other questions that Buhle failed to understand were questions 9.1 (did not understand the word 'departure'), 12.1 (did not understand the word 'convert'), 13 (did not understand what a 'flow diagram' is), 15.1 (did not understand the symbols), 18.1 (did not understand what the word 'amongst' means and what the question required him to do) as well as question 18.3 (in which he did not understand what the question required him to do).

Buhle also failed to understand questions 5.1 (he did not understand what the question required him to do), 7 (did not understand the words 'difference' and 'number sentence'), 9.1 (did not understand the words 'departures', 'destination' and what the question required him to do), 12.1 (did not understand the word 'convert'), 15.3 (did not understand the question) and 18.3 (did not understand the requirement of the question).

It is apparent that the lack of comprehension was due to the use of unfamiliar words. Duke and Pearson (2002) note that texts become easier to understand when learners know the structural shape which include tenses, vocabulary, participants, signal words for time and order of what they read. Learners who attend to the structure of texts learn more about the content even while attending to the structure (Duke & Pearson, 2002). They are able to identify the features of each text type and therefore predict how to read more effectively and as a result comprehend the text.

Next, I discuss the experiences of learners who needed extensive mediation in comprehension of questions.

7.3.2.3 Learners requiring extensive mediation comprehension

Learners who received extensive mediation in the comprehension skill were those who failed to understand almost all the questions in the interviews. Here I discuss two learners' experiences sharing examples of only two questions which they struggled to comprehend. Smily (B31) and Amos (C21)'s excerpts are discussed to demonstrate the difficulties they experienced with comprehension of the interview questions.

Smily's excerpt a:

Interviewer: OK, Smile. May you please read to me question 18.1?

Smily: This … this … b,b,b

Interviewer: bar

Smily: bar … g r… ga (*Pauses*)

Interviewer: graph

Smily: graph shows the most propo ... po

Interviewer: popular

Smily: kid

Researcher: kind

Smily: kind of sp … story … spo

Interviewer: sport

Smily: sport amo … ams t…

Interviewer: amongst

Smily: amongst the le … len

Interviewer: learners

Smily: learners in Grade 4

Interviewer: OK. The question reads: This bar graph shows the most popular kind of sport amongst the learners in Grade 4. OK. Grade 4 learners do these sports. Now finish reading the question.

Smily: Complain the …

Interviewer: Read this word again (*pointing to 'complete'*)

Smily: complete the t… tt

Interviewer: tally. Complete the tally table. Now the question says complete the tally tables. Do you know what tallies are?

Smily: No

Interviewer: When we are counting we may write these ones or sticks, if we count one, we write one stick, if two, two sticks. When you count five, you write four sticks and with the fifth stick you cross the four. So these sticks are the tallies. Do you now understand what tallies are?

Smily: (*remains silent*)

Interviewer: Now go to your graph and count the number of learners who do golf and come and write the tallies after the golf.

Smily: (*did not respond because she did not understand the instruction*)

Translator: Umbuzo uti 'Bala inani labafundi abandla igolf uze ungqalanise amanqaku apha, phinde wenze kwangolohlobo nakwabo badlala I baseball netennis *(count the number of learners who play golf and draw tally marks here and do the same for learners who play baseball and tennis*). Bangaphi abantwana abadlala i tennis? (*How many children play golf?*)

Smily: Two.

Translator: Good. Dwelisa amanqaku (*draw the tallies)*

Smily: (*Draws the tallies*)

Translator: Bangaphi abantwana abadlala i baseball?

Smily: Seven

Translator: Good. Dwelisa amanqaku (*draw the tallies*)

Smily: (*Draws the tallies*)

The excerpt illuminates that Smily's difficulties stemmed from poor reading and culminated in failure to comprehend the words she could not read. In a question of nineteen words, she failed to read ten words. The negative effects of poor reading fluency on comprehension were discussed earlier.

Smily's proficiency in English was very poor. As was evident from her reading, she also struggled to understand instructions given in English. When the interviewer asked her to go to the graph and count the number of children that do tennis and then draw tally marks for them, Smily did not respond because she did not understand this instruction. It was only when she was taken step by step in isiXhosa (her HL) that she could count and draw the tallies on the table. Thus she could demonstrate her skills only with maximum mediation from the translator. Following is another example in which Smily experienced difficulties in comprehension.

Smily's excerpt b

Interviewer: Can you please read to me question 15.3?

Smily: Us the fraction wall to ca, ca … colour ... calate

Interviewer: calculate

Smily: calculate ¼ +2/4

Interviewer: Do you know what 'calculate' means?

Smily: No

Interviewer: To calculate is to work out an answer or to find the answer. So do you now understand what the question wants you to do?

Smily: (*remains quiet*)

Translator: umbuzo uthi 'sebenzesa ufraction wall ibale ¼ +2/4 (*the question says 'use the fraction wall to find ¼ +2/4)*

Smily: (*uses the fraction wall to find the answer*)

Interviewer: Good

From this excerpt, it is also clear that the learner could solve the problem only with mediation through translation of the question. Next, I discuss excerpts showing Amos' struggles in comprehension of questions.

Amos' excerpt:

Interviewer: Ahah. Is there any word that you don't understand on this question?

Amos: (*Points to the word 'difference'*)

Interviewer: 'Difference'. What did I say about 'difference'? What does 'difference' mean?

Amos: (*no response*)

Interviewer: The answer that you get when you subtract a number. Which other word don't you understand there?

Amos: I understand

Interviewer: OK. Now can you answer the question? How are you going to get your answer?

Amos: I say four plus nine

Interviewer: Difference. What is the meaning of difference? When you want to find a difference what do you do?

Amos (*no response*)

Interviewer: Remember I said you subtract. You don't add. Now subtract.

Amos: (*stuck, doesn't understand*)

Translator: Subtract, Thabatha

Amos *(subtracted 9-4 and got 4)*
Interviewer: What is nine minus four?
Amos: it's four
Interviewer: nine minus four
Amos: (*counts fingers*) five

Like Smily, Amos experienced difficulties in comprehending questions which had words that were unfamiliar to him. Vocabulary knowledge is an important component of comprehension and correlates very highly with comprehension (National Reading Panel, 2000). Not being proficient in English, the learners could not understand the questions at all and it was only with mediation that they could demonstrate the subsequent skills. Poorly developed language skills were shown to undermine learners' mathematical performance (Bohlman & Pretorius, 2008).

These excerpts show that comprehension difficulties have their roots in lack of fluent reading. An improvement in learners' reading will concomitantly herald an improvement in their reading comprehension. According to MacGregor and Price (1999, cited in Fite, 2002), there is a mutual relationship between poor language skills (reading and comprehension) and poor mathematics skills, suggesting that both skills require the basis of competency in symbol processing.

In addition to the lack of fluent reading, the learners lacked the background knowledge of some of the material they were reading about. Butcher and Kintsch (2003, cited in Pardo, 2004) point out that the background knowledge that connects with the text makes it likely that the reader will be able to make sense of what is being read.

Pretorius and Lephalala (2011) note that South African learners' poor performance in reading comprehension clearly indicates that comprehension needs attention. Also, large-scale assessments of reading comprehension of Grade 4 and 5 learners in South Africa have shown very low comprehension levels (Howie et al., 2008). This is confirmed in this study.

What follows is a discussion on learners' experiences in the skills of transformation, process and encoding skills. These are discussed together because they are complementary.

7.3.3 Learners' difficulties in transformation, process and encoding skills

I first discuss the experiences of learners who demonstrated their skills with little difficulty and therefore with little mediation.

7.3.3.1 Learners requiring little mediation in transformation, process and encoding

A learner was said to have been able to demonstrate a transformation skill when they were able to choose the correct operation or series of operations for solving a mathematical problem. Some learners were able to choose the correct operations and do the correct process and encoding skills, others could choose a correct operation but still failed to do the correct process skills. In this sub-category, I discuss those learners who could choose the right operation and do the correct process skills. I present some excerpts of two learners (who did not struggle at all with reading and comprehension in some questions but experienced difficulties in transformation and process skills), girls named Anita (A5) and Delia (B12).

Anita's excerpt:

Interviewer: Please read the question to me; the first question. This question (*as she points at the question on the paper*).
Anita: (*In a low voice*) Mrs Mkhize
Interviewer: (Interrupts her) May you please read louder so that I can hear?
Anita: Mrs Mazibe buys an apple for R1.20 and sells it for R1.95. How much does she make by selling one apple?
Interviewer: Good. Are there words that you don't understand? On the questions that you read are there any words you don't understand?
Anita: No
Interviewer: OK. So tell me, what the question is asking you to do?
Anita: This one? (*As she points at the question*)
Interviewer: Yes

Anita: The question is asking me about how much Mrs Mazipe makes by selling one apple

Interviewer: Yes. So how are you going to get the answer?

Anita: I will first add these two (*as she points at the figures on the paper*)

Interviewer: Are you going to add?

Anita: (*nods in agreement*)

Interviewer: You want to find the profit; she bought it for one rand twenty and sold it for one rand ninety-five. How much profit did she make? How much profit does she make from selling one apple?

Anita: Fifty cents

Interviewer: OK. May I know how you got that? How do you get the answer?

Anita: I take the first one and add it to the other one

Interviewer: You do not add, you subtract one rand twenty from one rand ninety-fine. Can you work it out and write down the answer

Anita: (*works on her paper for about a minute*)

Interviewer: Ok what did you get?

Anita: (*she shows her the paper*)

Interviewer: Ok. One rand ninety-five is bigger than one rand twenty, so you put one rand twenty under one rand ninety-five. Now can you try and subtract it?

Anita: (*she works it out then hands back the paper*)

Interviewer: Ok you say five minus zero is five zero and nine minus two is seven, one minus one is zero so you don't write it; so she got seventy-five cents profit.

While Anita could correctly read and said she had understood the question, her difficulties were with choosing the proper operation to use in computing the question. Her answer, 'I will first add the two' clearly showed that she did not know how to calculate the extra money or profit Mrs Mazibe made. When she was asked if she was going to add, she nodded in agreement, showing that she believed that that was how she would get the answer. When asked again how she would get the answer, she said Mrs Mazibe would get 50c for profit, which she said she got by 'take the first one and add it to the other one' i.e. 1.20+1.95. Anita's response showed that she could not identify the required computation. When she was asked to subtract R1.20 from R1.95, she made a common error in subtraction, that is, she subtracted the smaller number from the bigger number, placing R1.20 on top of R1.95. Schunk (2004) notes that when learners do not know what to do, they modify the rules to fit the new problem that they have.

Below is an example of Delia failing to demonstrate the transformation and process skills.

Delia's excerpt:

Interviewer: Can you please read the next question?
Delia: How much does Mrs Mazipe make if she buys and sells ten apples?
Interviewer: For one apple she got seventy-five cents, what is she going to get if she sells ten apples? How are you going to get the answer?
Delia: (*whispers something that was not heard*)
Interviewer: Ok do you understand all the words and question?
Delia: Yes
Interviewer: Good. So if she got a profit of seventy-five cents for one apple, how much did she get for ten apples? How are you going to get the answer?
Delia: I take one rand ninety-five
Interviewer: Ok you are no longer working with one rand ninety-five but you are now working with seventy-five and ten. So what do you do now?
Delia: I say seventy-five subtract ten
Interviewer: Ok. You don't subtract, you multiply seventy-five by ten. Can you try and multiply seventy-five by ten here *(she points at the paper)*
Delia: (*working out*)
Interviewer: What did you get?
Delia: (*whispers answer*) hundred and seventy five and fifty
Interviewer: Ok seventy-five times ten is seven hundred and fifty. Every number that you multiply by ten you add a zero. So you say ten times ten which is a hundred you add a zero; two times ten is twenty you just add a zero; so seventy-five times ten is seven hundred and fifty cents; so your answer is seven rand fifty.

Although in the excerpt Delia said she understood the question, she could not choose the right operation to use in order to work out the answer. Even when the operation was provided, she did not manage the process skills. When she was asked how she was going to calculate the answer, she said she was going to 'take one rand ninety-five', reverting to the selling price from the previous question. Instead, she was supposed to multiply the 75c profit by 10. When prompted, she said 'I say seventy-five subtract ten'. Because in the previous problem she was told to subtract, she probably thought that she had to subtract again in this problem. When told to multiply, she failed to multiply 75 by 10 correctly. Firstly, Delia multiplied 75 by 10 and got 55. Secondly, she multiplied 10 by 10 and got 100 then she multiplied 2 by 10 but she did not write the answer. Finally, she wrote 75 as her final answer. The fact that Delia could not do the multiplication computation relates to her lack of mastery of the basics of addition and subtraction as we saw in the other transcript. Schunk (2004) contends that for one to understand multiplication and division, he or she has to understand the primary concepts of addition and subtraction. Multiplication is repeated addition and division is repeated subtraction. Schunk (2004) argues that the addition and subtraction operations are key for all further learning in mathematics, and without mastering them, the chances of a child achieving the multiplication and division skills would be limited.

Lemaire and Siegler (1995) assert that children make different types of errors in multiplication. For example, they add where they are supposed to multiply. Delia did the same error where she added 0 to 5 and got 5 instead of multiplying 5 by 0 to get 0. Both Delia and Anita struggled with mathematical computation. This shows that sometimes even if learners have understood the requirements of the question, they still fail to demonstrate the processing skill if they lack mathematical content knowledge.

7.3.3.2 Learners requiring extensive mediation in transformation, process and encoding

A learner was said to have been able to demonstrate a transformation skill when they were able to choose the correct operation or series of operations for solving a mathematical problem. Here I discuss the experiences of two girls, Rose, (C28) and Clara (B13) who struggled to demonstrate the skills of transformation, process and encoding skills of all the 15 questions but here I share only one example for each of them.

Rose's excerpt:

Interviewer*:* Can you please read the question to me?
Rose: *(reads)* Poppy buy … buy a two bottles of milk. She use five hundred millilitres
Interviewer: Millilitres
Rose: Millilitres of the milk to bark bake a cake. How much milk is left in the bottle?
Interviewer: Tell me, how do you get the answer?
Rose: Uh …. Uhh (*stuck*)
Interviewer: What do you do first to these two litres?
Rose: (*no response*)
Translator: Uyazi two litre? (*Do you know two litres?*)
Rose: Yes
Translator: Ngepi two litre yawaziwa? (*Which two liters do you know?*)
Rose: Two liter yecoke (two litres of coke)
Translator: yebo (*yes*)
Interviewer: OK. Do you know how many millilitres there are in one litre?
Rose: No
Interviewer: OK. In one litre there are one thousand millilitres, in one litre. This is one litre. What about in two litres?
Rose: (*no response*)
Interviewer: How many litres do we have in two litres?
Rose: (*works it out and got four thousand millilitres*)
Interviewer: No. You are saying two times one thousand
Rose: (*can't work it out*)
Interviewer: What is two times one thousand?
Rose: Uhh .uhh (*stuck*)
Interviewer: two times one thousand is two thousand. So you have two thousand millilitres. So two litres is two thousand milliliters. What do you do then, to get your

answer? We know that here it’s two thousand milliliters, how do you find the answer now?

Rose: Uhh … two times five hundred

Interviewer: Yoo times? Is it times? You don’t say ‘times’. Times means ‘multiply’. So you do not multiply here. What do you do to get the milk that is left? Do you times?

Rose: (*stuck*)

Interviewer: OK. You say two thousand minus five hundred. Now can try and work out the answer?

Rose: (*works it out*) seven thousand one hundred

Interviewer: two thousand minus five hundred

Rose: (*works it out again*)

Interviewer: What did you get?

Rose: (*does not answer but she got 4000*)

Interviewer: Oh, You did not subtract correctly. Can you please show me how you got this answer?

Rose: (*remains quiet*)

Interviewer: OK. The answer is one thousand five hundred. You calculate it like this …

The above excerpt shows that Rose experienced difficulties in transformation and process skills. Although there were interventions and mediation from the interviewer and translator, Rose still failed to demonstrate her process skills. Rose lacked the idea of capacity. She did not know what makes up a litre, how many millilitres are in one litre and so forth. Although she said she knew a two litre bottle of coke, she had no knowledge of what these litres were.

Rose experienced another difficulty in transformation when she was asked how she would find the amount of milk that was left in the bottle. She said ‘two times five hundred’ instead of subtracting 500 from 2 000. It is clear that Rose could not identify when subtraction or multiplication was supposed to be used. When Rose was told what to do (subtracting), she still struggled to process the computations. Firstly, she said she got 7 000 after subtracting 500 from 2000. She however, did this mentally because she did not work it on her paper. When she was asked to do the computations on the paper, she got 4000. There was no indication of where the 4000 came from and she could not explain it. From this it was evident that learners sometimes get so confused that they cannot explain what they have done to get their answers.

Following is an example of difficulties Clara experienced in transformation, process skills and encoding.

Clara's excerpt:

Interviewer: OK. Let's go to number 13. Can you please read the question to me?
Clara: Comp … comp … compleit
Interviewer: Complete
Clara: Complete the following flow (*pauses*)
Interviewer: Flow what?
Clara: *(no response*)
Interviewer: Diagram
Clara: Diagram, flow diagram
Interviewer: Have you ever seen a flow diagram? Or that diagram before, in class or in your books?
Clara: (*no response*)
Translator: uthi wake wayibona lediagram eclasini maybe ezinqwadini? (*She is saying 'have you ever seen that diagram in class or in a book?*)
Clara: No
Interviewer: OK. This is a flow diagram (*pointing to the diagram.*) Are there any words that you don't understand?
Clara: (*no response*)
Translator: akhona amawords ongawaqcondiyo? (*Are the words that you do not understand?*)
Clara: (*points to the word 'diagram'*)
Interviewer: Diagram. Diagram is this drawing with arrows (*pointing to the diagram),* these two arrows and these two rectangles. So the question is saying eh ..: work out the given numbers, these numbers, six, seven and nine, to find the answer.

When you work it out, you write your answer here. You have seven, in this box you have five plus nine. Can you work it out?

Clara: (*Does not respond*)

Interviewer: How do you work it out? We have seven here, here we have times five plus nine. How do you work it out?

Clara: (*no response*)

Interviewer: OK. What is seven times five?

Clara: (*no response*)

Translator: seven times five uphuma ngesiphumo siphi?

Clara: (*no response*)

Interviewer: OK. Seven times five means five sevens or seven plus seven plus seven … add seven fives

Clara: (*counts her fingers and got the correct answer*) thirty five

Interviewer: OK. What do you do next?

Clara: (*no response*)

Interviewer: You now add nine to thirty-five, say thirty five plus nine

The above transcript shows Clara's struggles with process skills but before that she also struggled with reading and with comprehension of the questions. Having no idea of what a 'flow diagram' was could have also contributed to his confusion on how to manage the process skills. Clara indicated that she did not know what to do by not responding or keeping quiet when asked what she was required to do. Her lack of response could also mean that she did not understand what the interviewer was asking her. Therefore, Clara had many difficulties which included not understanding what the question required her to do, not understanding what the interviewer was asking her as well as not knowing how to manage the process skill. The fact that when the translator translated the question to her (*seven times five uphuma ngesiphumo siphi?*) and she still did not know what to do confirms her difficulty as with process skills. Thus mediation in this case did not assist her to demonstrate the process skills. With finger counting she eventually managed to get the answer for 7 times 5. The next step was to add 9 to 35, Clara however, did not know what to do next and therefore, she remained silent when she was asked what she should do. Perhaps Clara did not know what the sign '+' means.

National Council of Teachers of Mathematics (NCTM) (2003) observes that:

> Knowing basic number combinations - the single-digit addition and multiplication pairs and their counterparts for subtraction and division - is essential. Equally essential is computational fluency - having and using efficient and accurate methods for computing (p. 32).

From the excerpts discussed, it was evident that these learners lacked the basic knowledge of subtraction, addition, multiplication and division, which we expected them to do with ease. NCTM (2003) goes on to claim that:

> By the end of grade 2, students should know the basic addition and subtraction combinations, should be fluent in adding two-digit numbers, and should have methods for subtracting two-digit numbers. At the grades 3–5 level, as students develop the basic number combinations for multiplication and division, they should also develop reliable algorithms to solve arithmetic problems efficiently and accurately. These methods should be applied to larger numbers and practiced for fluency (p. 35).

The requirements in the quote above were not met by the majority of learners who were interviewed in this study. These learners lacked the very basic skills of mathematics that they should have acquired in the FP. Because they could not master these basics in the foundation of learning mathematics, they were still struggling in the intermediate stage.

Baroody (2006, p. 26) notes that some children's learning difficulties are "attributed to their cognitive limitations". Children with these cognitive limitations are, according to Baroody (2006, p. 26), likely to be "forgetful, prone to confusion and unable to apply knowledge to even moderately new problems or tasks." Baroody (2006) gives a list of symptoms of children who have difficulties in learning mathematics. They include:

- A heavy reliance on counting strategies

- The capacity to learn reasoning strategies but an apparent inability to spontaneously invent such strategies
- An inability to learn and retain basic number combinations, particularly those involving numbers greater than 5
- A high error rate in recalling facts (e.g. "associative confusions," such as responding to 8 + 7 with "16" (p. 27).

Baroody's observations are supported in this study because many of the characteristics mentioned above applied to some of the learners who seemed to have learning difficulties. During the interviews, it was apparent that learners still relied heavily on finger counting (e.g. Clara) and committed many errors in recalling facts. As excerpt 15 shows, the learner responded to 9 – 4 with '4'. On the second attempt, she got the correct answer after counting fingers. This, therefore, is evidence that some learners have learning difficulties in mathematics.

Overall, with regard to the deeper analysis, this study established that the major difficulties that learners experienced in mathematics were due to the language factor, which is reading and comprehension although content knowledge factor (transformation, process skills and encoding) also played an important role in compromising the learners' performance.

Bharuthram (2012, p. 210) notes that "the relationship between reading and academic performance cannot be over-emphasized." In other words, reading is the key to academic achievement. Balfour (2002, cited in Bharuthram, 2012) argues that students' weak reading levels have serious implications for the following reasons:

- A poor ability to read and digest course material impacts negatively on students' performance and on their self-esteem.
- An inability to read affects students' ability to follow written instructions, be these in the form of essay questions or examinations.
- An inability to read texts impacts negatively on the students' ability to model their own writing on them — both conceptually, linguistically and structurally.
- For this reason an inability to read — and to model one's own writing production on what one reads — severely affects students' chances of

> sustaining their own language development once they complete the course (p. 211).

This also applies to young learners in primary school across all subjects. According to Bohlman and Pretorius (2002), performance for mathematics improve as learners' reading ability improve.

7.4 Chapter summary

The chapter analysed the learners' interviews, both quantitatively and qualitatively. While the more quantitative analysis dealt with organizing the data, summarizing the findings, displaying evidence and describing the profile of findings, the qualitative analysis presented what the learners' experienced in the interview process. Findings revealed that learners experienced difficulties in the following skills: reading, comprehension, transformation, process, encoding. The greatest difficulties were experienced in comprehension and in reading, especially in classes B and C where the learners were less proficient in English language. The excerpts illuminated that learners also struggled with mathematical computation, in addition to evident language challenges. Although most learners struggled with reading and comprehension of questions, some also struggled with transformation and process skills.

CHAPTER 8: ANALYSIS OF TEACHERS' EXPERIENCES OF THE LINGUISTIC CHALLENGES OF THE ANAS (Phase 4)

8.1 Introduction

In this chapter, I analyse the questionnaires which were administered in the fourth phase of the data collection. This data emanated from the two Grade 4 teachers, Busi and Anesipho (pseudonyms). Busi taught maths in two classes at school B (class B and C) while Anesipho taught one class at school A (class A). The two teachers shared their experiences on the linguistic demands of the Grade 4 mathematics ANAs. Anesipho has been teaching Grade 4 mathematics for the past seventeen years and Busi, for twelve years. They had also administered the ANAs since 2011 when they were introduced. They were therefore, considered to be sufficiently experienced in both the teaching of mathematics to Grade 4 learners, and the administration of ANA tests at that level to be conversant with the challenges that learners experience in learning mathematics and in writing mathematics ANAs. These insights were important for answering the research question 4:
What are the teachers' experiences of the linguistic challenges of the ANAs?

All of Anesipho's 40 learners for 2013 Grade 4 class were isiXhosa L1 speakers. Therefore, they were isiXhosa speakers who started learning in English at Grade 1. Busi's learners (two classes) were not all isiXhosa L1 speakers but had been learning in isiXhosa from Grade 1 to 3 and then in English as the LoLT from Grade 4. Therefore, Busi's and Anesipho's learners' exposure to English language was different, which could be the reason why Anesipho's learners who were interviewed could read and comprehend English better than Busi's learners.

As explained in the methodology chapter, the 2013 Grade 4 mathematics ANA items were analysed to investigate their linguistic complexity. Learner scripts were also scrutinised in order to establish why learners performed so poorly in the 2013 mathematics ANAs. The questions that were badly responded to were identified and task-based interviews were conducted on a selected number of learners in order to investigate the difficulties learners experienced as they solved the mathematical problems. It was also important to explore how teachers experienced the Grade 4 ANAs as they worked with learners in classrooms. Teachers' experiences were collected through open-ended questionnaires.

In this chapter, data is presented within five broad themes which emerged from thematic analysis of teacher responses namely:

- Teacher perceptions of the Grade 4 learners' experiences of the language of the mathematics ANAs (questions that gave rise to this theme were questions 2, 3, 4)
- Teacher perceptions of the learners' experiences of the Grade 4 ANAs in terms of reading skills (question that gave rise this theme was questions 5)
- Teachers' views on the ANA policy that teachers should not read questions to the learners (questions gave rise to this theme were questions 6 and 7)
- Teachers' experiences of the levels of cognitive demand of the Grade 4 mathematics ANAs (question that gave rise to this theme was questions 8)
- Teachers' recommendations on related issues (the questions that gave rise to this theme were questions 9 and 10).

Teachers' perceptions about the learners' experiences with the language of mathematics is an important supplement to the data on the learner interviews as it enriches the perspective on the language challenges that the learners' experiences revealed. The data also enabled a comparison between learners' experiences revealed in Chapters 6 and 7 and teachers' views of these challenges. On the whole, the data that follows points to strong coherence between teachers' views of learners' difficulties and the learners' difficulties which emerged in Chapters 6 and 7.

8.2 Teacher beliefs and perceptions on the Grade 4 learners' experiences of language of the mathematics ANAs

This data is presented for both teachers within the following category derived from the questionnaire in Appendix C.

- Teacher perceptions of learners' experiences of the language of mathematics ANAs

See Appendices D and E for a summary of teacher responses to the questionnaires according to the relevant themes. The questionnaire items that were used across the teachers are also in Appendix C.

In response to the question on the Grade 4 learners' experiences of the language of the mathematics ANAs there was consensus between the two teachers that mathematical language is difficult for their learners to understand. Anesipho and Busi explained this in the following words: (the quotes are taken verbatim and no attempt is made to correct grammatical or any other errors).

Anesipho: All the learners are Xhosa speakers. They have English as medium of instruction, and are still learning to speak the language. Maths has its own language, that some of them find it difficult to understand.

Busi: They performed badly in the past years. Maths language and its terminology all the time is their problem e.g. find sum of; they don't understand that sum is also total. During ANA they always ask for explanation from invigilator, they can't do on their own. Question papers are long and they became exhausted and leave other questions blank. Word sums are a nightmare as they don't know what operation they should use.

Anesipho and Busi's observations concur with Halliday's (1978) assertion that mathematical language is complex even for English HL speakers learning mathematics in English. The difficulty of using English as a language of learning and teaching even within English HL contexts is also acknowledged by Barbu (2010, p. 2) who says "learning English as it is used in an instructional context is likely to be considerably more demanding than acquiring basic conversational proficiency." The challenge is magnified in this study where learners were mostly not proficient in English yet they needed English to learn mathematics. Lemke (1990) argues that mathematics learners are required to possess competence in both everyday language and maths specific language if they are to perform well in mathematics. Busi and Anesipho's perceptions of mathematics as constituting a unique language difficult to understand confirms Bell's (2003) observation that mathematics achievement is generally not easy for learners learning through their L2 because of the highly specialized mathematical terms with meanings that are different from those used in everyday language. The specialized mathematical language Anesipho alludes to includes symbols like >, =, + ¼, ×, ÷ and highly specialized language like triangle, symmetrical, quadrilateral. Indeed the learner interview data points to learner difficulties with this specialised language and symbols. According to Bell (2003, p. 4), "mathematics vocabulary, special syntactic structures, inferring mathematical meaning, and discourse patterns typical of written text, all contribute to the difficulties many second language students have when learning mathematics in English". In this respect, Busi gave an example of learners knowing the word 'total' and not 'sum': e.g. 'find sum of; they don't understand that sum is also total'. This is evidence that she perceives that the language used in the ANAs is complex. Busi describes word problems as a 'nightmare' for learners because they do not understand the questions and therefore, cannot choose the correct operations to use in order to solve the problems. According to Busi, "learners always ask invigilators to help them with explanations of the questions which they do not understand and can't do on their own". It is not clear whether the two teachers give assistance to the learners when they ask for it although this is unlikely as it is not allowed and they do not invigilate their own classes. This rule poses a dilemma for the teachers on how to navigate between their knowledge of the local needs (support for language and reading difficulties) and at the same time comply with the national ANA policy.

In addition to the language challenges, Busi stated that the question papers are too long and learners become tired during the test, and as a result they leave some questions unanswered. Barbu (2010, p. 4) writes that research done by Ashcraft et al. (1992); Kalyuga et al. (2003) assert that the "Cognitive Load Theory holds that performance on complex cognitive tasks depends on whether the amount of information presented to the user equals or exceeds the availability of working memory; when working memory capacity is exceeded, the probability of errors will increase." This resonates with the experiences of the Grade 4 learners in the ANAs in this study who battled with both the density of the language and the length of the assessment.

Next I discuss the teacher stated perceptions of the learners' experiences of the Grade 4 ANAs in terms of reading skills. In the study, it was imperative to establish teachers' perceptions about the learners' experiences in reading since reading (as revealed in the interviews) is an important skill which determines learners' performance in assessments.

8.3 Teacher perceptions on the learners' experiences of the Grade 4 ANAs in terms of reading skills

Data on the responses to this question is presented for both teachers within the following theme:

- Teacher perceptions of learners' reading skills

Both teachers stated that the reading skills for most learners are weak. The following responses from Anesipho and Busi indicated their beliefs about the learners' reading in the ANA tests.

Anesipho: I think the learners' reading skills are not fully developed. Some learners read words without attaching any meaning to what they read, as some of them are not used to independent reading. Learners do not understand the instructions given to them as they read words, but without understanding. Lack of reading skills affect their performance. Some ANA questions are simple to understand but because of not so much exposure to different types of reading materials, some learners presume what question is asked by looking at the picture, without reading. In 2014 in the ANA question paper, there was a picture that looked like a school bus. Because another learner did not read the question, he assumed that the question was asking to name the object, and the learner wrote 'school bus' instead of side view. The question was simple and straightforward because it was only asking the view of the bus.

Busi: As they are slow in reading that makes them not to finish question paper.
Also they are stereotyped in terms of starting with the questions they know. If they don't know the word 'difference' that's a problem when its ANA test.

The above statements show that both teachers perceive learners' reading skills as weak in relation to both reading words and reading without comprehension.

Anesipho's view that learners' reading skills was confirmed by interviews in which some of her learners managed to read questions fluently but failed to understand what the questions asked of them. In this sense reading was not accompanied by comprehension. According to Pretorius and Lephalala, (2011), comprehension is what reading is all about. Anesipho viewed her learners as lacking independent reading skills as she writes, "…some learners read words without attaching any meaning … do not understand the instructions …." Anesipho's observation was consistent with what I observed during the learner interviews where in all three classes many learners could not read fluently without mediation and therefore, could not understand what they read. This consequently hampered their opportunity to solve the mathematical problems.

Anesipho also raised the issue of learners' lack of exposure to different types of reading materials. This possibly accounts for the general lack of a reading culture in South Africa as noted by Pretorius (2002) among others. According to the South African Department of Arts and Culture, and Print Industries Cluster Council (2007), many learners in South Africa are seldom exposed to storybook reading and do not have books in their homes, they do not have a reading habit. This relates to Machet's (2000) observation that many learners read books only when they prepare for examinations which accounts for their difficulty in reading and understanding examination questions.

The lack of reading skills, according to Anesipho's response, results in some learners not reading the question but simply looking at the picture and writing what they think is the answer. They thus hypothesize their own questions instead of reading the questions provided.

While Anesipho stated that her learners' problems concerned reading without comprehension, Busi's learners' hurdle was said to be in reading slowly. As a result Busi's learners did not finish answering all the questions. The interviews I did with Busi's 2013 Grade 4s also confirmed her statement as most of her learners were reading at the 'frustration level', taking almost a minute to read a sentence of five words when the curriculum expectations state that they were expected to read 158 words per minute (DoE, 2007b). Busi also observed the need for learners to be conversant with mathematics specific vocabulary like ‘difference’. It was interesting to note that in the learner interviews, many learners did not know what ‘difference’, the same word Busi used as an example, meant and as shown in Chapters 6 and 7 they struggled to answer the questions when it appeared. Knowledge of mathematics specific vocabulary was therefore, confirmed as vital for learners to understand the questions.

The next section discusses teacher responses to the ANA policy which prohibits the reading of questions to the learners from Grade 3 upwards.

8.4 Teachers’ views on the reading policy-Grade 4 learners should not be read to in the ANAs

The ANA policy says that during ANAs, Grade 1 and 2 learners may be read to if they cannot read the questions for themselves, but from Grade 3 onwards, no teacher should read for the learners (DBE, 2012). I present Anesipho and Busi’s responses to this:

Anesipho: It is fine but Grade 3s and 4s should also be included. I think they are not fully independent, they need some assistance.

Busi: Firstly, the question papers on their own is a nightmare; also they believe on something from their educators mouth. They hear the instruction better by being told than reading, they understand better by being told.

The above statements show that both teachers agreed that even the Grade 4 learners should be assisted during the ANAs. For Anesipho, there should be mediation in reading the mathematics ANAs for Grade 3s and 4s as well since some learners had not developed their reading skills sufficiently to be independent. This is consistent with Vygotsky’s (1978) observation that children's achievement, when assisted by an adult, improves. In the present study, if teachers assisted learners in the ANAs, teachers would have been aware of areas of difficulty for their learners.

For Busi, the ANA question papers are way beyond their capability. They do not understand them on their own. Busi believes that learners understand better when the questions are read to them (*they understand better when they are being told*).

This observation is noteworthy. It shows that the learners have developed some measure of competence in the English language at the oral level which allows them to comprehend statements read to them. By extension, it also shows that the learners have not sufficiently developed their competence in reading the written form of the language which explains their inability to comprehend what they read for themselves. This leads on to the fact that learners have not adequately developed their reading fluency which results in the short term memory being taxed as it can only hold a few items for a limited duration (Abadzi, 2008). By the time the slow reader is finished with the last words of a long question, the first words would have been lost and comprehension is compromised. When the teacher reads for them fluently, they are more likely to memorise all the words of the sentence/question and determine its meaning.

In response to whether learners would profit from the reading of the questions by the teachers, the responses were as follows:

Anesipho: Definitely yes. Most of the learners do not perform in the maths ANAs. After they have written the ANAs, I take normally the same questions from the ANAs and they perform much better because of the explanation, but not explaining each and every question.

Busi: Yes.

Anesipho noted that mediation through reading and explanation of the questions helped learners to demonstrate transformation and process skills. This was also confirmed by the interviews that I carried out with Busi and Anesipho's 2013 Grade 4 learners. The learners' performance in the ANAs that they wrote without assistance from their teachers was very poor. On the other hand, learners' performance in the interviews, where there was mediation from the interviewer improved greatly with most of the interviewed learners improving on more than half of the 15 questions that they answered. This confirms the teachers' comments. It was important to establish the teachers' experiences of the levels of cognitive demand of the Grade 4 mathematics ANAs which is addressed in the following section.

8.5 Teachers' experiences of the levels of cognitive demand of the Grade 4 mathematics ANAs

In response to this question the teachers expressed the following views:

Anesipho: It is relevant and appropriate for Grade 4. There is quite a wide range of levels of difficulty which is good so as for learners to be able to identify, compare, solve problems or to match.

Busi: Immediate understanding; as they are from Grade 1 where everything is their mother-tongue. Maths should be taught in English from lower grade; then we won't experience this disasters. Firstly additional language is not their mother-tongue; simple English should be used.

Anesipho argued that the cognitive level of demand of the problems given in the ANAs was appropriate for Grade 4 level. If the range of levels of difficulty was considered appropriate for the learners, the implication is that Anesipho sees the problem as one that lies with learners who cannot read and who do not understand the language of mathematics. It was important for her that the levels tested learners in different learning outcomes. Although earlier in the questionnaire she criticised the language of the ANAs for being difficult for the learners to understand, she agreed with the variety of different activities and learning outcomes that the ANAs test, which she claimed to be 'relevant and appropriate for Grade 4'.

For Busi, the main issue compromising learners' performance was the difficult language and similarly the language of instruction for learning. While not explicitly addressing the issue of cognitive demand, she advocated simple language in the ANAs, however, relinquishing herself from the role of teaching the terminology and language of mathematics. Busi raised a tension here in relation to the teaching of mathematics in mother-tongue. She said that mathematics ‘should be taught in English from lower grades’. This implies access to mathematics in the English language earlier in their schooling. However, learners would then have difficulties learning mathematics in English in the foundation grades.

Busi’s statement “… additional language is not their mother-tongue” shows that she noted difficulties with learners learning mathematics in an additional language. The following is Busi’s ‘confession’ to using isiXhosa in class when teaching mathematics although the language of instruction was ‘supposed’ to be English.

Busi: To be honest in class usage of code switching is too much during teaching as I should start them from naming numbers. Questioning for them is too advanced, e.g. Arrange from descending to ascending, instead of saying start with the bigger/smaller number.

Busi raises a tension here in relation to her use of code switching. This is because ‘Questioning for them [learners] is too advanced’. The implication is that Busi has to navigate between the knowledge of the local needs, i.e. learners who need explanations in the mother-tongue, and to comply with the language policy that from Grade 4 the LoLT should be English. This results in her having to rely on code switching in order to make her teaching accessible to learners. This tension concurs with the research by Setati (2005) in which she argues that learners benefit from code switching because they learn and understand better when they are taught in their HL.

Another implication is that although the mathematics vocabulary is difficult to learn, it has to be taught in order to be known and for learners to be able to read and understand questions. Through judicious use of the HL and English, the LoLT, learners can be exposed to the target language and learn the mathematics language.

It was also important to find out what teachers recommended to those who set the Grade 4 mathematics ANAs and to those who set the language policy in their schools as they are the ones who work with learners every day. Next I discuss the teachers’ recommendations in two categories.

8.6 Teacher' stated recommendations for the ANAs and the language policy

Data on the theme of teachers' recommendations is presented for both teachers within the following two categories:

- Teachers' recommendations to those who set the Grade 4 mathematics ANAs
- Teachers' recommendations for language policy in their schools and/or the country as a whole.

8.6.1 Teachers' stated recommendations to those who set the Grade 4 mathematics ANAs

In response to this question, the teachers wrote the following:

Anesipho: I think those who set the Grade 4 maths ANAs should bear in mind that some learners are not English speakers. The ANAs should be in English for home language speakers and English first additional language. The questions should be straightforward and not tricky.

Busi: To meet or collect information from teachers to see where they are in terms of syllabus, because we experienced that some of the questions were not yet taught

Anesipho's recommendation that those who set the Grade 4 mathematics ANAs should remember that they are setting it for those who are not English language speakers suggested that the language used in the ANAs is geared at learners who were proficient in English. It implies that it is beyond the learners' actual level and needs to be simplified. It is however, tricky if this simplifying of mathematics language promotes 'ghetto-ising' of mathematics language for ELLs. The teachers' concern is however, that in these early stages of learning where learners have had little exposure to English it is essential that the language of assessments are simplified in order to enable comprehension of questions. Developing mathematics language is a critical part of mathematics learning and teachers have to do their duty of teaching the language to learners no matter how difficult the language is.

Busi said in one of her responses, ‘they [learners] don’t understand that <u>sum</u> is also <u>total</u>’. These are some of the ‘tricky’ questions that Anesipho referred to in her response. Both teachers believe that complicated language should be avoided. Anesipho suggested that the Grade 4 mathematics ANAs for first additional language should be set in simpler English, as is the case with the English ANAs that have English for first additional language speakers.

Busi’s concern was also with the content of the mathematics ANAs. She pre-supposed that those who set the Grade 4 ANAs did not consider what the learners had studied by the time the ANAs were written. Busi was of the opinion that some teachers would not have covered some topics as expected by the syllabuses which stipulates what progress was to be made by the learners.

8.6.2 Teachers’ stated recommendations for language policy in the teachers’ schools and/or the country

In response to the question to comment on their recommendations for the language policy in their schools or country, the teachers respond as follows:

Anesipho: I would suggest that there should be one period weekly allocated for reading English books, so as for readers to develop their literacy skills.

Busi: [For the teachers] to be part and parcel when they are making those policies as they are going to collect recommendations from the schools as it is teachers who are delivering education to learners.

Anesipho’s recommendation was to do with developing the children’s reading skills so that the learners are able to cope with the English language and language of the ANAs. This idea is important to ensure that the learners’ reading skills are well developed before thinking of simplifying the language of the ANAs. As discussed earlier, fluent reading is key to reading comprehension and the way to be a good reader is through lots of reading (Cunningham & Stanovich, 2003). Learners should be inducted into a culture of reading.

On the other hand, Busi felt that teachers being part of the 'policy makers' could assist in the children's performance in the ANAs. Perhaps Busi referred to teachers needing to contribute ideas to the process. This could improve the ANAs based on teachers' experiences and increase teacher buy-in. Recently the 2015 ANAs scheduled for September have been postponed due to teacher union pressure that schools should not participate in the ANAs. Thus there is increasing resistance to the ANAs from teachers through their unions (Taylor, 2015).

Overall, both teachers agreed that learners experienced difficulties in the mathematics language of the ANAs and there is a need for the language to be pitched at the learners' level. Learners struggle to understand the mathematics ANAs on their own and they stated that with teachers' assistance learners would perform better than they did during the test. The teachers recommended that teachers get involved in the planning of the language policies in relation to the ANAs.

8.7 Chapter Summary

The focus of this chapter was to present data which responded to the fourth research question relating to the teachers' experiences of the linguistic demands of the Grade 4 mathematics ANAs. The chapter presented data on the following features; firstly, teacher perceptions of the Grade 4 learners' experiences and the language of the mathematics ANAs. The second aspect was the teacher perceptions of the learners' experiences of the Grade 4 ANAs in terms of reading skills. The third aspect concerned the teachers' views on the ANA policy of not reading to the learners and the fourth was on the teachers' experiences of the levels of cognitive demand of the Grade 4 mathematics ANAs. Lastly, the recommendations by the teachers were discussed.

While Chapters 6 and 7 indicated the extent to which learners struggled with solving mathematical problems, Chapter 8 shows that the teachers concur with the learner difficulties as revealed in the learner interviews. Analysis of teachers' perceptions indicated a range of tensions and dilemmas that teachers encounter and these included the dilemma of whether teachers should assist learners during the ANAs, satisfying the local needs of learners or whether they should comply with the rules of the ANA policy, and not help learners when they asked for assistance.

The chapter also illuminated that most learners who participated in the study had challenges with reading and comprehension of English texts because they did not have exposure to different reading materials. Therefore, their reading skills were weak. The teachers stated that learners would perform better if they were assisted with the reading of the ANA test items which they could not read on their own.

Based on the presentation of data made in Chapter 6, 7 and this chapter, and its accompanying discussion and analysis, the next and final chapter concludes the study and raises implications for various stakeholders (teachers and ANA policy makers) and suggests further avenues of research.

CHAPTER 9: CONCLUSION, RECOMMENDATIONS AND IMPLICATIONS DRAWN FROM THE STUDY

9.1 Introduction

The study set out to explore the nature of the linguistic challenges of the 2013 Grade 4 mathematics ANAs in South Africa, the learners' difficulties in answering the questions, and the Grade 4 mathematics teachers' experiences of the mathematics ANAs. Concerns about the existing extreme underperformance of learners in both literacy and numeracy, especially at Grade 4, alongside the relative newness of the ANAs, gave impetus to this study. The study addressed the following research questions:

The study addressed the following research questions:

1. a. What is the nature of the linguistic challenge of the Department of Basic Education Grade 4 2013 Mathematics ANAs?
   b. What difficulties do learners experience as they solve mathematical problems?

   c. Which of the learner mathematical difficulties can be attributed to linguistic factors?

2. What are the teachers' experiences of the linguistic challenges of the ANAs?

This chapter discusses the limitations in the research, the overall implications of the findings of the current research and recommendations for future research.

9.2 Limitations of this study

In this study I have recognized the limitations in terms of the number of schools, learners and teachers I used to investigate the difficulties that learners experience in solving the mathematics ANAs. In particular, the majority of my learners were first language isiXhosa learners learning mathematics in Grade 4 in English. In many Grade 4 classrooms in South Africa, numerous languages are spoken by learners, and this would add to the complexity of finding ways to provide linguistic mediation for learners while writing the ANAs. In such classrooms the option of providing questions in two languages would be difficult as different learners would require different dual language scripts. The implications of this research study has thus pointed to a wide range of further research that could inform ANA policy including research into possible ways of administering the ANAs across multiple and varying South African contexts in order to enable linguistic mediation especially in the early IP grades. In this respect conducting similar research with similar procedures of interviewing learners and generating data from teachers on a large scale would be necessary.

9.3 Findings

Chapters 5 to 8 were devoted to the presentation and analysis of findings. These chapters focused on findings in relation to each of the research questions, thus: Chapter 5 focused on the findings of the analysis of the 2013 Mathematics ANA question paper and exemplar paper (phase 1); Chapter 6 focused on the findings of the analysis of 106 learner written responses on the 2013 mathematics ANA across the three case study classes (phase 2); Chapter 7 focused on analysis of the findings of the 26 sampled learner interviews (phase 3); and Chapter 8 focused on the analysis of the findings from the two participating teachers' experiences of the linguistic challenges of the ANAs (phase 4).

In this concluding chapter, the overarching or central findings responsive to each of the above research questions, are synthesised and summarised. These are followed by a discussion of the possible implications and avenues for further research highlighted by this study.

9.3.1 Research question 1a. What is the nature of the linguistic challenge of the Department of Basic Education (DBE) Grade 4 Mathematics ANAs?

a) The study began with a content and format analysis of the 2013 mathematics ANA items as compared with the 2013 exemplars provided by the Department of Education to teachers in order to establish the extent to which the testing format and language used in the ANAs corresponded with that of the exemplars the learners were exposed to during the preparation for the ANAs. Both teachers in the study confirmed that they used these exemplars to prepare their learners for the test. The analysis revealed that most questions in the

ANAs corresponded with those in the exemplars but revealed some inconsistencies in the questioning format and the language used in the 2013 ANAs and ANA exemplars. The similarities and differences indicated the extent to which learners were exposed to some of the mathematical language used in the 2013 ANAs (e.g. 'the difference between' while other words from the 'mathematical register' in the 2013 ANAs were not present in the exemplars and thus may not have been familiar to learners (e.g. 'reflection' or 'vertical')). This analysis provided some context for learner's prior exposure to the language of some of the ANA questions before they wrote the assessments. However, this prior exposure to the language or the question format in the exemplars did not necessarily lead to high levels of success in these questions in the 2013 ANAs (for example, question 12 of conversion).

Shaftel et al.'s (2006)'s linguistic complexity checklist and Vale's (2013) LCI formula were used to explore the complexity of each of the 38 2013 mathematics ANA questions (19 items). The findings revealed several questions with a high LCI and thus several that posed linguistic challenges. These challenges were particularly in relation to repeated use of: 7 or more letter words, specific mathematics vocabulary, prepositional phrases and homophones in the majority of questions which are the linguistic features that have been identified by research that add complexity to the English language and compromises comprehension especially to ELLs like the learners who were involved in this study. Removing the 7 questions with LCI of 0 the average LCI of the questions was 17.69. Twenty-eight out of thirty-eight questions had an LCI of over 10 indicating they were difficult for this level even for first language English speakers who have an intuitive knowledge of the language. Thus, according to Shaftel, "In order to be useful, the test needs to show teachers what their learners do not know and where to start remediation" (p.32) and the poor performance by the learners in the assessment meant that the assessment failed to inform the teachers that to do.

9.3.2 Research questions 1b. What difficulties do learners experience as they solve mathematical problems? **1c.** Which of these difficulties can be attributed to linguistic factors?

Research question 1b was answered in two phases. Firstly by the analysis of 106 learner written scripts for the 2013 mathematics ANA (i.e. their written answers to the ANA questions) across three classes of learners in the two participating schools. As a result I noted which questions posed particular difficulty and identified a suitable sample of items for follow up interview with learners. Secondly interviews with 26 learners across the three classes provided for a deeper understanding of the nature of the problems as identified through the analysis of learner scripts. In addition I could see where linguistic factors were at play (thus enabling answering 1c). Below I summarise the findings of the two phases in relation to these questions.

The analysis of learner written responses for the 2013 mathematics ANAs revealed that learners performed very poorly, with only 25% of Santa Anna primary learners attaining the 50% basic requirement and only one learner from Biko primary getting close to that basic requirement (44%). An analysis was done in order to establish the difficulties learners experienced as they solved (in written form under ANA test conditions) mathematical problems. The analysis of the learners' test responses enabled the identification of three categories of questions based on learner performance, namely:

* Questions not answered by more than 50% of learners possibly because learners were unfamiliar with some mathematical vocabulary and prepositional phrases and pronouns that were used and therefore jointly adding to the linguistic complexity of the questions. There were three such questions in the 2013 mathematics ANAs.

*Questions that were wrongly answered by more than 50% of the learners possibly because the questions were not understood or they were misinterpreted. Learners may not have understood the mathematics vocabulary used (e.g. convert, difference, number sentence), as well as the use of long sentences with unfamiliar words. There were 14 such questions in the 2013 mathematics ANAs. In some of these questions however, learners were challenged by mathematical computations rather than the language as was the case with questions on the four operations that involved little language.

*Questions that were answered correctly by less than 10% per class. In this category, learners struggled with both mathematical computations and comprehension of the questions. There were 16 of these questions in the 2013 ANAs. In addition, use of mathematical vocabulary, multiple meanings words and prepositional phrases in the questions were key obstacles.

Learners struggled to understand many of the questions because of the language that was used which was either unfamiliar or unnecessarily complex for Grade 4 learners using English as an additional language. The analysis indicated that the majority of the questions that learners failed to answer were difficult in terms of their length and complex grammatical patterns.

In addition to the findings from the analysis of the learner written scripts, learners' experiences and difficulties portrayed through task-based interviews were analysed. It emerged from the analysis of the 26 learner interviews that learners were particularly weak in the following skills: reading, comprehension, transformation, process, and encoding. Reading in class A (in which English was the medium of instruction from Grade 1) was stronger than in class B and C (in which English only became the medium of instruction in Grade 4) but comprehension of questions was poor in all three classes. The fact that most learners in class A learners could read well but failed to comprehend the questions perhaps suggests a 'rote' type reading skill, rather than reading for meaning. Thus analysis of the 26 interviews indicated that learners' efforts to solve the mathematical problems were compromised mainly by their lack of comprehension of the questions.

In addition, analysis of task-based interviews indicated that learners had difficulties in demonstrating different skills because many learners failed to read and/or understand many mathematics words (e.g. difference, number sentence, reflection) or unfamiliar words (e.g. destination, departures) in the questions. This can be attributed to the fact that these words are not part of BICS and because learners lacked English proficiency in both CALP and BICS.

A question worth asking in this respect is whether assessments at this level could test for transformation, processing and encoding skills without first needing learners to successfully read and comprehend difficult words. For example, would assessments be more valid and accessible in terms of assessing learners' mathematical competence if questions were read and translated to learners into their mother tongue? A counter argument to this is that part of mathematical problem solving involves the skill of reading and comprehension of mathematics specific vocabulary (which is not always available in the mother tongue). However, considering that many Grade 4 ELLs are still developing basic CALP in English and thus are unlikely to have developed BICS in the English language, the LoLT, it would seem important to conduct research into the possibility of increasing accessibility to the mathematical demands of assessment items at least in the early years of exposure to mathematics in English (or Afrikaans). Similarly this could assist in the transition period from the FP to the IP where learners are just beginning to shift from learning to read, which many students demonstrated competence in, and reading to learn, which this research indicated learners struggled with and this affected their access to the mathematical demands of the ANA questions. Learners' reading in this study largely pointed to a decoding rather than a comprehending activity.

Although learners could not manage the language well, it was evident that they also lacked mathematical content knowledge and this hampered their solving of the mathematical problems. The vast majority of learners' poor performance and inability to successfully solve most of the mathematical problems in the 2013 ANA was seen to be both due to lack of proficiency in English language (exacerbated by the high linguistic complexity of the majority of items) and lack of mathematical content knowledge. The linguistic dimension however, seemingly represented the greater challenge since learner interviews with linguistic mediation (including translation), in many cases, led to improved performance in terms of solving the question successfully. Thus the study found that the linguistic challenge of several of the questions prevented learners from unlocking the textual meaning and consequently from applying mathematical computations that they demonstrated in the interviews they were capable of. Thus this study advances a form of mediation - "linguistic mediation" - as has been shown in the analysis and findings. It suggests that some level of linguistic mediation in the ANAs could increase the validity of ANA results. Future research would need to investigate these possibilities and to interrogate where such mediation begins and how far it should go.

The fact that the NEA approach has not been used before in South African primary school but has successfully utilized in Papua New Guinea, Thailand and Phillipines indicates that the study new knowledge to these contexts with the specificity of the South African context.

9.3.3 Research question 2. What are the teachers' experiences of the linguistic challenges of the ANAs?

The teachers' (Anesipho and Busi) perceptions of the learners' experiences of the Grade 4 mathematics ANAs was discussed in relation to the learners' experiences and the language of the mathematics ANAs, the learners' experiences of the Grade 4 ANAs in terms of reading skills, and the teachers' views on the ANAs reading policy. In addition, the questionnaire requested that teachers provide recommendations for the Grade 4 mathematics ANAs. Analysis of the two case study teacher questionnaires indicated that they both perceived the mathematics language to be a challenge for Grade 4 learners who had not had enough exposure to the English language. According to the teachers, it was not easy for the learners to learn in an additional language, let alone the mathematics ANA language which is complex and 'difficult to understand'.

Both teachers stated that reading skills for most learners were weak in relation to reading words, reading fast and fluently, and in reading with comprehension. Most learners were reading at 'frustration level'. The teachers recommended that reading skills needed to be developed through letting learners read a lot of material independently.

In terms of the teachers' views on the reading policy that Grade 4 learners do not have the ANA questions read to them or the language mediated in any way as is the case with Grade 1 and 2 learners, both teachers stated that they would prefer it if they were allowed to read the questions for the Grade 4 learners who struggle with reading. They stated that some of the learners would perform better in the ANAs if they were assisted with reading the questions. Anesipho attested that her learners performed better in the same ANAs when they wrote them with her assistance (reading and explaining the questions to them). Therefore, the teachers emphasized the need for mediation in the ANAs (including for Grade 3s).

The teachers recommended that those who set the Grade 4 mathematics ANAs should consider that the learners are not yet proficient in the English language and should simplify the language of the mathematics ANAs so that they 'come to the learners' level', but as Anesipho stated, this should be without compromising the standard of the assessments. Both teachers perceived that the Grade 4 mathematics ANAs used 'tricky language' which sometimes confuses learners and the teachers in the study recommended that the language should be straightforward.

Teachers also recommended that those who set the ANAs should set the questions considering the curriculum covered by teachers and learners at that point in time as the ANAs are written prior to the full academic year being completed. The issue of the timing of when in the academic year the ANAs are written should be considered. The teacher feedback indicates that possibly the ANAs could be written at the end of school year. This could be feasible since some teachers (for example, Busi) complain that the ANAs are written in October when "some of the questions were not taught". Additionally however, if the ANAs are to serve a dioagnostic purpose, for planning teaching, then considerations of writing these at the beginning of the academic year would be important.

In terms of recommendations to the schools and/or the country, teachers felt that the learners' reading skills should be developed by increasing independent reading periods. This would give learners intime to read on their own and interact with different types of reading material.

9.3.3.1 Tensions and dilemmas raised by teachers in the study

Tensions and dilemmas were raised by the Grade 4 teachers on how they should navigate between their knowledge of the local needs of their learners (Xhosa speaking learners, mostly with weak reading skills, writing the Grade 4 ANAs in English) and the needs of the system, i.e. to comply with the national policy of the ANAs (which does not allow reading or language mediation). Busi raised the point that the learners always ask the invigilators to help them by explaining the questions. That the ANA invigilation policy forbids teachers from reading or explaining to the Grade 4 learners creates an uncomfortable tension with the teacher's role as being caring and responsive to learner needs. Graven and Venkat's (2014) research similarly pointed to this tension for several teachers in terms of their experiences of the mathematics ANAs.

Busi raised another issue in relation to her managing the difficulties of teaching mathematics in English through the use of code switching during teaching. She felt learners understand better if their HL is used together with English to teach mathematics. Although the language policy at her school stipulated that from Grade 4, the LoLT is English, teachers find themselves in a quandary whether to continue teaching the learners in English which they do not understand or use the learners' HL. Therefore, teachers like Busi meet the local needs of learners' access to mathematical understanding through code switching, rather than using English throughout her teaching. This concurs with wider research in the South African context on the use of code switching in mathematics teaching (Setati, 2000; Setati et al., in press). A wide range of literature reviewed in this study indicates that judicious use of learners' L1 is necessary especially if it benefits learners to understand mathematics.

Another tension that was raised was that the mathematics language for Grade 4 is too difficult for learners and therefore, those who set the ANAs should try and make the language accessible. This however, has the implication that if mathematics is a language on its own, learners have to learn this language even if it is difficult because without the knowledge of the language, it becomes even more difficult for children to learn mathematics. As indicated in the early chapters of this research, four transitions can be identified for the majority of South African learners moving from Grade 3 to

Grade 4. These are: transition from using a HL to using English as a LoLT; transition from reading mostly narrative, story-like texts whose language closely approximates ordinary language of everyday social interaction in the FP, to reading expository texts with more content-dense vocabulary in Grade 4; the shift from 'learning to read' to 'reading to learn' (DBE, 2008) and the movement from more concrete thinking in the FP to more abstract thinking in the IP.

In this respect this study has argued that particular sensitivity to linguistic complexity is important in Grade 4. Although the Grade 4 language of mathematics ANAs may be simplified for assessment purposes, especially during the transition of learners from the FP to the IP, it is nevertheless important that teachers ensure that learners increasingly develop their mathematical vocabulary and ability to read and interpret mathematics assessment items in the language the LoLT. In this respect, it would seem useful for further research to investigate the extent to which enabling progressively reduced linguistic scaffolding of the ANAs from Grade 4 to Grade 6 would be a possible way forward.

9.4 Theoretical implications

That mathematics language is more difficult for ELLs is consistent with Halliday's (1978) contention that mathematics language is difficult even for English language speakers. Learners in this study were seen to struggle with comprehension of words, sentences and whole questions. Drawing on a Vygotskian perspective, the study has shown the way in which learners were able to demonstrate levels of mathematical competence when linguistic mediation that allowed the ZPD to emerge was provided during task-based interviews. Vygotsky's construct of the ZPD emphasizes the importance of considering what learners can do with access to a more knowledgeable other rather than only assessing what they can do on their own. While Vygotsky's work was not looking at learners in assessment contexts, the findings in this research show the possibility for considering providing some form of mediation (even if it is only linguistic) in order to more appropriately assess learners' mathematical competence. The task-based interview in this study indicated that several learners were able to demonstrate far more mathematical competence when provided basic linguistic mediation than they were able to demonstrate in the written ANAs under strict invigilation conditions and with no linguistic mediation allowed.

In this study the task-based interviews with learnerswere more of the dynamic assessment, following Vygotsky, than static assessment since they integrated instructions, prompts and linguistic assistance to learners who struggled in order for them to ‘move toward an emergent future’ and not only concentrating on what they could not do.

9.5 Policy implications

In respect of this contention, it has also been argued that test developers should analyse their tests according to the LCI and adjust the items accordingly. They could also consider a revision of invigilation policies that would allow for reading and translation or definition of unfamiliar words so that learners would have improved and increased access to the mathematical demands of questions, especially in the early years of the IP.

Regarding the ANA policy that only Grade 1s and 2s can be read to, evidence from several studies and this thesis seems to point to the fact that young ELLs in lower grades like Grades 3 and 4 have still not mastered the required reading skills and struggle to read and understand mathematical questions on their own. Would it not be fairer to all to accord them the same treatment as that the policy provides for Grade 1 and 2 learners? Assistance in reading the questions would allow them to demonstrate their mathematical skills to best advantage. This study has used empirical findings to show that the current ANA reading policy of reading to learners should also apply to Grade 3s and 4s. The Grade 4 teachers in this study attested that with their assistance, learners performed better than they did on their own.

In a large-scale study on multilingual assessments, Makgamatha, Heugh, Prinsloo and Winnaar (2013) found that learners perform better where their HL is used as a language of assessment. This implies that in large-scale assessments like the ANAs, it is worth researching a multilingual assessment (perhaps where questions are phrased in both English as the LoLT and the mother tongue) so that learners have access to both and are not unfairly disadvantaged by a lack of language proficiency. Such research and efforts at increasing learner access to assessment items is important for addressing educational equity in terms of equity in language use in assessments (Makgamatha et al., 2013).

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Appendices

Appendix A: 2013 Mathematics ANAs

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

MARKS	

ANNUAL NATIONAL ASSESSMENT 2013
GRADE 4 MATHEMATICS TEST

MARKS: 50

TIME: 1½ hours

PROVINCE______________________________

REGION______________________________

DISTRICT______________________________

SCHOOL NAME______________________________

EMIS NUMBER (9 digits)

CLASS (e.g. 4A) ______________________________

SURNAME ______________________________

NAME______________________________

GENDER (✓)

BOY		GIRL	

DATE OF BIRTH

C	C	Y	Y	M	M	D	D

This test consists of 11 pages, excluding the cover page.

Instructions to the learner

1. Read all the instructions carefully.
2. Question 1 consists of 6 multiple-choice questions. Circle the letter of the correct answer.
3. Answer questions 2 to 19 in the spaces or frames provided.
4. All working must be done on the question paper and not on rough paper.
5. The test counts 50 marks.
6. The test duration is 1½ hours.
7. The teacher will lead you through the practice exercise before you start the test.
8. You may not use a calculator.

Practice exercise

Circle the letter of the correct answer.

8 x 6 =

A 48
B 84
C 72
D 60

You have answered correctly if you have circled (A) above.

NOTE:
- You will answer more questions like the one you have just completed.
- Do your best to answer each question even if you are not sure of the answer.
- Write down the answer that you think is the best and move to the next question.
- When you have answered all the questions on a page, please move to the next page.
- Look only at your own work.

The test starts on the next page.

1. Circle the letter of the correct answer.

1.1 What is the value of the underlined digit in 3 <u>8</u>70?

A 80

B 8 000

C 800

D 8 (1)

1.2 The number 6 555 rounded off to the nearest 100 is:

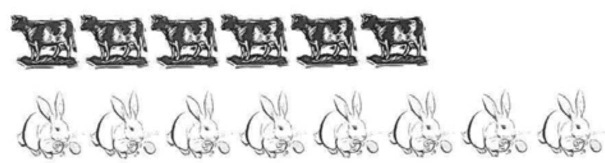
A 6 550

B 6 650

C 6 500

D 6 600 (1)

1.3 The ratio of the number of cows to the number of rabbits is:



A 6 : 2

B 6 : 8

C 8 : 6

D 2 : 6 (1)

1.4 Which number is a multiple of 6?

A 3

B 2

C 36

D 1 (1)

1.5 Complete the following number pattern:

3 275 ; 3 225 ; 3 175 ; ______.

A 3 150

B 3 225

C 3 125

D 3 325 (1)

1.6 Which number is a factor of 12?

A 24

B 4

C 8

D 10 (1)

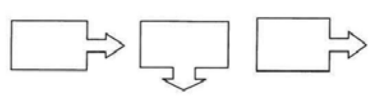
2. Complete:

(2 × 3) + (2 × 4) = 2 × (___ + 4) (1)

3. Complete each of the following patterns:

3.1 4 900 ; 4 925 ; 4 950 ; ________ ; 5 000 ; ________. (1)

3.2



__________________. (1)

4. Complete each of the following number patterns:

4.1 $\frac{2}{5}$; $\frac{3}{5}$; $\frac{4}{5}$; ______ . (1)

4.2 2 ; 4 ; 8 ; 16 ; ______ . (1)

5. Mrs Mazibe buys an apple for R1,20 and sells it for R1,95.

5.1 How much money does Mrs Mazibe make by selling 1 apple?

____ (1)

5.2 How much does Mrs Mazibe make if she buys and sells 10 apples?

____ (1)

6. Calculate the answers for questions 6.1–6.4.

6.1 3 456 + 2 909

(2)

6.2 5 433 – 2 104

(3)

6.3 78 x 42

(3)

6.4 654 ÷ 6

(3)

7. Write a number sentence for the sentence below.

The difference between 1 613 and 859 is seven hundred and fifty-four.

____ (1)

8. Draw the hands on the given clock face to show that the time is a quarter past eight.

(1)

9. Look at the departures board at the airport and answer the questions that follow.

DEPARTURES		
DESTINATION	**TIME**	**FLIGHT NUMBER**
Mossel Bay	07:45	SAA 769
Knysna	10:20	BA 172
Johannesburg	20:00	SAA 372

9.1 Write down the flight number of a flight which will depart for its destination before midday. (1)

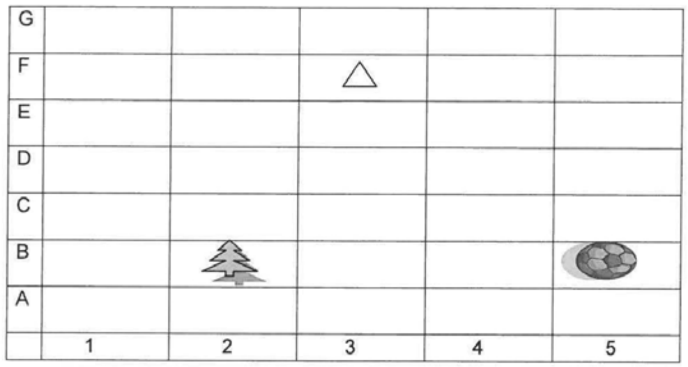
____

(1)

9.2 Write down the flight number of a flight which will depart for its destination after midday.

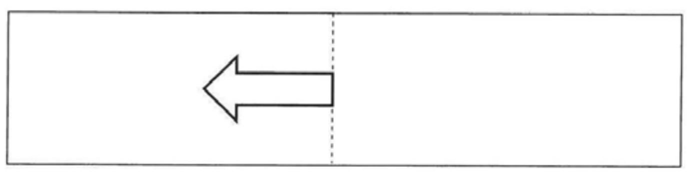
____

10. Look at the grid below and write down the position of the picture  .



The position of the picture  is ________. (1)

11. Draw the reflection of the arrow on the vertical dotted line.



(1)

12. Convert the following:

12.1 12 m 48 cm = ________________ cm (1)

12.2 80 minutes = _____ hour _______ minutes (1)

13. Complete the following flow diagram:

Input		Rule		Output
7	⟶	× 5 + 9	⟶	______

(1)

14. Poppy buys a 2 ℓ bottle of milk. She uses 500 mℓ of the milk to bake a cake.

How much milk is left in the bottle?

______________________________ mℓ (2)

15. Use the fraction wall to answer the questions that follow.

1 whole			
$\frac{1}{2}$		$\frac{1}{2}$	
$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$

15.1 Write the symbol < , > or = between the fractions to make a correct statement.

$\frac{1}{2}$ __________ $\frac{2}{4}$ (1)

15.2 Colour in $\frac{3}{4}$ of a fraction strip in the fraction wall. (1)

15.3 Use the fraction wall to calculate $\frac{1}{4} + \frac{2}{4}$.

____________ (1)

15.4 Mom shared a cake equally amongst Mary and her 3 friends.

What fraction of the cake did each get?

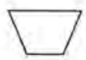
____________ (1)

16.

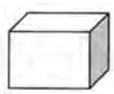
HEXAGON	**PENTAGON**	**QUADRILATERAL**	**TRIANGLE**

From the above frame choose the word to name each of the 2-D shapes.

16.1  ______________________ (1)

16.2  ______________________ (1)

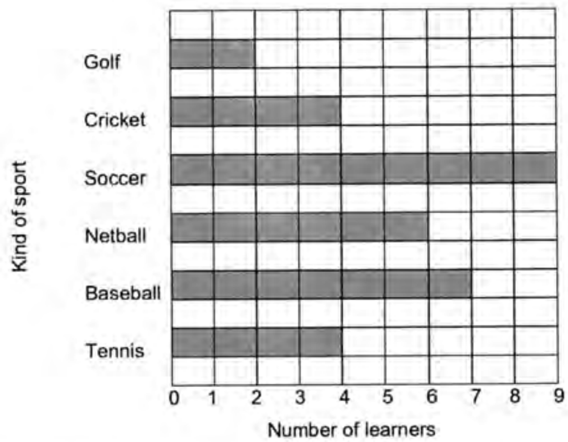
17. Complete the table:

OBJECT	**NAME OF OBJECT**	**SHAPE(S) OF THE FACES**
	______________	Rectangles
	Triangular prism	Triangles and ____________

(2)

18. This bar graph shows the most popular kind of sport amongst the learners in Grade 4.

LEARNERS' FAVOURITE SPORT



18.1 Complete the tally table.

KIND OF SPORT	TALLY MARKS
Golf	
Baseball	
Tennis	

(3)

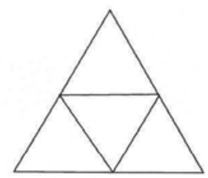
18.2 Which is the learners' favourite kind of sport? (1)

____

18.3 What is the difference between the number of learners who prefer soccer to cricket? (1)

____

19. How many triangles are there in the diagram altogether?



____

(2)

TOTAL: 50

Appendix B: 2013 ANA Exemplar

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

ANNUAL NATIONAL ASSESSMENT 2013

GRADE 4

MATHEMATICS EXEMPLAR QUESTIONS

This booklet consists of 12 pages, excluding the cover page.

GUIDELINES FOR THE USE OF ANA EXEMPLARS QUESTIONS

1. How to use the exemplar questions

While the exemplar questions for a grade and a subject have been compiled into one comprehensive set, **the learner does not have to respond to the whole set in one sitting. The teacher should select exemplar questions that are relevant to the planned lesson at any given time.** Carefully selected individual exemplar questions, or a manageable group of questions, can be used at different stages of the teaching and learning process as follows:

1.1 At the beginning of a lesson as a diagnostic test to identify learner strengths and weaknesses. The **diagnosis** must lead to prompt **feedback** to learners and the development of **appropriate lessons** that address the identified weaknesses and consolidate the strengths. The diagnostic test could be given as homework to save instructional time in class.

1.2 During the lesson as short formative tests to assess whether learners are developing the intended knowledge and skills as the lesson progresses and ensure that no learner is left behind.

1.3 At the completion of a lesson or series of lessons as a summative test to assess if the learners have gained adequate understanding and can apply the knowledge and skills acquired in the completed lesson(s). Feedback to learners must be given promptly while the teacher decides on whether there are areas of the lesson(s) that need to be revisited to consolidate particular knowledge and skills.

1.4 At all stages to expose learners to different techniques of assessing or questioning, e.g. how to answer multiple-choice (MC) questions, open-ended (OE) or free-response (FR) questions, short-answer questions, etc.

While diagnostic and formative tests may be shorter in terms of the number of questions included, the summative test will include relatively more questions, depending on the work that has been covered at a particular point in time. It is important to ensure that learners eventually get sufficient practice in responding to the exemplar questions.

2. Memoranda or marking guidelines

A typical example of the expected responses (marking guidelines) has been given for each exemplar question and for the ANA model test. Teachers must bear in mind that the marking guidelines can in no way be exhaustive. They can only provide broad principles of expected responses and teachers must interrogate and reward acceptable options and variations of the acceptable response(s) given by learners.

3. Curriculum coverage

It is extremely critical that the curriculum must be covered in full in every class. The exemplar questions for each grade and subject do not represent the entire curriculum. They merely **sample** important knowledge and skills and covers work relating to terms 1, 2 and 3 of the school year.

1. Circle the letter of the correct answer.

1.1 The value of the underlined digit in 5 565 is:

A 500
B 50
C 5
D 5 000 (1)

1.2 What is the value of the underlined digit in 7 999?

A 90
B 9
C 900
D 9 000 (1)

1.3 Which number is missing in the following number pattern?
1 215 ; 1 230 ; _____ ; 1 260.

A 1 240
B 1 235
C 1 245
D 1 255 (1)

1.4 The next number in the number sequence 1 766; 1 866; 1 966; ... is:

A 2 166
B 2 066
C 1 266
D 1 366 (1)

1.5 6 423 rounded off to the nearest 100 is:

A 6 400
B 6 425
C 6 430
D 6 420 (1)

1.6 The number 1 542 rounded off to the nearest 1 000 is ...

A 1 500
B 1 000
C 2 500
D 2 000 (1)

1.7 Which number in place of # will make this number sentence true?

15 ÷ 5 = # ÷ 15

A 5
B 15
C 30
D 45 (1)

1.8 3 is a factor of ...

A 12
B 10
C 16
D 13 (1)

1.9 Which number is not a multiple of 9?

A 27
B 56
C 72
D 36 (1)

1.10 Which number is not a factor of 6?

A 3
B 6
C 12
D 2 (1)

1.11 Jacob is 4 years old and Julie is 12 years old. The ratio of Jacob's age to Julie's age is ...

A 3 : 1
B 1 : 3
C 12 : 16
D 16 : 4 (1)

1.12 Matthew is 16 years old and Sue is 14 years old. The ratio of Matthew's age to Sue's age is ...

A 7 : 8
B 8 : 7
C 16 : 30
D 8 : 14 (1)

2. Complete:

2.1 4 330 rounded off to the nearest 100 is ____________________. (1)

2.2 7 625 rounded off to the nearest 1 000 ≈ ____________________. (1)

3. Answer the following questions.

3.1 The value of the underlined digit in 7 <u>6</u>31 is ... (1)

3.2 Write the value of the underlined digit in <u>7</u> 894. (1)

4. Complete by writing the following number in expanded notation:

1 515 = (1 x 1 000) + (____ x 100) + (1 x ____) + (5 x 1) (2)

5. Which number is written in expanded notation as (4 x 1 000) + (5 x 100) + (8 x10) + (2 x 1)? (1)

6. Which number is written as: (6 x 100) + (8 x 1 000) + (1 x 1) + (2 x 10) in expanded notation? (1)

7. Calculate:

7.1 2 036 + 1 055 (2)

7.2 3 846 + 3 217 (2)

7.3 2 752 + 4 356 (2)

7.4 2 158 – 526 (2)

7.5 4 000 – 1 481 (2)

7.6 5 726 – 1 334 (2)

7.7 83 × 15 (3)

7.8 48 x 12 (3)

7.9 698 ÷ 7 (3)

7.10 936 ÷ 3 (3)

8. Complete the number sentence: 2 x 6 = 4 x __________ (1)

9. Answer each of the following questions.

9.1 Tasneem bought sweets for 35 of her friends. If each sweet costs R1,30, how much did Tasneem spend altogether? (2)

9.2 Tasneem paid with a R50,00 banknote. How much change should she have received? (1)

10. Jabu wants to buy a T-shirt for R86,99 and a poster for R25,89.

10.1 How much will this cost altogether? (2)

10.2 Jabu only has R100,00 in his wallet. How much more money does he Need to buy a T-shirt and a poster? (1)

11. Simplify: (1)

$\frac{1}{10} + \frac{3}{10} =$ ________

12. What is $\frac{3}{4} + \frac{1}{4} - \frac{2}{4}$ equal to? (2)

13. Ismail had a bar of chocolate consisting of 6 blocks. He ate 2 blocks. What fraction of the chocolate bar was left? (1)

14. Mum baked a cake and cut it into 6 equal pieces. Dad had 2 pieces. You had 1 piece. What fraction of the cake is left? (2)

15. Lauren first eats $\frac{1}{8}$ of a chocolate cake before supper, and then eats another $\frac{1}{8}$ after supper.

15.1 What fraction of the chocolate cake did she eat altogether? (2)

15.2 What fraction of the chocolate cake was left? (2)

16. Use the fraction wall to answer the question.

1 whole					
$\frac{1}{2}$			$\frac{1}{2}$		
$\frac{1}{3}$		$\frac{1}{3}$		$\frac{1}{3}$	

$\frac{3}{3}$ = ______________ (1)

17. Write down a number sentence for each of the following word sums.

17.1 Nabeelah and Nomsa each have fifteen dolls. How many dolls do they have altogether? (1)

17.2 Yusuf has R84,00 to buy chocolates for his friends. One chocolate costs R6,00. How many chocolates can he buy? (1)

18. Complete the following patterns.

18.1 9 000 ; 8 975 ; ________ ; ________ ; 8 900. (1)

18.2 0 Δ Ø 0 ______ ______. (1)

19. Complete the following number chain. (1)

8 255 $\xrightarrow{-2}$ ______ $\xrightarrow{-7}$ ______ $\xrightarrow{-9}$ ______. (1)

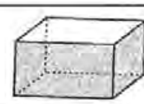
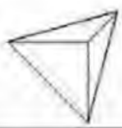
20. Complete the tables below:

20.1

NAME OF 2-D SHAPE	NUMBER OF STRAIGHT SIDES
____________	5
____________	6

(2)

20.2

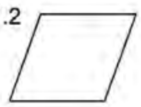
3-D OBJECT	NAME OF OBJECT	SHAPE OF THE FACES
	Rectangular Prism	____________
	____________	____________

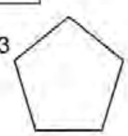
(3)

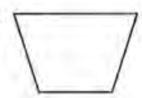
21. Use the names given in the table to name the 2-D shapes.

Trapezium	Pentagon
Parallelogram	Hexagon

21.1 

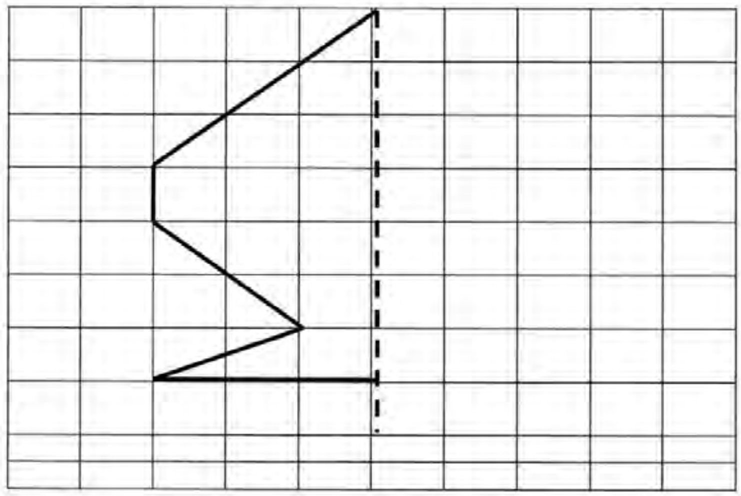
21.2 

21.3 

21.4 

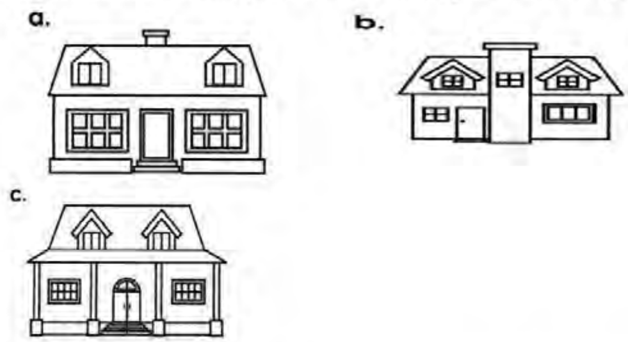
__________ __________ __________ __________ (4)

22. Draw the right-hand side of the sketch to make a symmetrical 2-D shape.



(1)

23. Only colour in the house(s) that has/have a symmetrical shape



(2)

24. Draw in the line(s) of symmetry for those pictures which you think are symmetrical.

(3)

25. Write down the time shown, in the afternoon, on the following clock face.

____________________ (1)

26. Complete:

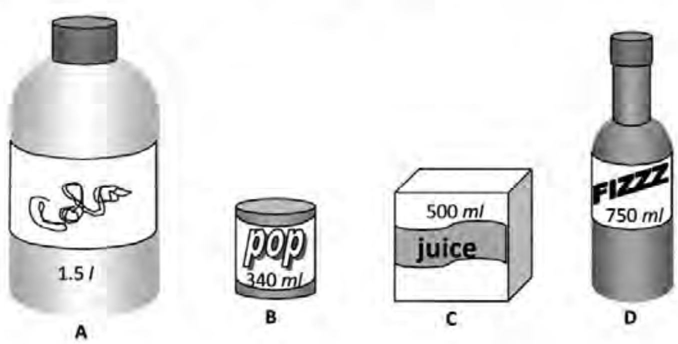
26.1 1 year = _________ weeks (1)

26.2 1 year = _________ months (1)

26.3 1 cm = _________ mm (1)

26.4 1 km = _________ m (1)

27. Use the letters A, B, C and D to order the capacities shown in the containers from the most to the least.



____ (2)

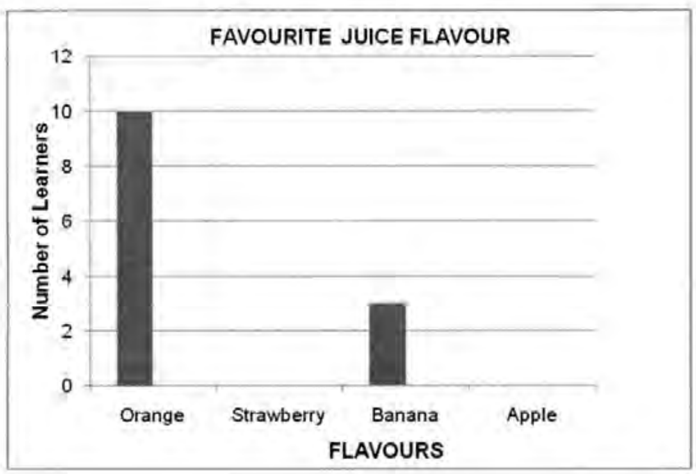
28. A survey was conducted amongst Grade 4 learners to determine their favourite flavour of juice. Each pupil could vote only once for their favourite flavour.

FLAVOUR OF JUICE	TALLY MARKS	FREQUENCY
Orange		10
Strawberry		8
Banana	III	3
Apple	~~IIII~~	5

28.1 Fill in the missing tally marks in the above table. (2)

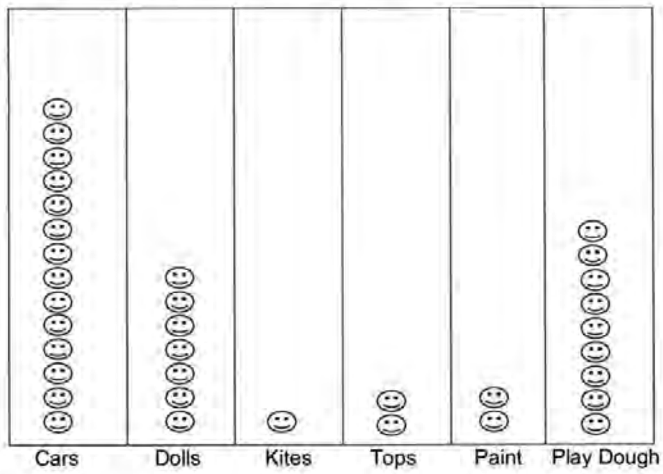
28.2 Which flavour was liked the least? (1)

28.3 Complete the bar graph.



(2)

29. The pictograph shows the popular toys amongst learners.



KEY- 1 face represents 5 learners.

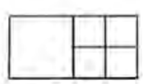
29.1 Which toy is the most popular? (1)

29.2 Which toy is the least popular? (1)

29.3 How many learners chose play dough? (1)

29.4 How many more learners prefer dolls to tops? (1)

30. How many squares are there in the diagram altogether?



__________ (2)

Appendix C: Questionnaire schedule

1. How long have you been teaching Grade 4 learners mathematics? Have your Grade 4 learners written the ANAs every year since 2011?

2. Can you comment on your Grade 4 learners' experiences of the language of the Maths ANAs?

3. Were all of the learners in your class in 2013 first language isi-Xhosa speakers?

4. Do you think the language challenges are greater for some learners than for others and if so why?

5. Can you comment on your learners' experiences of language of the Grade 4 ANAs in terms of reading skills?

6. What are your views on the policy that questions can only be read to learners in Grade 1 and 2?

7. Do you think learners would perform better in Grade 4 Mathematics if you were allowed to read the questions to the learners?

8. Can you comment on your experience of the level of cognitive demand of the Mathematics ANAs?

9. What recommendations, if any, do you have for those who set the Grade 4 Mathematics ANAs?

10. What recommendations, if any, would you have for language policy in your school and or the country?

11. Anything else you would like to share in terms of your experiences of the language demands of the Mathematics Grade 4 ANAs?

Appendix D: Teacher (Busi) Questionnaire response

Interview questions: focus on language use in the ANAs

How long have you been teaching grade 4 learners mathematics? Have your Gr 4 learners written the ANAs every year since 2011?

12 years
Yes.

Can you please comment on your Grade 4 learners' experiences of the language of the Maths ANAs.

They performed badly in past years. Maths language and its terminology all the time is their problem eg. find <u>sum</u> of; they don't understand that <u>sum</u> is also total. During ANA they always ask for explanation from invigilator, they can't do on their own. Question papers are long and they become exhausted and leave other questions blank. Word sums are a nightmare as they don't know what operation they should do.

Were all of the learners in your two Gr 4 classes in 2013 first language isi-Xhosa explain.

No.

Did you notice any differences in your two classes in terms of how they managed the ANAs and the language of the ANAs? Explain

To be honest in class usage of cold switching is too much during teaching as I should start them from naming numbers. Questioning for them is too advance eg. Arrange from <u>descending</u> to ascending, instead of saying <u>start</u> with the bigger/smaller number.

What are your views of the policy that questions can only be read to learners in Grade 1 and 2?

Firstly, question paper on their own is a nightmare; also they believe on something from their educators mouth. They hear the instruction better by being told than reading, they understand better by being told.

Do you think your learners would perform better in the Gr 4 mathematics ANAs if you were allowed to read the questions to the learners?

Yes.

Can you comment on your experience of the level of cognitive demand of the Grade 4 Mathematics ANAs?

Immediate understanding; as they are from Gr 1 where everything is their mother tongue. Maths should be taugh in English from lower grade; then we won't experience this disaste

What recommendations if any do you have for those who set the Grade 4 Mathematics ANAs

To meet or collect information from teachers to see where they are in terms of syllabus, because we experienced that some of other question were not yet taugh

What recommendations if any would you have for language policy in your school and or the country?

To be part and parcel when they are making those policies as they are going to collect recommendations from the schools as it is teachers who are delivering education to learners

Anything else you would like to share in terms of your experiences of the language demands of the Mathematics Grade 4 ANAs:

It was a frustrating period & anxiety because you just know the results. Also our learners should not be judged by ANA

Appendix E: Teacher (Anesipho) questionnaire response

Interview questions: - a focus on language use in the ANAs

How long have you been teaching grade 4 learners mathematics? Have your Gr 4 learners written the ANAs every year since 2011?

FOR THE PAST 17 YEARS. THE GRADE 4 LEARNERS HAVE WRITTEN THE ANAs EVERY YEAR SINCE 2011.

Can you comment on your Grade 4 learners' experiences of the language of the Maths ANAs

ALL MY LEARNERS ARE XHOSA SPEAKERS. THEY HAVE ENGLISH AS MEDIUM OF INSTRUCTION, AND ARE STILL LEARNING TO SPEAK THE LANGUAGE. MATHS HAS ITS OWN LANGUAGE, THAT SOME OF THEM FIND IT DIFFICULT TO UNDERSTAND.

Were all of the learners in your Gr 4 class in 2013 first language isi-Xhosa explain.

YES, ALL 40 OF THEM.

Do you think the language challenges are greater for some learners than for others and if so why?

YES. LEARNERS COME DIFFERENT BACKGROUNDS. FOR SOME, THEY ONLY HEAR ENGLISH AT SCHOOL AND AT HOME THERE IS NO ENGLISH MATERIAL FOR READING, SO THEY FACE SO MANY CHALLENGES. SOME LEARNERS ARE ENCOURAGED AT HOME TO GO TO THE LIBRARY TO TAKE READING MATERIALS TO DEVELOP THEIR LITERACY SKILLS.

Can you comment on your learners experiences of the language of the Gr 4 Maths ANAs in terms of reading skills?

I THINK THE LEARNERS READING SKILLS ARE NOT FULLY DEVELOPED. SOME LEARNERS READ WORDS WITHOUT ATTACHING ANY MEANING TO WHAT THEY READ, AS SOME OF THEM ARE NOT USED TO INDEPENDANT READING. LEARNERS DO NOT UNDERSTAND THE INSTRUCTIONS GIVEN TO THEM AS THEY READ WORDS, BUT WITHOUT UNDERSTANDING. LACK OF READING SKILLS AFFECT THEIR PERFORMANCE. SOME ANA QUESTIONS ARE SIMPLE TO UNDERSTAND BUT BECAUSE OF NOT SO MUCH EXPOSURE TO DIFFERENT TYPES OF READING MATERIALS. SOME LEARNERS PRESUME WHAT QUESTION IS ASKED BY LOOKING AT THE PICTURE, WITHOUT READING. IN 2014 IN THE ANA QUESTION PAPER, THERE WAS A PICTURE THAT LOOKED LIKE A SCHOOL BUS. THE QUESTION ASKED ABOUT THE 'VIEW' OF THE BUS. BECAUSE ANOTHER LEARNER DID NOT READ THE QUESTION, HE ASSUMED THAT THE QUESTION WAS ASKING TO NAME THE OBJECT, AND THE LEARNER'S WAS 'SCHOOL BUS' INSTEAD OF SIDE VIEW. THE QUESTION WAS SIMPLE AND STRAIGHT FORWARD BECAUSE IT WAS ONLY ASKING THE VIEW OF THE BUS.

What are your views of the policy that questions can only be read to learners in Grade 1 and 2?

IT IS FINE BUT GRADE 3 + 4 SHOULD ALSO BE INCLUDED. I THINK THEY ARE NOT FULLY INDEPENDANT, THEY NEED SOME ASSISTANCE.

Do you think your learners would perform better in the Gr 4 mathematics ANAs if you were allowed to read the questions to the learners?

DEFINITELY YES. MOST OF THE LEARNERS DO NOT PERFORM IN THE MATHS ANAS. AFTER THEY HAVE WRITTEN THE ANAS I TAKE NORMALLY TAKE THE SAME QUESTIONS FROM THE ANAS, AND THEY PERFORM MUCH BETTER BECAUSE OF THE EXPLANATION, BUT NOT EXPLAINING EACH AND EVERY QUESTION.

Can you comment on your experience of the level of cognitive demand of the Grade 4 Mathematics ANAs?

IT IS RELEVANT AND APPROPRIATE FOR THE GRADE 4. THERE IS QUITE A WIDE RANGE OF LEVELS OF DIFFICULTY WHICH IS GOOD SO AS FOR LEARNERS TO BE ABLE TO IDENTIFY, COMPARE, SOLVE PROBLEMS OR TO MATCH.

What recommendations, if any do you have for those who set the Grade 4 Mathematics ANAs ?

I THINK THOSE WHO SET GRADE 4 MATHS ANAS SHOULD BEAR IN MIND THAT SOME LEARNERS ARE NOT ENGLISH SPEAKERS. THE ANAS SHOULD BE IN ENGLISH FOR HOME LANGUAGE SPEAKERS AND ENGLISH FIRST ADDITIONAL LANGUAGE. THE QUESTIONS SHOULD BE STRAIGH FORWARD NOT TRICKY.

What recommendations if any would you have for language policy in your school and or the country?

I WOULD SUGGEST THAT THERE SHOULD BE ONE PERIOD WEEKLY ALLOCATED FOR READING ENGLISH BOOKS, SO AS FOR LEARNERS TO DEVELOP THEIR LITERACY SKILLS.

Anything else you would like to share in terms of your experiences of the language demands of the Mathematics Grade 4 ANAs:

LEARNERS WILL FACE SOME CHALLENGES IN UNDERSTANDING MATHEMATICAL LANGUAGE, WHICH THEY DO NOT ENGLISH AS A SUBJECT. THE WORD 'DIFFERENCE' MEANS TWO DIFFERENT THINGS IN MATHS AND, IN ENGLISH AS A SUBJECT.

Appendix F: Learner task-based interview questions

5. Mrs Mazibe buys an apple for R1,20 and sells it for R1,95.

5.1 How much money does Mrs Mazibe make by selling 1 apple?

________________________________ (1)

5.2 How much does Mrs Mazibe make if she buys and sells 10 apples?

________________________________ (1)

7. Write a number sentence for the sentence below.

The difference between 1 613 and 859 is seven hundred and fifty-four.

____

9. Look at the departures board at the airport and answer the questions that follow.

DEPARTURES		
DESTINATION	**TIME**	**FLIGHT NUMBER**
Mossel Bay	07:45	SAA 769
Knysna	10:20	BA 172
Johannesburg	20:00	SAA 372

9.1 Write down the flight number of a flight which will depart for its destination before midday.

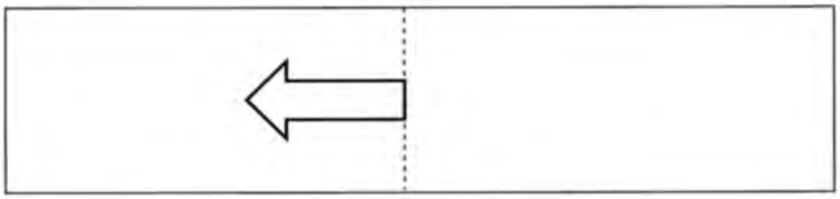
(1)

____

(1)

9.2 Write down the flight number of a flight which will depart for its destination after midday.

11. Draw the reflection of the arrow on the vertical dotted line.



12. Convert the following:

12.1 12 m 48 cm = ________________ cm (1)

13. Complete the following flow diagram:

Input		Rule		Output
7	→	× 5 + 9	→	______

(1)

14. Poppy buys a 2 ℓ bottle of milk. She uses 500 mℓ of the milk to bake a cake.

How much milk is left in the bottle?

______________________________ mℓ (2)

15. Use the fraction wall to answer the questions that follow.

1 whole			
$\frac{1}{2}$		$\frac{1}{2}$	
$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$

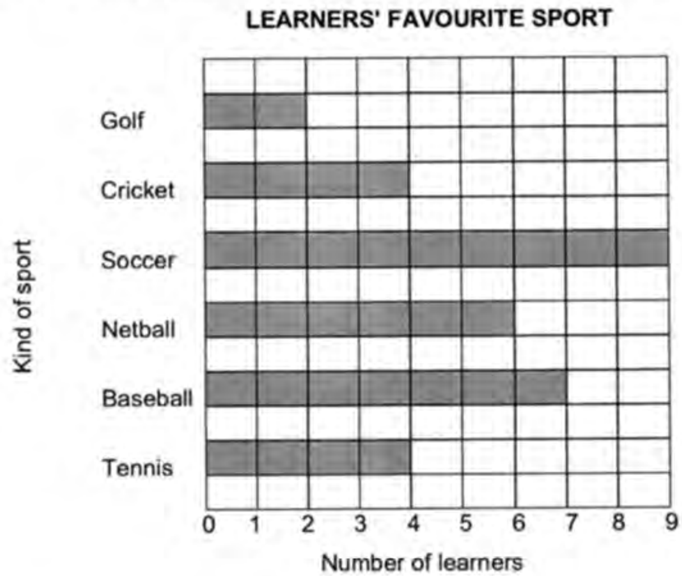
15.1 Write the symbol < , > or = between the fractions to make a correct statement.

$\frac{1}{2}$ ____________ $\frac{2}{4}$ (1)

15.2 Colour in $\frac{3}{4}$ of a fraction strip in the fraction wall. (1)

15.3 Use the fraction wall to calculate $\frac{1}{4} + \frac{2}{4}$.

18. This bar graph shows the most popular kind of sport amongst the learners in Grade 4.



18.1 Complete the tally table.

KIND OF SPORT	TALLY MARKS
Golf	
Baseball	
Tennis	

(3)

18.2 Which is the learners' favourite kind of sport? (1)

____

18.3 What is the difference between the number of learners who prefer soccer to cricket? (1)

Appendix G: Learner interview questions: Adapted from Newman

Item 5

5.1

1. Please read the question to me.
2. Are there words that you don’t understand? (teacher translates them to isiXhosa)
3. Tell me what the question is asking you to do.
4. (Reword to make it simple): How much profit (extra money) does she get from selling one apple?
5. Tell me how you are going to find the answer.
6. “Talk aloud” as you do it, so that I can understand how you are thinking.
7. Now, write down your answer to the question.

5.2

1. Please read the question to me.
2. You can only get the correct answer to this question after getting 5.1 correct.

3. Tell me what the question is asking you to do.
4. (Reword): If Mrs Mazibe sells 10 apples, how much will she get?

5. Show me what to do to get the answer.

   (Teacher restates in isiXhosa if they seem not to understand the question).

6. Now, write down your answer to the question.

Item 7

1. Please read the question to me.

2. Is there a word you do not understand?

3. Write a number sentence for this.

4. (Reword): So instead of words, use numbers and signs such as +, -, x, ÷and =

5. Now write down the answer.

Item 9

9.1

1. Please read the question to me.

2. Is there a word you do not understand? (explain and translate the word to their language)

3. (Reword): Write the flight number of a flight that leaves before 12 o'clock midday.

4. Use this simplified table

Going to	Time it leaves	Flight number
Mossel Bay	07:45	SAA 769
Knysna	10:20	BA 172
Johannesburg	20:00	SAA 372

9.2:

Write down the flight number of a flight that leaves after 12 o'clock midday.

Item 11

1. Please read the question to me. If you don't know a word, leave it out.

   (Read the word if any has been left out and translate it to their language)

2. Draw the right hand side of the sketch to make a symmetrical 2-D shape.

3. (Reword and simplify the sentence): Complete the picture so that the two sides of the line look the same.

4. Now can you try and show me what to do to get the answer.

Item 12

12.1

1. Please read the question to me.

2. Are there any words that you do not understand? (give other words which mean the same with them and explain that m means metres and cm means centimetres)

3. (Reword): change 12m 48cm to cm so that the amounts are still the same (translate to isiXhosa)

4. Can you now try and work it out.

Item 13

1. Please read the question to me. If you don't know a word, leave it out.

2. Are there words that you do not understand? (translate the words to isiXhosa).

3. Tell me what the question is asking you to do.

4. (Reword to make it simpler): Work out the given numbers to find the answer.

5. How you are going to find the answer?

6. Now, write down your answer to the question.

Item 14

1. Please read the question to me. If you don't know a word, leave it out.

2. Are there some words that you do not understand? (translate them to isiXhosa)

3. (Reword the question): How many millimetres of milk is now in the bottle?

4. Show me what to do to get the answer.

5. Now, write down your answer.

Item 15

15.1

1. Please read the question to me. If you don't know a word, leave it out.

2. Are there any words you do not understand? (translate them to isiXhosa).

3. (Reword): Use <, > or = to make the statement below true.

   Translate to isiXhosa.

4. Now, write down your answer to the question.

15. 2

1. Please read the question to me. If you don't know a word, leave it out.

2. Are there any words you do not understand? (translate them to isiXhosa).

3. (Reword the question): shade three-quarters of piece or row of the picture (then translate to isiXhosa).

4. Now can you try and answer it?

15.3

1. Please read the question to me. If you don't know a word, leave it out.

2. Tell me what the question is asking you to do.

3. (Reword the question): Use the picture to work out 1/4+2/4

4. Show me what you do to get the answer.

5. Now, write down your answer to the question.

Item 18

18.1

1. Please read the question to me. If you don't know a word, leave it out.

2. Are there words that you do not understand?

3. Tell me what the question is asking you to do.

4. (Reword the questions): Draw tally lines in the table (give examples of tally lines).

5. Now can you try and draw the tally lines?

18.2

1. Please read the question to me.

2. Are there words you do not understand? (translate the words into isiXhosa).

3. (Reword the question): Which sport do learners like most?

4. Now, write down your answer to the question.

18.3

1. Please read the question to me. If you don’t know a word, leave it out.

2. Are there any words you do not understand? (translate them to isiXhosa).

3. (Reword the question): More learners like soccer more than cricket. How many more learners like soccer?

4. Show me what to do to get the answer.

5. Now, write down your answer to the question.

Appendix H: Letter to the Grade 4 mathematics teachers

RHODES UNIVERSITY

Grahamstown 6140 South Africa

EDUCATION DEPARTMENT

28 October 2013

Mrs/Mr _____________

___________________ School

Grahamstown

6140

Dear Madam

Re: YOUR AGREEMENT TO ALLOW ME INTO YOUR CLASSROOM

Thank you very much for agreeing so readily to have me work with you and your learners, and for your willingness to thereby contribute to my PhD research. I'm most grateful to you.

If there is anything which you are unhappy or uncertain about regarding the way I am going about the research, please do tell me, and we can work around it. Please know also that if at any stage you wish to withdraw from the project that is entirely your prerogative.

Sincere regards

Sibanda Lucy

Appendix I: Letter to the school principals

RHODES UNIVERSITY

Grahamstown 6140 South Africa

EDUCATION DEPARTMENT

28 October 2013

Mr/Mrs _____________

___________________ School

Grahamstown

6140

Dear Sir/ Madam

Re: ACKNOWLEDGEMENT OF YOUR PERMISSION FOR ME TO CONDUCT RESEARCH IN YOUR SCHOOL

I am very grateful for the permission you granted me to conduct research at your school.

As a reminder of what we discussed earlier, I am doing PhD in mathematics education with Rhodes University. My research is to explore the linguistic challenges of the 2013 Grade 4 mathematics ANAs and how learners and teachers experience them. I have now paid visits to the Grade 4 mathematics teacher and I briefed her as to my research entails and she has been most welcoming to me.

When it comes to writing up the thesis I shall, of course, preserve the anonymity of the school, learners and the teacher concerned through the use of pseudonyms. No learners will be identified. If at any time the teacher or learners wish to withdraw from the project that's entirely their prerogative. I do, of course, fervently hope that this circumstance will not arise. Should you and/or the class teacher be interested in reading the final product of this research I'll very gladly provide a copy of the thesis.

Once again, I am very grateful for allowing me to carry out my study in your school.

Yours Faithfully

Sibanda Lucy

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Appendix J

Linguistic Complexity Checklist
Adapted from Shaftel et al. (2006, p. 126)

Count the instances of each of these in the problem

NUMBER OF SENTENCES: _________
A: BASIC
1. ________ Number of words in item

B: WORD LEVEL CHARACTERISTICS
1. ________ Number of different words with 7 letters or more
2. ________ Number of relative pronouns
3. ________ Number of examples of slang, homophones and homonyms
4. ________ Number of abbreviations

C: SENTENCE LEVEL CHARACTERISTICS
1. ________ Number of prepositional phrases
2. ________ Number of infinitives
3. ________ Number of complex verbs
4. ________ Number of complex / compound sentences
5. ________ Number of conditional constructions
6. ________ Number of comparative constructions

D: PARAGRAPH LEVEL CHARACTERISTICS
1. ________ Number of cultural/or experience-specific references
2. ________ Number of American holidays

Vale's 2013 Linguistic Complexity Index:
LCI = (Number of words + Sum B + Sum C + Sum D) Number of sentences
= __________________________