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Research Proposal

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1. Context of study

The present study investigates the linguistic challenges presented by mathematical Annual National Assessment texts and how teachers mediate mathematical texts to support learner comprehensibility. The study is situated within the South African literacy and numeracy context, the nature of which is reflected in international and national literacy evaluations all of which affirm to the underperformance of learners in both literacy and numeracy. The Progress in International Reading Literacy Studies (PIRLS, 2001, 2006) assesses reading literacy through comprehension tests in order to provide comparative data for different countries) (40 in 2006 and 55 in 2011). Both 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 six literacy or numeracy performance with no improvement over the seven year period (Spaull, 2013). The survey indicated that South Africa ranked 10th out of fourteen education systems for reading and 8th for mathematics, performing below poorer countries like Tanzania, Kenya and Swaziland (Spaull, 2013, p. 3). South African learners participating in this study lacked basic literacy and numeracy skills rendering them functionally illiterate and innumerate (Shabalala, 2005). The DoE Annual National Assessment (ANA) results for 2011 and 2012 (DoE, 2011, 2012) also confirm the poor performance in literacy and numeracy and the report advances different reasons for learners' poor performance.

Causes of underachievement in literacy and numeracy in South Africa have been identified as related to: learning in a second language (L2), poorly resourced schools, child labour, low income in homes lack of reading and reading material at home, poor methods of teaching like 'rote' method which produce learners who can only reproduce rather than generate knowledge (Barbarin & Richter, 2001; Fleisch, 2008; Boylan, 2010), misinterpretation of the new curriculum, poor subject knowledge of teachers (Fleisch, 2008) among a host of other constraining factors. Of particular interest to the present study is the challenge of learning in a second language.

The majority of South African learners learn in a L2 they are not familiar with (Setati & Barwell, 2008; Setati, Molefe and Langa, 2008) as they use indigenous languages for communication. Policy requires that in the first three years of formal learning, they use their home languages as Language of Learning and Teaching (LoLT). They switch to English as the LoLT in Grade 4 and as Setati and Barwell (2008) note, the majority of learners learn mathematics in the language that they are not fluent in. This then compromises their ability both to comprehend and express mathematical ideas. The present study straddles literacy and numeracy, two key areas of learners' learning, for which

national and international benchmark assessments have consistently reported underachievement. This it does by investigating linguistic challenges endured by English L2 learners within the discipline of mathematics focusing on Grade 4 mathematics ANAs.

The study takes place in schools in Grahamstown. It focuses on the reading challenges of many isiXhosa speaking learners who learn to read in their mother tongue from Grades 1-3 and then transition into reading to learn in English from the fourth grade. However, it also recognises that there are many English and Afrikaans medium schools in Grahamstown in which the majority of the learners are learning in their L2 throughout their schooling.

In South Africa Grade 4 is a critical stage where many Eastern Cape learners experience four significant transitions from the Foundation Phase (FP). The first transition from Grade 3 to Grade 4 is from using isiXhosa (in the Eastern Cape where I am doing my study) to using English as a LoLT in Grade 4. 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 movement 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 come to 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). Mathematics abstraction is particularly critical for progress in the IP.

The teaching of 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 National Curriculum Statement (NCS) dispensation when teaching in the FAL was not compulsory. If some of these learners used isiXhosa as LoLT in Grade 1 and 2 and only started using English in Grade 3, then it would be naive to expect them to have already acquired the basic vocabulary in English which they need to communicate and learn in that language. The threshold hypothesis by Cummins (2000) postulates that for a learner to be able to read well in an additional language, he or she must have acquired the reading skills in a first language. The learner should attain the requisite thresholds in both languages. Such may not be true with learners in the proposed study.

What compounds the challenge is Hirsch's, (2003) observation of United States learners that "even with the home language (HL) English speakers there is also a sudden drop-off between third and fourth grade in the reading scores…" (p.10). This is confirmation of Halliday's (1989) assertion that it is not only English L2 learners who struggle with mathematical English but also English HL learners. If English HL speakers are also challenged by reading despite their intuitive knowledge of the language, the challenge can only be worse for those learning in English as an additional language. Learners also have to deal with complicated mathematical language. 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 computations, concepts and operations. An additional challenge is that of being assessed in a language which is not their HL and in the case of the ANAs teachers are not allowed to read or mediate the language for Grade 4 learners (only Grade 1 and 2 ANAs are read).

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 need of assistance most, and inform parents about their children's performance (DoE, 2011). Results of the ANAs for the past two years are, however, disturbing. The 2011 and 2012 reports for the ANAs (Department of Education, 2011, 2012) reveal that learners performed poorly in mathematics across grades. In the FP, learners performed better but as they proceed to IP, the levels of achievement decreased significantly. The national average performance for Grades 1, 2, 3, 4, 5, 6 and 9 in numeracy in 2012 is given below:

Table 1: National average performance in numeracy 2012

Grade	**1**	**2**	**3**	**4**	**5**	**6**	**9**
Ave mark	68	57	41	37	30	27	13
% decrease from previous grade	*not applicable	11	16	4	7	3	14
% learners achieving 50% +	77,4	67,8	36,3	26,3	16,1	10,6	2,3

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 by about 10% each year from 68% in Grade 1 to 27% in Grade 6 and then to 13% for Grade 9s (DBE, 2012). The marked decline in learners' performance as they go up the grades is so sustained that no higher grade has performance equal to, or better than that of the preceding grade. That 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 in the case in Grade 1 and 2), suggests the challenge could be related to reading and language issues among other possible causes. Also that 73,3% of Grade 4 IP and 97,7% of Grade 9 learners do not meet basic numeracy requirements (i.e achieve over 50%) suggests a need for understanding the causes of the problems. The Eastern Cape results mirror the national pattern of decline across all grades (see table 2 below).

Table 2: Eastern Cape Province: average performance in 2012

Grade	**1**	**2**	**3**	**4**	**5**	**6**	**9**
Ave mark	65,2	55,2	40,5	35,3	28,1	24,9	14,6
% decrease from previous grade	* not applicable	10	14,7	5,2	7,2	4	10,3
% learners achieving 50%+	72,8	63,3	34,9	22,7	12,0	8,1	2,6

The crisis of declining performance is possibly exacerbated in the Eastern Cape because it is a poorer province. Most learners are in rural, under resourced schools and have less access to English as LoLT in the general environment. They have less English language infrastructure.[1]That the underperformance of learners reported in Table 1 and 2 was established from ANAs justify the investigation of the extent to which the language in which they are administered gives a fair chance of success to English L2 learners, hence the focus of the present study on their readability and understandability, particularly at a linguistic level. This is because mathematical tests also measure language skills (AERA, APA, & NCME, 1999) not just mathematical skills. Learners have to be proficient in the language of assessment to register success in the assessment.

Cummins and Swain (1986) argue that questions cognitively undemanding to a native speaker will be more 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 factored into the test (Abedi, 2006). Cummins and Swain (1986) also argue that English L2 learners require 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

[1]In rural schools, they learn and teach in a context where there is a very limited English language infrastructure. This means English is only heard, read, spoken and written in formal school context (Setati & Adler, 2000. p. 251)

production strategies different from everyday oral interactions (Cummins and Swain, 1986). According to Halliday (2010) fairness in assessment depends on a consideration of learners' language proficiency. The present study investigates the linguistic difficulty of test items, which may limit learners' access and success in mathematical assessments.

Setati (2002) envisages a 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 a learner attempts 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 down students and cause learners' cognitive overload. Their thinking is disturbed and confused leading to failure in understanding question items. 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 and this research also aims to investigate how teachers mediate mathematical text in the case of the preparation of the ANAs. Research by Graven and Ventatakrishnan (2013) in the Eastern Cape and Gauteng indicates that teachers use the departmentally issued ANA exemplars and spend several weeks preparing for the ANAs.

My research will therefore, consist of two parts. The first part explores the linguistic complexity of Grade 4 ANAs (from 2011 to 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 home language to using an additional language (usually English) as LoLT. The second part investigates the way in which the participating Grade 4 teachers mediate learner access to the language of the texts. The study hopes to contribute to a better understanding of some of the causes of poor performance in numeracy, particularly those of a linguistic nature.

2. **Purpose and Significance of the study**

The purpose of my research is twofold. Firstly, it is to analyse the nature of language used in the Grade 4 ANAs and establish the nature of the linguistic challenge that learners face as they solve mathematical problems. Secondly, I investigate how teachers address the challenges presented by mathematical text written in English and how they mediate mathematics text. Since mathematical

texts can be difficult to understand, and the participating learners in this study are mostly not proficient in English, teacher mediation is necessary for learners to comprehend the texts. It is hoped that the empirical findings of the linguistic challenges of the ANAs will inform educationists, especially those involved in the design of national assessments, on the nature of language challenges that learners face when writing the mathematics ANAs. Secondly, it is hoped that the in-depth case study will illuminate ways in which teachers mediate language demands in the preparation for the ANAs so that insights from this can enrich our understanding of the linguistic demands of the ANAs and can inform teacher practice and teacher support in ANA preparation.

Historically, the South African education system only assessed learners at the end of Grade 12. This system did not allow educators to understand the learning process and the learners' performance in the lower grades. As a result, educators did not know exactly at what stage learners struggle with numeracy and literacy. Now that learners' performance is assessed at different stages in primary school, it is possible to establish where they struggle all the way through to Grade 12. However, it is more important that learners' tests are valid and at the right level.

It is essential to ensure that the ANA is a fair and valid tool, for example, in making sure that the levels of the items are fair and not too high or too low (DoE, 2011). Seeing that ANAs are important, my research will contribute to the knowledge of linguistic challenges that may impact the readability of the ANAs.

Being relatively recent assessments, not much research has been done on them. In a press article, however, Hemming and Dampier (2012) argue that there is need for this research especially in South Africa where the majority of learners grapple with learning in a second language. The importance of the research will also have implications for other countries where the issue of learners writing assessments in L2 or third language (L3) is a problem. In a study done by Graven & Venkatakrishnan (2013), teachers agreed that ANAs are important because they are standardized and provide guidance on what is expected. However, several noted that they have some weaknesses like the complexity of language used to ask questions. In response to this, my study will investigate the complexity of the mathematical questions by analysing the ANAs written so far. It is envisaged that this study will help educators who set ANA tests and teachers who prepare learners for the tests to consider several aspects related to the linguistic level of both the tests and the learners.

The context, together with the literature on the interface between language and mathematics learning inform my intended research which is guided by the research goal and research questions which follow.

3. Research goal

To investigate the nature of linguistic complexity of the ANA test items and how teachers mediate learning in preparation for the ANAs.

3.1 Research Questions

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

1b. What errors do learners make as they solve the mathematics problems?

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

2a.How do two selected Grade 4 Mathematics teachers mediate the language of the ANA exemplars to aid learner comprehension in preparation for the ANAs?

2b.What perceptions do the Grade 4 teachers hold about the readability and understandability of the Grade 4 mathematics ANA tests?

4. Literature Review

The literature review discusses the reading challenges faced by learners learning mathematics in an L2 and the errors that they make when they solve mathematical problems. It also discusses local and international studies on assessments. This discussion is relevant to this study.

4.1 Reading challenges of Mathematics texts for learners learning in English as a second language (ESL) in South Africa

The concept of Cognitive Academic Language Proficiency (CALP) developed by Cummins is concerned with literate skills in the first and second language. According to Cummins (2000), CALP is that language proficiency one should have if one has to read textbooks, to speak fluently, write and answer questions correctly in a language. CALP also enables learners to learn about things which are abstract and unfamiliar to them. Cummins (2000) goes further to say that learners who have not yet developed their CALP could be at a disadvantage in learning content area subjects because their academic language has not yet developed. They are not able to read fluently or write in English. What they have is Basic Interpersonal Communicative Skill (BICS), which enables them just to communicate in their native language and talk about informal, concrete things. Learning mathematics in English is problematic for ESL learners because they first have to learn English and

then learn mathematics language (Setati, 2002, Cummins, 2000). Schlleppegrell (2007) describes mathematical language as a language with:

> … multiple 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).

The language of mathematics is different from the language that learners use socially at home and with their peers, and in other subject areas at school. It 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 L2. For the majority of South African learners, especially those in primary schools located in townships and in rural areas, the majority of learners have only developed BICS and some CALP in their Home languages and may not have developed BICS in the LoLT (Howie, Venter, van Staden, Zimmerman, Long, du Toit, Scherman, Archer, 2008; Plüddemann, 2010). According to Cummins (2000), it takes five to seven years for CALP to develop. As mentioned earlier, CALP is needed if learners are to read textbooks, write and answer questions. South African Grade 4 learners struggle to learn mathematics possibly because they lack this required academic language proficiency which takes time to develop.

4.2 Error Analysis

Learners make errors as they attempt to solve mathematical problems. Error analysis in mathematics education has a long history (Peng, 2010). Buswell and Judd back in 1925 cited more than 30 studies dealing with how to analyse errors. The Newman approach to error analysis has been widely used in Australia since the 1980s (Clarkson, 1980; Clements, 1980; Clements & Ellerton, 1992) in India (Kaushil, Sajjin Singh & Clements, 1985) in Malaysia (Ellerton & Clements, 1992) and many other countries. White (2005) notes that Newman’s Error Analysis (NEA) provides the framework for the reasons that underlie the difficulties learners face. It also allows the determination of potential problem areas and then identifies ways to resolve these problems. For White, the NEA tool makes a good link between literacy and numeracy (White, 2005).

Learner errors manifest themselves in a variety of ways as they respond to mathematical items. According to Newman (in White, 2005, p. 15), when learners respond to a written mathematics question, they have to surmount a number of hurdles including reading, comprehension,

transformation, process skills and encoding. Errors leading to failure to solve problems are categorised as follows:

- Reading errors refer to when a child could not 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) (White, 2005).

Newman then developed a diagnostic tool (NEA) which links numeracy and literacy using an interview involving five questions (in White, 2005). This tool will be useful in the analysis of learner errors which will then be followed by case study in terms of learners using NEA with adaptation and transition into isiXhosa.

Table 2: 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 (1977)

Besides these errors, Newman (1983) acknowledges that learners can make careless errors when they solve mathematical problems due to a range of reasons including to lack of motivation. This study will examine errors made by two classes of Grade 4 learners as they answer Grade 4 mathematics ANA questions. Particular attention will be paid to those errors which point to language proficiency and literacy issues and these will be further explored in case study interviews of purposively selected learners across a range of performance levels.

4.3 Research on the ANAs in South Africa

I have shown above that the ANA reports for 2011 and 2012 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 the situation is worse in the Eastern Cape (DoE 2011, 2012). Bansilal (2012) carried out a study whose intention was to analyse 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 read the instructions for themselves so maybe some learners failed to read and understand the instructions. Grade 4 learners performed even worse than Grade 3 learners perhaps because the language of instruction used in the assessments was English yet the majority of them were isiZulu speaking. Another finding was that the learners whose home language was Afrikaans performed better than other learners whose first language was not Afrikaans, from Grade 1 up to Grade 9. According to Bansilal (2012), this could be because the learners were using their mother tongue in the assessments. Bansilal (2012) recommends that research be done which identifies reasons for the results, and then plans for interventions can be done to address the problems. He also recommends for research on the actual items, in order to investigate their fitness for purpose. This research feeds into this call for research in another province and is going to look at the test items and see if the language used give learners a fair chance to demonstrate learning.

Graven and Venkatakrishnan's (2013) research on the ANAs found that Grahamstown and Johannesburg primary school mathematics/numeracy teachers said they spent several weeks (a range of one to eight weeks with a mean average of 3,97) of school time with the preparation and writing of the ANAs. The teachers agreed that ANAs are important because they are standardized but they also noted weaknesses like the complexity of language used to ask questions. This is unfair to weak learners who struggle with reading and comprehension of English (Graven & Venkatakrishnan, 2013). According to this research, teachers also complained that the ANA exemplars and memorandums do not allow them to use different methods of problem solving and this discourages teachers who believe that there are many ways of solving mathematical problems. In addition to this, teachers felt that those who set 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 (Graven & Venkatakrishnan, 2013).

Given the newness of the ANAs it is to be expected that there is little published research on them. While Henning and Dampier reviewed the language of Grade 1 and 2 ANAs, there is, however, no published research to date which analyses the Grade 4 test items to see if the language used in them

is readable especially bearing in mind the transitions for many from writing in L1 to L2. In this respect research has not also looked at how teachers mediate and prepare learners for the ANAs. It is this gap that my research intends to investigate and contribute towards.

4.4 Primary mathematics assessment research internationally

Internationally, much research has been done on assessment of primary learners. The research largely seeks to find out the performance of learners so that intervention may be done where there is need. My research will contribute to the knowledge on why learners underachieve in national assessments, especially those learners who learn in a second language worldwide.

PIRLS (Progress in International Reading Literacy Study) and TIMSS (Trends in International Mathematics and Science Study) are projects of the International Association for the Evaluation of Educational Achievement (IEA). They are designed to monitor and evaluate the reading, mathematics and science achievement of fourth grade pupils (Eivers & Clerkin, 2012). Forty-eight countries participated in the PIRLS assessment, while 50 countries participated in the 2003 TIMSS assessment and 45 countries participated in the Year 8 TIMSS assessment (Thomson, Hillman, Wernert, Schmid, Buckley and Munene, 2012b). Reddy (2006) also reports that South Africa was the lowest performing of 50 countries in the 2003 TIMMS study.

The international reports on TIMMS for reading (Mullis, Martin & Drucker, 2012b), mathematics (Mullis, Martin, Foy & Arora, 2012a) and science (Martin, Mullis, Foy, & Stanco, 2012) give a detailed description of the performance of learners in all participating countries, and relate performance to selected characteristics of individual learners, and their home, class and school environment (Eivers & Clerkin, 2012, p.1).

Saeed, Gondal and Bushra (2005) assessed the achievement of primary (Grade 3 and 5) learners and factors affecting achievement in Pakistan. Learners' achievement was found to be affected by parental education, economic and social status, book reading and homework and teacher guidance which had positive and negative effects on their achievements. Saeed, Gondal and Bushra's (2005) research is of value to those who wish to understand the achievement levels of primary school learners in developing countries. Similarly, the Southern and East African Consortium for Monitoring Educational Quality (SACMEQ) which aims to facilitate the expansion of quality education in sub-Saharan Africa by providing data to monitor educational quality, and improve educational planning indicates a range of factors affecting learner performance across these African countries (Spaull,

2011). Of particular relevance to my study are issues raised in relation to language. The study emphasised that language, race and socio-economic status are highly related and people should be careful not to relate the entire difference between wealthier students and poorer students to socio-economic status, since some of this difference may be due to linguistic advantage (Spaull, 2011). These findings concur with Fleisch's (2008) summary of local research into this issue and its influence on the primary mathematics and literacy education crisis.

5. Theoretical Framework

This study is guided by an assumption that language is central in the learning of mathematics. 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 students (Schleppegrell, 2007; Abedi & Lord, 2001; Adams, 2003). The linguistic challenges in the ANAs will be uncovered through content analysis and the ways teachers mediate learning, through observations.

This study is framed by a socio-cultural view of language and learning, whereby Vygotsky's influential work will inform the theory of language and learning. Hallidayan language theory, will also be used, which coheres well with Vygotsky' theory because for both language is central to learning. For research question 1 I draw on various analytical tools and framework that cohere and have been developed from a Vygotskian perspective of learning. Vygotsky's theory is guided by six assumptions.

- 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 advanced individual.
- Tasks that are challenging promote cognitive development.
- Play is important and allows children to stretch themselves cognitively (Vygotsky, 1978).

Vygotsky (1978) maintained that speech is a major psychological tool in the child's development of thinking. As the child ages and develops, his or her basic speech becomes more complex. According to him, "sometimes speech becomes of such vital importance that, if not permitted to use it, young children cannot accomplish the given task" (p. 26).

In this study, language is both a carrier and creator of knowledge and reality. Language gives meaning to everything. In the first part of this study, the focus will be on assessment of the language

complexity of test items and learners 'performance in tests. Systemic Functional Linguistics (hereafter SFL), a social theory of language developed by Halliday, informs this part of the study (particularly Research Question 1). For this reason, I elaborate on this theory further below.

5.1 SFL as a theoretical/analytical framework

According to Achugar and Colombi (2008), SFL theory situates language in socio-cultural context, and the patterns of the language are linked to particular cultural situations that are relevant. It is based on the view that language is a system for meaning-making (Halliday, 1978). Halliday believes that a child is socialised into his or her culture through language. Similarly to Vygotsky, he argues:

> In the development of the child as a social being, language has the central role. Language is the main channel through which the patterns of living are transmitted to him, through which he learns to act as a member of a "society"—in and through the various social groups, the family, the neighbourhood, and so on - and to adopt its "culture", its mode of thought and action, its beliefs and its values (Halliday, 1978, p. 9).

According to the SFL theory, language is analysed in relation to how it is used socially and how it functions and all these assumptions follow on from Vygotsky's socio-cultural theory of learning.
Halliday (1978) posits that context influences the type of language used, and users further shape the type of language used in different contexts. By systemic, Halliday (1978) refers to the fact that when we use language, we make choices from sets of available options. People choose how they want to use language in certain contexts. By functional, Halliday assumes that every time we make a choice from the available options, we are doing so in order to fulfil a communicative purpose (Halliday, 1978). Language is essential not only for communication between the members of a group, but also for expressing social roles and maintaining the channels of interaction among them open.

For Halliday, meaning and form cannot be separated, but stand in a dialectic relation to each other (Halliday, 1978). Meanings do not exist before the words that realize them. Thus, grammar as a semiotic mode of activity models the material mode while being itself a component of what it is modelling (Halliday, 1998, p. 186). Eggins (1994, p.1) postulates that the focus falls on the analysis of authentic products of social interaction (texts) considered in relation to the cultural and social context in which they are negotiated.

Learning, in Halliday's view, is a language-based semiotic activity (Halliday, 1993). Language is central to learning. Language has a role to make meaning as well as facilitate learning. Halliday

(1993) states that learning of any subject matter is linguistic in nature. Here grammar plays a central role in making meaning in learning. “Accordingly, a natural language embodies in its grammar a theory of human experience” (Halliday, 1998, p. 194). This implies that in our everyday experience, we use our common sense, but when it comes to more advanced academic experience, we think in abstract ways, in terms of objects which help us to make sense of our environment. Grammatical features are seen in relation to meaning-making practices in SFL (Williams, 2004). Therefore, failure to know and comprehend grammatical features is failure to make sense of the language. Pimm (1987) and Setati (2002) drawing on Halliday’s view also point that mathematical speech and writing have different language types and grammar that learners should understand if they are to participate appropriately in learning mathematics.

Learners participating in the present study are mainly isiXhosa speaking using English as LoLT. Because English is not their mother tongue, they do have limited linguistic resources to respond appropriately to the demands of academic contexts in which English is the LoLT. They lack experience in the use of language (English), both at home and outside the classroom and need to expand their meaning making resources in order to be able to use English in more specialised and abstract forms. As long as learners lack proficiency in the medium of instruction, comprehension and learning may be impeded.

5.1.1 SFL as a tool

SFL as a framework of analysis will be useful to evaluate test items and to explore the linguistic challenges in them. SFL is concerned with the analysis of the sequence of parts (i.e. the words, word groups, clauses, clause complexes and paragraphs), which form stages in the development of the text (O'Halloran, 2008, p. 447). According to Lirola (2010) SFL offers a tool for analysis of grammatical features in written texts, in a given language. For example, lexical choices such as technical vocabulary; types of verbs and noun groups; types of conjunctions and so on. In the case of this study, using SFL to analyse the grammatical features used in the test items will help me to understand the features that bring complexity to the ANA texts, leading to possible problems in readability and access of the test items. For example, when the text is full of technical vocabulary, dense noun phrases, conjunctions with technical meanings, verbs *be* and *have*; precise and technical meanings of conjunctions among others (which Schllepegrell (2007) describe as challenging), it will be an indication that the text maybe likely to be complex for the learners using it, especially for L2 learners.

The present study seeks to analyse the complexity of mathematical test items written by South African Grade 4 learners. I argue that SFL is a useful and indeed powerful tool for the analysis and comparison of these texts, through its emphasis on the functional basis of language structure and the view of language as meaning potential. It has a very systematic way to analyse sentences and understand their constituents. The distinction in SFL of three levels: ideational (experiential), interpersonal and textual (metafunctions)[2] within the semantic component of the model helps highlight the features of the texts in a particularly clear, powerful, and objective manner. Texts may then be analysed in terms of the range and nature of such options. In Systemic Functional Grammar, language is analysed in three ways (strata): semantics (meaning of a word, phrase, sentence, or text) phonology (the sound system of a given language), and lexicogrammar (Chappell, 2013). According to Chappelle (2013) SFG presents a view of language in terms of both structure (grammar) and words (lexis). The term "lexicogrammar" describes this combined terms. The linguistic Complexity Checklist will also be used to evaluate the linguistic complexity on an item by item basis as outlined by Shaftel, Belton-Kocher, Glasnapp and Poggio (2006), in accordance with SFL.

For questions 1b and 1c and in order to illuminate learners' responses in relation to linguistic demands of the ANAs, I research the nature of errors learners make as they solve mathematics problems. For this I will use the Newman's Error Analysis which I discussed in section 4.2 above. Analysis of the nature of learner errors will support and enable interviewing of learners and teachers (in Research Question 2).

6. Mediation and the Activity Theory (AT)

The second part of this study answers my second research question which deals with the investigation on how the participating teachers mediate learning. In the ANAs, the isiXhosa speaking learners in this study have to independently read mathematical texts in English from Grade 3 and solve mathematical problems encoded in this language (and of course mathematical symbols). Perhaps as a result of these challenges, Graven and Venkatakrishnan's (2013) study indicates that on average teachers spend between one to eight weeks preparing for the ANAs. My interest is in how teachers mediate learners' understanding of written mathematical language in English when

[2] SFL describes three main functions of language which Halliday (1978) calls metafunctions. These are encoding:
•Experiential meaning: these are meanings about the inner and outer worlds or representation of experience. Speakers represent their experience by the content component of language mainly in terms of participating entities, processes and circumstances.
•Interpersonal meaning: social interaction or relations. Speakers use language to command something, to ask questions or give information. Language also expresses one's opinions and views.
•Textual meaning: relevance in context. Speakers create text by indicating topic and relevance in how they organise language (Halliday, 1978).

preparing them for the ANAs. Research (National Centre of Curriculum and Research Development, 2000; Adler, 1996, 1998, 2001) indicates that code-switching has been observed as a linguistic feature of multilingual classrooms and the learners' home language is used to scaffold understanding of English mathematical text. Therefore, in this study it is assumed that code-switching may also be found in the classrooms as a way of mediating learning in relation to the preparation for the ANAs. In the next section I discuss mediation of learning and the Activity theory.

6.1 Mediating learning and scaffolding

Mediated learning is the subtle social interaction between teacher and learner in the enrichment of the student's learning experience (Presseisen & KoZulin, 1992). It is imperative especially for learners struggling with learning L2, like learners participating in this study. Monroe and Panchyshyn (2005) and O'Halloran (2005) point out that for learners to be successful at making sense of and solving mathematical problems of worded mathematical texts then the meaning of mathematics specific vocabulary needs to be scaffolded. Derewianka (1998) also argues that not only do teachers need to scaffold the use of language, but tools for learning have to be provided to learners in order to increase their awareness of language and how it works. 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). 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."

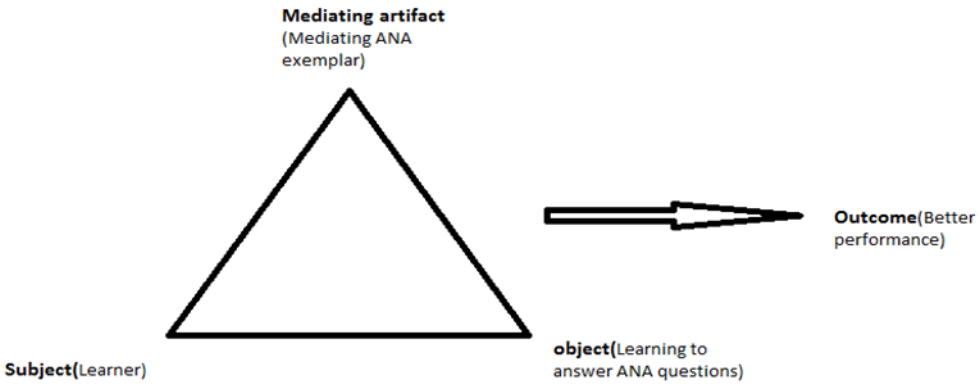
A learner first does a task with the assistance of a teacher or other knowledgeable person until the learner has internalised the task and can do it on his or her own. When a child interacts with an adult, peer or teacher who is at a higher level of skills or knowledge, the child has an effective learning experience and moves to the next stage of learning and understanding (Kao, 2010). This is what scaffolding means. Some examples of scaffolding includes offering clarifications related to an activity, inviting students' participation, maintaining students' focus on an activity, reinforcing key features of an activity and evaluating students' understandings. Kao (2010) also argues that mediators do not only provide knowledge, but they also provide learners with confidence, willingness to learn as well as help for 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 ANAs learners have to independently read mathematical text in English and solve mathematical

problems encoded in this language (and of course mathematical symbols). This study investigates how teachers mediate mathematical texts to prepare learners for the ANAs.

Vygotskian Activity Theory (hereafter AT) will also be used to conceptualize this part of the study. The AT, a socio-cultural theory, is proving a useful tool for research. AT complements SFL. It describes, not social contexts, but social networks in which the interpersonal is central. Chapelle (2013) also argues that the ideational arises out of the need for people to work together and to use material tools. Therefore, AT analysis cannot be done apart from the interpersonal. Classroom activity is often reduced to linguistic action, making meaning with language. Vygotsky (1978) picks out language as a special type of tool to mediate both understanding and situated social action, and observes that these two are related.

The AT begins with the notion of activity. Vygotsky's idea of cultural mediation of actions is commonly expressed as the triad of subject, object, and mediating artefact. The idea is summarised in the famous triangular model.

Figure1: The basic triangular representation of mediation (Vygotsky, 1978)



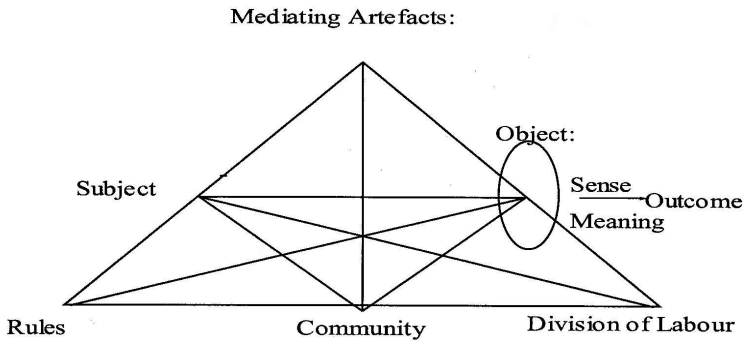
The diagram above emphasises that objects in the world fundamentally mediate how people think and act. As Kuutti (1996) asserts, an activity is seen as a system of human "doing" whereby a subject (actor/s engaged in the activities, that is teacher or learners in the case of my study) works on an object (learning to solve mathematical problems in the ANA exemplars) in order to obtain a desired outcome, which is being able to access and solve the mathematical problems. In order to obtain the desired outcome, the subject (leaners) employs tools, which may be external (e.g. ANA exemplar) or internal (e.g. language, instructional talk or questions). Jonassen et al (cited in Hardman, 2007) posit that the activity consists of 'goal-directed actions that are used to accomplish the object or tasks,

actions and operations that transform the object' (p. 54). As an illustration, an activity might be a teacher mediating learning in order to assist learners to understand, like in the case of this study. For Kuutti (1996), the tool (exemplars or language) mediates between the activity and the object. The tool may at the same time enable or limit the subject in the transformation or learning process. For instance, language as a tool can be enabling if the language used for learning is well known to learners. Because learners come to school with an everyday language with which they have constructed their knowledge of the world, the school can build on that knowledge and language and move learners toward new and more scientific and technical understandings by being aware of the linguistic challenges that accompany the conceptual challenges of learning (Schleppegrell, 2007, p.140).

In this study AT will be used in order to understand the process of transformation occurring when teachers use different tools of teaching/learning for mediation. For Vygotsky (1978) humans use tools to change the world and are themselves transformed through the use of tools. He proposed that development depends on how children and teachers interact and share cultural tools. Tools can be internal or external, hence psychological or material tools, including language. First generation AT depicts the subject, object and those tools or artefacts that mediate the subject towards the object (Asghar, 2013). It emphasises the role of tools in mediation. In my study, I will look at how the ANA exemplars and language are used as tools to mediate learning.

Engestrom (1987) developed further the AT model, the second generation, which adds three other components; rules, community and division of labour while emphasising the importance of analysing their interactions with each other and how different systems like object, rules and the division of labour interact with each other in order to bring an outcome of learners who understand mathematics (Engestrom, 1999). It emphasizes the collective nature of human activity, like a class of learners.

Figure 2. Structure of a human activity system (Engeström, 1987)



Rules are both explicit and implicit and define how subjects must fit into the community. In the case if my study, AT will allow me to see the role of rules, which rules and how these rules shape the mediation process when the ANA exemplars are being used as a tool for mediation. In a mathematics classroom, when a teacher is mediating learning, for instance, rules may be overt, such as mathematical rules. Examples are rules used when adding decimal fractions or when multiplying three digit numbers. Rules may also be tacit, for instance, one person speaking at a time or raising hands when you want to give an answer. Rules mediate between teachers and the class. The community is the group of people who share the same object, like a Grade 4 class learning mathematics. AT also helps us to understand the role of the division of labour. Division of labour describes how the object is related to the community. In a mathematics classroom, for instance, the teacher has his or her roles like explaining concepts, asking questions and administering tests. Hardman (2007) sees the role of a teacher as being that of a mediator. A teacher using an ANA exemplar as an artefact for mediation uses it in different ways in order to scaffold mathematical language. Similarly, learners also have their own roles in the classroom. They have to answer question orally or in writing. They also ask questions for verification and negotiation and work in groups, assisting each other. It is unfortunate that the language tool used in the Grade 4 class participating in this study is not very familiar to them. The language is not well known to their society and culture of learners and code-switching may thus take place to mediate learning.

From the above discussion of AT, it is apparent that the theory could enable me to understand the pedagogic activities that may take place in a classroom, as teachers mediate learning.

7. Research Design and Methods

Although the contribution of this study is predominantly empirical, it would provide methodological insights. These insights will largely be in respect of the use of various linguistic analytical tools in the specific context of the ANAs at a critical language and mathematical transition point (taking place in Grade 4 when learners move from the foundation phase to the intermediate phase as discussed earlier). These insights and possible adaptations would provide pathways for future research into linguistic issues and such assessments at this level**.**

7.1 Research orientation

The ontological and epistemological views of a study determine the research approach and method that will be employed. 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 inform the data gathering tools used in this study.

The approach that will be used in this study will be interpretive in nature drawing on both qualitative and quantitative methods. Interpretivist positions are founded on the theoretical belief that reality is socially constructed and fluid. Thus, what we know is always negotiated within cultures, social settings, and relationship with other people (Schwandt, 2001). Cohen, Manion and Morrison (2007) describe interpretive research as a research that seeks to understand a phenomenon: in the case of the present study, the linguistic challenges of the 2011, 2012 and 2013 ANAs and how learners experience them, as well as how the Grade 4 teachers mediate learner access to the ANA test items. Interpretive research relies heavily on naturalistic methods like interviewing, observation and analysis of existing texts (Schwandt, 2001). It also ensures an adequate dialogue between the researchers and those with whom they interact in order to collaboratively construct a meaningful reality (Alvermann & Mallozzi, 2010).

7.2 Mixed methods

Denscombe (2007) defines mixed methods as using data collecting methods that collect both qualitative and quantitative data. Collins et al. (2006, pp.78-79) 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 kinds of data or sources. This assists because biases intrinsic to single-method approaches are avoided, as a way of compensating specific strengths and weaknesses associated with particular methods.

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 will feature at different stages. Analysing the linguistic complexity of Grade 4 ANAs and learners written texts would have a quantitative dimension in that some numbers will be included. Investigation of teachers' mediation of learning will largely be qualitative as indicated in the data gathering and analysis sections discussed below. Mixed method research and its flexibility to numerical and textual data suits the present study which

deals with content analysis (quantitative) and the description and analysis of teacher mediation through observation, video recordings and error analysis (qualitative).

7.3 Case study

The case for the present study is the Grade 4 ANAs and the teacher's mediation of learning. In order to understand the linguistic challenges in the ANA items it is necessary to examine in detail the case in order to understand the complexities of the language used in the items and how they affect the readability of the text. The teacher's mediation of learning will also be explored. These will be studied within their natural learning context using several data sources. The case study method allows me to do this. It can provide a great amount of description and detail about a particular case. According to Flyvbjerg (2006,) in a case study, emphasis is on learning and not on proof. This method will also allow me to use more than one data gathering tool which includes content analysis, Newman's Error Analysis, observation and interviews. Such a study requires a combination of both quantitative and qualitative methodologies within a mixed method research design (Rocco at al, 2003).

7.5 Research sites and participants

This study is situated within a large South African Numeracy Chair (SANC) Project. The selected two schools will be part of the Numeracy Inquiry Community of Leader Educators (NICLE). Therefore, opportunity sampling will take place. The reasons for choosing these two schools are that the project has a good relationship with them. The other reason is that the SANC project needs to understand and support teachers to improve performance in a range of assessments including the ANAs. There is also access to background data (which includes ANA results for the learners) in these schools, which has been already collected by SANC project from the NICLE teachers. The NICLE schools include those with learners who have used isiXhosa as LoLT from Grade 1 up to Grade 3 but then switched to English at Grade 4 and those who have used English from Grade 1 but they are isiXhosa speaking. Since this research focuses on Grade 4 learners, it is important that it works with Grade 4 teachers who are willing to participate and reflect on their experiences with the ANAs. NICLE focuses on working with teachers at the critical transition from Foundation to Intermediate phase (i.e. Grade 3 and 4) (Graven, 2012). According to Graven (2012), these teachers' numeracy or mathematical identities are being strengthened through their participation, especially the Intermediate Phase teachers, who teach mathematics only. While the mathematical competence of participating teachers would not be available without content assessments, as regular participants of NICLE the teachers would have had access to a wide range of up to date mathematics teaching

resources and the support of their NICLE community which would provide a level of support for the teaching of mathematics at Grade 4 level. From the participating Grade 4 NICLE teachers I will use convenience sampling which, according to Plano Clarke and Creswell (2008), involves drawing samples that are both easily accessible and willing to participate. Thus for this particular study, two schools will be sampled from the schools falling within Grahamstown (chosen because of convenience of travel). I will be restricted to only two teachers because the observations will need to be done in the few weeks before the ANAs when teachers will be preparing for the ANAs. Therefore, observing many teachers will not be possible because I hope to observe each for at least four to five lessons (approximately a week). Thus moving between more than two teachers in the period before the ANAs would not be feasible. With the teachers', parents', learners' and schools' permission I will use the Grade 4 class so that I can assess the learners' understanding of the mathematics ANAs. All the Grade 4 learners in the class selected who would willing to participate and whose parents had agreed would be part of the sample. I would also want to observe the teachers to see how they mediate texts in preparation for the ANAs. There will not be any sampling of the ANAs as I will just analyse all the three mathematics ANAs that have been written to date.

7.6 Data Collection/Analysis

The research questions will determine the collection and analysis of the data. Data will be collected and analysed in four phases. The first phase seeks to determine the linguistic complexity of Grade 4 mathematics ANAs, the second phase seeks to test the Grade 4 learners in order to investigate the kind of errors the learners make as they solve mathematical problems. The third phase seeks to investigate how two Grade 4 teachers mediate learning to prepare learners for the ANAs. The fourth phase will explore the participating Grade 4 teacher's perceptions of the readability and understandability of the ANAs. The first and second phases are largely quantitative while the third and fourth phases are predominantly qualitative. The table below summarises the data gathering and analysis procedure.

Table 4: Data gathering and analysis procedure

Phase	Research question	Data generation and instruments	Analytical tool	Data source
1	1a. What is the nature of the linguistic challenge of the Department of Basic Education (DBE) Grade 4 Mathematics ANAs?	Document/content analysis	SFL, Linguistic complexity checklist, readability tests	ANA mathematics documents Grade 4 2011 Grade 4 2012 Grade 4 2013
2	1b. What errors do learners make as they solve the mathematics problems? 1c.What kinds of errors can be attributed to linguistic factors?	Newman's error Analysis Newman's Error Analysis interview	Newman's error analysis	Learner scripts, two Grade 4 classes of plus/minus 40, 4 purposively selected learner interviews
3 **4**	2a.How do two case study Grade 4 Mathematics teachers mediate learning to aid learner comprehension in terms of language use in the ANA exemplars in preparation for the ANAs? 2b.What perceptions do the Grade 4 teachers hold about the readability and understandability of Grade 4 mathematics ANA tests?	Observation of teachers' lessons and Video recording Less-structured interviews for teachers' perceptions	Activity theory	2 teachers 4-5 lessons per teacher 2 teachers

AT is particularly useful as a lens in qualitative research methodologies, especially in a case study. It provides a method of understanding and analysing a phenomenon, finding patterns and making inferences across interactions, describing and presenting phenomena (Scanlon & Issroff, 2005). Each subject (e.g teacher, learner) is treated as a unit of analysis, allowing pedagogic practices to be explored in detail, from a qualitative perspective using a framework of AT. The unit of analysis in AT is the concept of object-oriented, collective and culturally mediated human activity, like teacher using different tools to mediate learning, or activity system which may include learners learning with

teachers' assistance. In analysing data, AT provides a means for observing the emergence of patterns in human activity in terms of achieving goals, focus of attention and tools (Scanlon & Issroff, 2005).

7.7 Rationale for using the data gathering tools that I used

7.7.1 Content Analysis

Much of the data for this study already exists. I will use content analysis to analyse existing test items. Specifically, the 2011, 2012 and 2013 mathematics ANA items will be analysed looking at the grammatical patterns that cause linguistic complexities in the texts. I have chosen to use content analysis because it allows me to gather large samples that may be difficult to employ in purely qualitative studies (Elo & Kyngas, 2007). This method validates evidence from other sources, like in the case of this study, observation and interviews will be used. According to Lal Das and Bhaskaran (2008), content analysis has generalizability. This means the results obtained by the researcher can be applied to other similar situations.

7.7.2 Learners' answer scripts analysis

The participating learners will be tested on the ANA tests for 2013. The answer scripts will be marked and these students' scripts will be analysed, noting which questions have been answered incorrectly. Thereafter, a purposive sample of student answer scripts for the test will be done. A detailed error analysis will be performed on these scripts using NEA. The rationale for using the NEA is that it has been successfully used by many researchers (Papua New Guinea by Clements, 1982 & Clarkson, 1983, 1991; Philippines by Jimenez, 1992; Thailand by Singhatat, 1991, and many others) to learners who are not English speakers and these researchers were able to identify the causes of errors made by learners. Likewise, my research seeks to analyse the errors that will assumedly be made by the Grade 4 learners taking part in this study. The learners are also learning mathematics in English, though English is not their home language. While interview questions in relation to learners interpretation and working with ANA questions will be initially asked in English (the language of the ANA and instruction at Grade 4 level) it is likely that many learners may require translation and that translation would help provide learners with the opportunity to hear and engage in isiXhosa. Therefore, an interpreter, who is experienced in interpretation of isiXhosa within the context of mathematics lessons, will be used for interviews. The learners may need to use isiXhosa to answer the interview questions and this will be encouraged. Learner responses will later be transcribed verbatim and then translated (again by an experienced translator of isiXhosa to English with a mathematics teaching context).

7.7.3 Structured Classroom based – observations

I will observe two Grade 4 mathematics teachers to see how they mediate the exemplars in preparation of the ANAs. The observation that will take place will be a structured observation. These observations are systematic in that they measure classroom behaviours from direct observations that give a specific event and behaviour that are being observed and how they are to be recorded. I anticipate that the observations will allow me to observe teachers as they teach and see how they mediate learning as they prepare learners for the ANAs. The Grade 4 teacher' classroom talk will then be analysed to determine how the teacher mediates learning as way of increasing the likelihood of learners understanding the texts. The observational data will be used to conform or refute the hypotheses the observation would have generated.

7.7.4 Voice and Video recordings

The video recorder will be used to capture the activities taking place as the teacher teaches mathematics. I anticipate that this will be done simultaneously with observation, to complement it. It is meant to capture how the teacher prepares learners for the ANAs. The greater strength in video recording is that participants can be invited to discuss their behaviour after the event, and to explain why they did what they did. It can also re-awaken the memories and experiences of a researcher.

7.7.5 Teacher interview

Two Grade 4 teachers will be interviewed in order to get the perceptions they hold about the readability and understandability of Grade 4 mathematics ANA tests and how they mediate language to provide additional data to observations. I will use a less structured interview. I have chosen to use a less structured interview as well because it is in-depth and emphasises validity and how close answers get to the respondents' real views. Respondents can answer questions in as much detail as they want. It as well gives researcher highly personalized data. During the interview there are opportunities required for probing deeper into a response given by an interviewee. It also allows greater flexibility in wording, sequence and direction as the interview is taking place (Gray, 2004).

The interview will be recorded and fully transcribed verbatim. One limitation of this type of interview is that it is time consuming. This, however, will not be a problem because I will carry out only two interviews for two teachers, which I intend to make it as detailed as possible.

The stages I will take in the analysis are, generating natural units of meaning, classifying, categorizing and ordering these units of meaning, structuring narratives to describe the interview contents and interpreting the interview data.

8. Ethics

Research ethics refers to the moral principles guiding research, from its inception through to completion and publication of results and beyond... (ESRC: 20). The study, being part of South African Numeracy Chair research project has already benefitted from the granting of permission by the Department of Education. I will, however, secure district and school permissions for the project. Permissions should also be granted from learners, teachers and the principals. The learners' parents will be asked to sign permission to do error analysis and interviews on the learners. All the participants will be clearly informed about the process and reasons for the study, risks and discomforts that are likely to be encountered; benefits that might derive from the research and assured that their participation will be on a voluntary basis. This means the subject has the right to refuse to take part or to withdraw from taking at any time or part of research without prejudice to the participant and rejoining the project (Nachmias & Nachmias, 1990). The anonymity of the schools, teachers and learners will be respected, and confidentiality guaranteed. Identifiable personal data collected for one particular research purpose cannot automatically be used for other research. Such data must not be used for commercial or administrative purposes.

9. Validity and reliability

Golafshani (2003) pointed out that in qualitative research reliability and validity is replaced by the idea of trustworthiness, in which triangulation is trusted to be a way to establish this trustiness of the results of a study. In this research, triangulation of data collection methods will help validate my research. Triangulation refers to the use of more than one approach to investigate a research question in order to enhance confidence and reliability in the findings (Mills, 2003). Mills argues that researchers should not rely on only one source of data. Cohen, Manion, & Morrision (2007) argue that a researcher can reach credibility through giving an accurate description of the phenomena being researched and taking long in the field whilst observing persistently, in addition to triangulation.

In this study, I will try to make the data available to colleagues and supervisors in order to provide a means of checking the categories and themes that I will get from the data. Silverman (1993) calls this inter-rater reliability, whereby a researcher gets others to analyse the same data according to those categories and to see whether the categories are recognizable in the data. In the teachers' interview analysis I will try and give the transcripts in verbatim so that the reader may be able to make their own judgements on the recognisability of the themes and categories drawn from the given data.

The study has contextual validity which Ryan, Scapens and Theobald (2002) see as emanating from the description and reporting on a context in its natural state. This is true with this case study. It is done in a classroom with teachers and learners, which is the natural context. According to Denscombe (2007), authenticity and representativeness of documentary sources make them valid. The ANAs used in this research are authentic, set and approved by the Department of Basic Education. They are also representative of all the Grade 4 mathematics ANAs written in the whole of South Africa.

According to Maxwell (2004b) qualitative research takes into account two types of validity. These are descriptive and interpretive validity, and, theoretical and explanatory validity. Descriptive and interpretive validity is attained through careful transcriptions and recognizable categories that are supported by the data (Maxwell, 2004b). I will as much as possible make careful transcriptions and recognisable categories in my research. The second is achieved by systematically linking theoretical concepts to the theoretical framework of the study.

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