A COMPARISON OF isiXHOSA-SPEAKING LEARNERS' RESPONSES TO WORD PROBLEMS GIVEN IN ENGLISH AND isiXHOSA

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DECLARATION

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

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ABSTRACT

According to Prins(1995), readability factors in Mathematics text do not only influence the comprehension of questions, but also have a marked influence on learner achievement levels. Extending on Prins (*op cit*), this study sought to investigate whether there are any differences in the quality of interpretation and choice of algo-heuristic methods when isiXhosa-speaking learners respond to mathematical word problems set in English and isiXhosa.

The study was located within an ethnographic framework, with all of the 109 participants speaking isiXhosa as L1. The participants were in grades 8 (44), Grade 9 (29) and grade 10(36) and all took Mathematics as one of their school subjects. Learners were divided into four groups based on achievement levels in English in June examinations. The study was cross-sectional, with each of the four groups comprising learners who were good achievers, average achievers and under achievers in English second language.

A unique methodological and data collection design was undertaken in such a way that each of the participants responded to word problems set in both English and isiXhosa. Two questions were administered to all learners (one in each of the two languages). The two questions were written in two sessions. If a learner responded in English during the first session, s/he will respond in isiXhosa during the second session and *vice versa*. There was a 5-minute break in between the sessions.

Data was analysed both quantitatively and qualitatively. The broad focus of the analyses was on learners' quality of interpretation of the given word problems and the choice of computational methods they employed when they responded to the word problems. Three categories were investigated under each of the focus areas. Categories investigated under the quality of interpretation were:

- ❑ Totally false interpretation
- ❑ Partially correct interpretation and
- ❑ Totally correct interpretation

Categories investigated under the choice of computational methods were:

- Standard methods
- Non-standard methods
- Unidentifiable methods

The evidence gathered suggested that isiXhosa-speaking learners interpret word problems better when they are set in isiXhosa rather than English. Another important finding was that isiXhosa-speaking learners prefer to use standard methods when they respond to word problems set in English and also prefer to use non-standard methods when they respond to word problems set in siXhosa.

OPSOMMING

Volgens Prins (1995) beïnvloed leesbaarheidfaktore in Wiskundetekste nie net die verstaan van vrae nie, maar het dit ook 'n merkbare invloed op leerders se prestasievlakke. Ter uitbreiding op Prins (*op cit*) het hierdie studie gepoog om ondersoek in te stel of daar enige verskille in die kwaliteit van interpretasie en keuse van algo-heuristiese metodes is wanneer isiXhosasprekende leerders op wiskundige woordprobleme reageer wat in Engels en isiXhosa gestel is.

Die studie is binne 'n etnografiese raamwerk geplaas. Al 109 deelnemers het isiXhosa as eerste taal gepraat. Die deelnemers was in Graad 8 (44), Graad 9 (29) en Graad 10 (36) en het Wiskunde as een van hul skoolvakke geneem. Leerders is in vier groepe verdeel, en die indeling is op prestasievlakke in Engels in die Junie-eksamen gebaseer. In hierdie deursneestudie het elk van die vier groepe uit leerders bestaan wat goeie presteerders, gemiddelde presteerders en onderpresteerders in Engels tweede taal was.

'n Unieke metodologiese en data-insamelingsontwerp is op so 'n wyse toegepas dat elkeen van die deelnemers op woordprobleme gereageer het wat in beide Engels en isiXhosa gestel is. Twee vrae is aan elke leerder gestel, een in elk van die twee tale. Die twee vrae is in twee sessies beantwoord. As 'n leerder tydens die eerste sessie in Engels reageer het, sou sy/hy tydens die tweede sessie in isiXhosa beantwoord, en omgekeerd. Daar was 'n pouse van vyf minute tussen die sessies.

Data is beide kwantitatief en kwalitatief ontleed. Die breë fokus van die analises was op die kwaliteit van die leerders se interpretasie van die woordprobleme en die keuse van bewerkingsmetodes wat hulle aangewend het wanneer hulle op die woordprobleme reageer het. Drie kategorieë is in elk van die fokusareas ondersoek.

Die kategorieë wat onder die kwaliteit van interpretasie ondersoek is, was:
- 'n Algeheel verkeerde interpretasie
- 'n Gedeeltelik korrekte interpretasie en
- 'n Algeheel korrekte interpretasie

Kategorieë wat onder die keuse van bewerkingsmetodes ondersoek is, was:

- Standaardmetodes
- Nie-standaardmetodes en
- Onidentifiseerbare metodes

Die gegewens wat ingewin is, het daarop gedui dat isiXhosasprekende leerders woordprobleme beter interpreteer wanneer die probleme in isiXhosa eerder as in Engels gestel is. 'n Ander belangrike bevinding was dat isiXhosasprekende leerders verkies om standaardmetodes aan te wend wanneer hulle op woordprobleme wat in Engels gestel is, reageer, en dat hulle ook verkies om nie-standaardmetodes te gebruik wanneer hulle op woordprobleme reageer wat in isiXhosa gestel is.

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LIST OF ACRONYMS

DET   Department of Education and Training

MOI   Medium of Instruction

L1   Primary Language/First Language

L2   Second Language

LAC   Language Across the Curriculum

S.A.   South Africa

UNESCO United Nations Educational, Scientific and Cultural Organisation

NESB   Non-English Speaking Background

ESL   English Second Language

NDE   National Department of Education

SGB   School Governing Body

GETC   General Education and Training Certificate

OBE   Outcome Based Education

CHAPTER 1 - INTRODUCTION AND LITERATURE SURVEY

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1.1 Rationale and overview

The purpose of this case study is to produce some information and understanding of the possible effects of the language in which word problems are given on learners' interpretation of the word problems and the way in which they try to solve the problems. The research comprises an empirical investigation with four cohorts of learners in grades 8, 9 and 10. All learners were from the same school in the Western Cape and spoke isiXhosa as a primary language. Questions were administered to all learners in English and isiXhosa and then their responses were coded and compared.

This study is conducted against the backdrop of a major curriculum shake-up manifested in the form of Curriculum 2005 and the New Curriculum Statement or "streamlined curriculum" aimed at overhauling the South African education system within the philosophical framework of outcomes-based-education (OBE). Intricately interwoven with the new curriculum initiatives are new forms of assessment aimed at encouraging "…flexible thinking and independent learning" (Department of Education; 1997). However, the majority of South African learners are taught and asked questions (verbal or written) in a language whose idiom they do not fully understand, hence language issues are pertinent to the success of such curriculum initiatives. In addition to issues related to MOI is the core issue of integration of the curriculum to life experiences. Such integration can at best be carried through description of contexts (in class). However, if the language in which contexts are articulated is poorly understood, little can be achieved in respect of the said integration.

Specific to the study, the new South African curriculum prioritises integration between different learning areas. In the learning of Mathematics, this emphasis on integration (amongst other implications) elevates the role of "word problems" which require learners to respond mathematically to situations relating to other learning areas. In word problems, situations to which learners have to respond to mathematically are described in ordinary language.

1.2 The focus of the study

Whilst much of the current literature on learning Mathematics in a second language focuses on pedagogy and assessment, the study reported here is narrowly focussed on the nature and extent of possible difficulties that are caused to isiXhosa-speaking learners, when they respond to word problems that are given in English. The present study thus comprises an empirical case study into isiXhosa-speaking learners' responses to word problems given in English and isiXhosa.

Nevertheless, a brief overview of some of the current literature and reported research on learning and assessment of Mathematics in a second language (L2) is given below. A brief look will also be taken on some of the governmental policies related to assessing learners in a second language.

1.3 Origin and background of the study

Of the several studies performed to demonstrate the interconnectedness of language and learning, there has always been lack of clarity as to whether errors committed by second-language learners are indeed language based or are as a result of learners simply being incapable of demonstrating knowledge. There is ample anecdotal evidence that points to the fact that learners whose primary language (L1) is not the language of learning are at a severe disadvantage in the classroom (Clarkson, 1991; Carrasquillo and Rodrigues, 1996). In addition, the shift from the ordinary manipulation of numbers to the important area of problem solving has inevitably caused an increase in the amount of ordinary language in mathematics text (Prins; 1995)

In South Africa (SA), as is elsewhere, the language issue at schools has always been shifted from the academic battlefield into the political battlefield. In addition to the fact that the Minister of Education has always been a politician, there are other reasons for this state of affairs. In the case of South Africa in particular, language in education has

been used as a political tool dating back to the Verwoerdian era[1], during whose term of office, the Bantu Education Act was passed. One of the successful outcomes of Bantu Education was to instill a sense amongst South Africans that African languages can never be fully used as media for learning, particularly in the secondary and tertiary phases of schooling. In addition, L1 learning using African languages has come to be associated with inferior education under Bantu Education (National Education Policy Iinvestigation "NEPI", 1992:13). As a result, parents have come to view English as a gateway to better education.

Fewer studies performed (since Piaget and Vygotsky) reveal the interrelationship between language on the one hand and learner mental output and schemes of thought[2] on the other. In "Thought and Language", Vygotsky elucidates that:

> *It may be appropriate to view word meaning not only as a unity of thinking and speech, but as a unity of generalization and social interaction, a unity of thinking and communication. This… has tremendous significance for all issues related to the genesis of thinking and speech… and reveals the true potential for a causal-generic analysis of thinking and speech. Only when we learn to see the unity of generalisation and social interaction do we begin to understand the actual connection that exists between the child's cognitive and social development.*
> (p.49)

(It may be helpful to note that in this quote Vygotsky was referring to the link between language and thought in children of pre-school age).

The Human Sciences Research Council (HSRC)[3] commissioned a report in response to

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[1] Hendrick Verwoerd was a South African statesman and regarded as the chief architect of the apartheid system.
[2] Taken from Piaget. It refers to mental patterns of behaviour.
[3] The HSRC is a statutory independent body whose main function is to perform research and provide information on education in South Africa. The report referred to above is about the performance of South African learners in Science and Mathematics literacy compared with their peers internationally

the Third International Mathematics and Science survey (TIMMS)[4]. In the TIMMS survey, a number of learners across countries, including S.A., were given a Mathematics test based on high school concepts. A different test was administered for learners in the junior secondary phase and the senior secondary phase of school. For many of the countries that participated, learners answered the questions in their L1. However, to many of the South African learners who participated, the questions were in a L2. The results of the TIMMS test revealed that the South African group fared poorly in the test compared to learners from other countries, including developing countries[5]. One probable explanation for the poor performance of the South African learners in the TIMMS survey could be traced to poor literacy in the language in which the test instrument was administered, namely English. 72% of the South African group that participated in the TIMMS survey were not native speakers of English.

1.4 Relationship between readability of Mathematics problems and achievement

Prins(1995) , researched what the probable effect of language was on Grade 12 learners' understanding of mathematics questions. Of her subjects, one group was L1 English speakers, the second group was L1 Afrikaans speakers and the third group spoke one of several African languages as a L1. The test instrument was in English. All learners in Prins' sample were above average achievers. The framework developed to analyse protocols comprised:

- ❑ unfamiliar vocabulary
- ❑ structural problems
- ❑ obscure information
- ❑ visualisation difficulties

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[4] TIMMS is an international body that surveys the achievement of learners in Mathematics and Science cross-nationally. In this case South African learners in grades 7, 8 and 12 were tested and the results compared with that of their peers in 21 other countries.
[5] Previously referred to as Third World countries, these are countries whose economies are underdeveloped.

❑ non-verbal factors

In that study, the hypothesis that learners whose MOI is not L1 are disadvantaged during assessment by language was confirmed. In addition, the study revealed that the proximity of one's L1 to MOI plays an important role in academic achievement. In that respect, the Afrikaans group whose language is closer to English fared better compared to learners who speak African languages as L1. In another development of the study, subjects were asked to adapt the questions in order to improve their readability. Learner adaptations of the questions included lexical, syntactical, discourse and non-verbal factors. It was also found after this exercise that once readability was improved, learners taking English L2 could do better like the English L1 group. A significant outcome of that study was that readability factors do not only influence the comprehension of mathematics examination questions, but also have a marked influence on learner achievement levels. In addition, it was found that in all three language groups, the same level of competency was demonstrated on the non-verbal items of the test.

1.5 Language, inter-problem and intra-problem

Adetula (1990) proposes that the language of learning operates at two levels, i.e. the inter-problem and the intra-problem. The inter-problem concerns problems confronting a child who cannot grasp the full meaning of word problems because the language of presentations of these problems is foreign. During the inter-problem, the learner's performance is directly influenced by the language of learning, particularly if learning takes place in L2. He further states that "…the teaching-learning process is hampered if given in a foreign language because children are forced to learn an increased number of new words in order to be able to think and express themselves entirely in the foreign language for mathematical purposes."

The intra-problem relates more not only to the language of learning, but also to the

language of the problem. More often than not, the wording of a problem can have a keyword with a misleading meaning. This has the propensity of altering the context of the problem. Intra-problem thus affects both L1 and L2 speakers.

In relation to the inter-problem, Adetula devised a model of how language may operate in the classroom context.
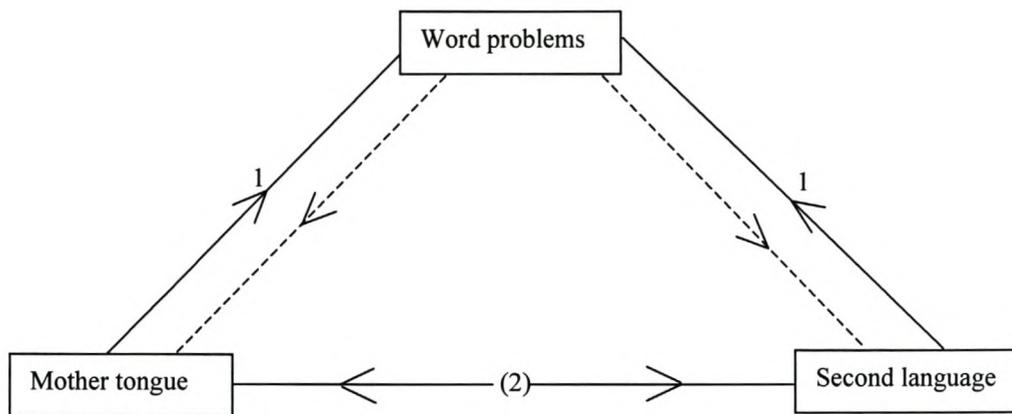
(Adetula; 1990)

1 – representation of the problem

2 – translation

Figure 1.1: How language may operate in the classroom context

The model substantiates that if word problems are in L2, learners have to endure multiple translations that may lead to a loss of meaning. This may also lead to L2 learners taking longer to answer questions.

1.6 Heuristic processes in problem solving

Polya (in Prins, 1995) identifies a conception of problem-solving behaviour as a heuristic process consisting of the following phases; namely

- Understanding the problem
- Devising a plan
- Carrying out the plan and
- Looking back

To be able to understand the problem, a learner needs to have sufficient linguistic skills. Following Polya's heuristic process, learners who fail to understand the problem will never be able to devise nor carry out a plan . Prins (*op cit*) takes the point forward by suggesting that to be able to devise a plan, one has to clearly see what is required and how the various items are connected. Questions like the following need to be asked:

- What is the known?
- What are the data?
-What is the condition?

If one does not understand the problem correctly, all the above questions will be answered incorrectly.

Schoenfield (in Prins, 1995) also identifies what he calls a series of "episodes" in problem-solving moves: viz - Reading

- Analysis
- Exploration
- Planning /implementation
- Verification

As identified in Schoenfield, reading embraces an element of understanding. To be able to correctly analyse and explore questions, learners have to have a good understanding of the particular word problem. In addition, verification (like 'looking back' in Polya cited above) involves aspects of metacognition. It is difficult for a person to think about his/her thinking unless the thinking is done in a language they understand best. In metacognition, a person has to thoroughly interrogate his/her thinking.

Schoenfield's "episodes" are corroborated in Newman's hypothesis (in Adetula, *op cit*). Newman proposes that when a person is confronted with a verbal problem, s/he has to read it, comprehend what s/he has read, carry out the transformation from the words, select an appropriate mathematical model and finally apply the necessary process skills and encode the answer. From Newman's model, it becomes imperative for one to have good understanding of the language of the question before the process of encoding can take place. If the language is misinterpreted, the problem will also be wrongly encoded.

1.7 Role of keywords (clues) in understanding word problems posed in L2

One other problem faced by second language learners when they solve mathematics word problems is that they cannot determine which words in the question serve as clues and leads towards the answer. Clarkson (1991) noted that when ESL learners were given a mathematical word problem in English, they ignored information that made no sense to them. They simply picked up what they deemed the essential bits of the problem and worked with them. More often than not, what seemed the "essential bits" to learners are the words that they can connect or relate to. In this way, valuable leads and clues are ignored, making it difficult for them to come to the correct conclusion.

In another study by Fung Lin Ng Li (1990), it was noted that superfluous information creates greater cognitive demand on children to selectively attend to and remember the relevant information. He also suggests that when children are presented with a mathematics problem, they fail to distinguish the superfluous sets from the relevant sets. What they do is to manipulate the numbers according to verbal cues in the content. In order for learners to be able to solve Mathematics problems, he argues, they should be able to isolate the essential numerical information in story(word) problems. The conclusion reached by Fung Lin was that problems which were without superfluous information were more accurately answered by L2 learners than problems with such information.

In a similar study performed by MacGregor (1991) the following conclusion was reached:

> *When reading, L2 learners take longer to recognise words that they know, especially when the words are part of a specialised vocabulary. They do not have access to a wide range of semantic associations that are automatically triggered for the native speaker who sees a familiar word or phrase in text. In addition, they do not have the knowledge of language that enables the native speaker to predict meanings and construct interpretations as reading progresses. This factors lead to slow comprehension and the possibility of misunderstanding. Many NESB[7] students need more time than native speakers for reading mathematical text. (p8)*

Research by Adetula (*op cit*) also highlighted the critical role played by "keywords" in mathematical texts. Primary language readers do not usually go through the whole text in order to understand its meaning. Adetula noted that when ESL children solved problems presented in English, they seldom took cognisance of the wording of the problem. To the contrary, they invoke what he terms "the keyword formula" as a weapon of problem attack. Invoking the keyword formula presupposes an understanding of semantic

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[7] Non-English Speaking Background

associations of phrases in a text. Second language learners do not have the necessary linguistic capacity to realise this.

1.8 Linguistics and Mathematics education

In 1974, UNESCO commissioned a symposium carrying the theme, "Interactions between Linguistics and Mathematical Education". The main object of the symposium was to establish the causal-link between second language pedagogy and assessment on learners' performance in Mathematics and how to improve the performance of learners learning Mathematics in a second language. After much deliberation, the symposium came to the conclusion that language did impede learners' understanding of mathematical concepts. On the relationship between Mathematics and language, it stated that:

> *Difficulties in the learning of Mathematics thus depend on the language of*
> *learning, because different languages "support" mathematical concept*
> *formation, precision and systematization in different ways. Also, the socio-*
> *cultural context inherent in any natural language relates to Mathematics in*
> *varying forms. It should however be emphasized that all languages include*
> *linguistic features of benefit for the acquisition of mathematical concepts. Such*
> *features should clearly be exploited in Mathematics education. (p8)*

1.9 The Mathematics register

One of the other findings of the UNESCO symposium mentioned above was that what learners usually fail to come to terms with in the classroom was the mathematics register. Most of the concepts used in mathematics are derived, in particular, from the Greek-German terminology. For a learner to whom L1 is not a cognate language to these languages, mathematical language becomes Greek. The core of the difficulty in the Mathematics classroom is that the teacher often takes for granted the whole register of

Mathematics and thinks only of the mathematical aspect of these items. The Mathematics teacher should thus be aware of the register as a subset of English and should thus assist the language-based difficulties faced by the learner to whom English is foreign language (UNESCO, 1974).

1.10 The effect of the distance between MOI and L1

The effect of the distance between English and primary languages is felt more by learners who speak African languages as L1 than learners who speak Afrikaans as L1.This is so because English is cognate to Afrikaans and non-cognate to the African languages. It is documented that the further away from learners' L1 English is, the more difficult it becomes to make meaningful connections from L2 to L1. In addition, L2 learners are disadvantaged because the readability of materials in a L2 becomes obfuscated. Ellerton and Clements (1989) noted that the learning task is considerably increased for the student who must first learn English as a L2 as a basis of learning Mathematics. This becomes even more difficult if the L1' semantic structure, vocals and its fundamental worldview is completely different from English.

Berry (1985) also studied the issue of cognate languages. He suggested that learners whose L1 was semantically and culturally close to their L2, will find it easier to learn mathematics than those learners to whom the gap was wider. If the gap between learners' L1 and L2 is wider, learners find it difficult to establish a common frame of reference for making judgements.

In Prins (1995), it was established that when questions were set in English, learners to whom Afrikaans was L1 performed better than those who spoke African languages because of the proximity of Afrikaans to English. This seems to confirm Berry's (*op cit*) assertions that learners whose language is semantically closer to the MOI will perform better in word problems than those whose language is further away from MOI

semantically.

In a study by Harris (1989), it was observed that the challenge is always great for an ESL whose L1 is remote from English. This is partly so due to the differences in the semantic structure, vocabulary and also in the fundamental worldview. "There is a major difference in mental preparation for Mathematics learning between a learner whose language makes use of the international Greek-Roman terminology, its prefixes and roots, and a learner whose language contains neither these items nor any translation equivalent of them" (Harris, 1989: 86).

Jones (1982) researched the effect of the distance between MOI and L1 language. The conclusion he reached was that if a child's L1 is linguistically remote from English, there might be no directly equivalent terms in the child's language that can be referred to for clarification of meaning. It was also found that the majority of children learning Mathematics in a L2 grow up in an environment that does not support the development of the L2 even at the everyday conversation level. All these factors are not conducive to the rapid and early acquisition of key relational terms in Mathematics.

1.11 Additive biligualism

In the South African education system, curricula intended for African children in particular, uses a system of additive bilingualism[6]. In this system, the initial learning takes place in L1 and subsequently English is introduced as MOI. Notwithstanding the merits of this system, by the time English is introduced as MOI, learners are not sufficiently proficient to apply it as a language of learning. Eventually what is assessed in the classroom is not how knowledgeable a learner is, but how well they understand English. In Secada, Fennema and Adajian (1995), it is noted that when new meanings are

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[6] System of education where learners initially learn all subjects in their L1 with MOI being gradually introduced later.

developed, the language that the child comprehends best should be the one used. It is further argued that the use of L1 in instruction provides the support needed while the student continues to develop proficiency in the L2, specifically as it is used academically in classrooms and textbooks.

1.12 Rote learning and L2 assessment

The use of English as MOI to L2 speakers also carries with it some negative spin-offs. In response to language-based learning difficulties, learners devise strategies in order to cope with the academic workload. One of the strategies employed is that of rote learning. Durkin and Shire (1991) noted that as Mathematics tasks become more complex through language, this leads to an increase in the symbolic load. In such cases, learners tend to rely on memory skills. However, in problem-solving situations, memory skills become insufficient. It was also discovered that the more successful learners in the higher grades were those who were able to utilise their language abilities.

Gudschinsky (1977) also explored the phenomenon of rote learning amongst L2 learners in his study. He observed that L2 learners manipulate word tokens without meaning because of lack of understanding of the problem situation. Though not a bad exercise *per se,* rote learning in L2 learning situations is used to substitute real meaningful learning. If a problem situation is defined in words different from the one a learner has memorised, it becomes difficult for them to recognise the similarity with the problem they have memorised.

1.13 Language of assessment tasks versus thought and culture of testees

One aspect of language, which cannot be separated from all natural languages, is the construct of culture. Culture plays a pivotal role in shaping a person's paradigm of thinking as different cultures possess different worldviews. Adetula (*op cit*) noted that

"…language is a manifestation of culture, a wealth of cognitive instruments at the service of thought, a critical instrument for the individual to regulate his own cognitive functions and above all, a coherent set of deep meanings for mathematical word problems".

Prins (*op cit*) also recognises the important relationship between culture, language and learning. She states that the language of a people reflects their culture and that since cultures are different, different cultures would necessarily use language in different ways. Different cultures thus experience the world in different ways and therefore not all cultures share the same concepts.

Kaplan (1980) performed studies which linked cultural thought patterns to language. He experienced that L2 students who were brought to the level of proficiency necessary for the writing of text, wrote texts that differed in important ways from the texts written by native speakers of English. The difference was not only in the level of discrete sentences, but on the rhetoric level as well i.e. at the level of organisation of the whole text. He further states that schemata are not only reticulated sets of ideas, but prefabricated sets of discourse structures specific to a language as well. His discourse structures were identified as follows:

(a) <u>English</u>   (b) <u>Semitic</u>

(c) <u>Oriental</u>

(d) <u>Romance</u>   (e) <u>Russian</u>
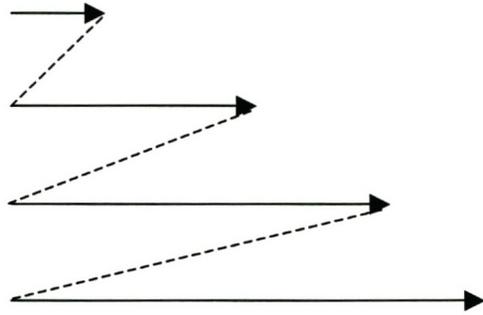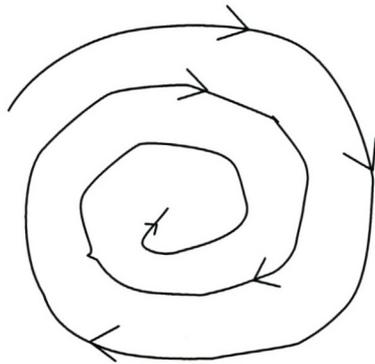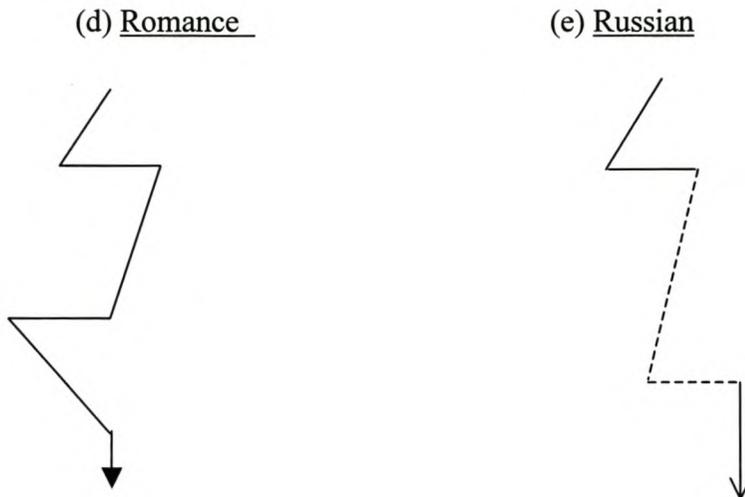
(Kaplan; 1980)

Figure 1.3: Discourse structures from Kaplan (1980)

These structures were explained as follows:

(a) Linear constructions (English), sequence of thought is direct.

(b) Parallel constructions (Semitic), with the first idea completed in the second part.

(c) Circularity with the topic looked at from different angles- a more indirect approach. (Oriental)

(d) Freedom to digress and introduce "extraneous" information. (Romance)

(e) Similar to (d), but with different lengths and parenthical amplifications of subordinate elements. (Russian)

In support of Kaplan, Whorf (1956), devised what he termed the '*linguistic relativity hypothesis*". In this hypothesis, he contends that language influences cognitive processes in a variety of ways. He notes that the view one holds of the world depend on the concepts by which one categorises her/his experiences. Speakers of different languages

code their experiences into different categories and their thought patterns are therefore different. The concepts one builds are always channeled through one's L1.

Lanham (1980) asserts that the relationship between language, thought and culture is much more complex and that the variables are interdependent and interactive in terms of mental function. In a further proposal, he came up with a model (figure 1.4) to show the interrelationship between language, thought and culture.

Language(semantic systems underlying the lexicon and the formal systems of the grammar)

Culture
(pattern of behaviour and what they mean)

Thought
(cognition and cognitive processes)

(Lanham: 1980; 9)
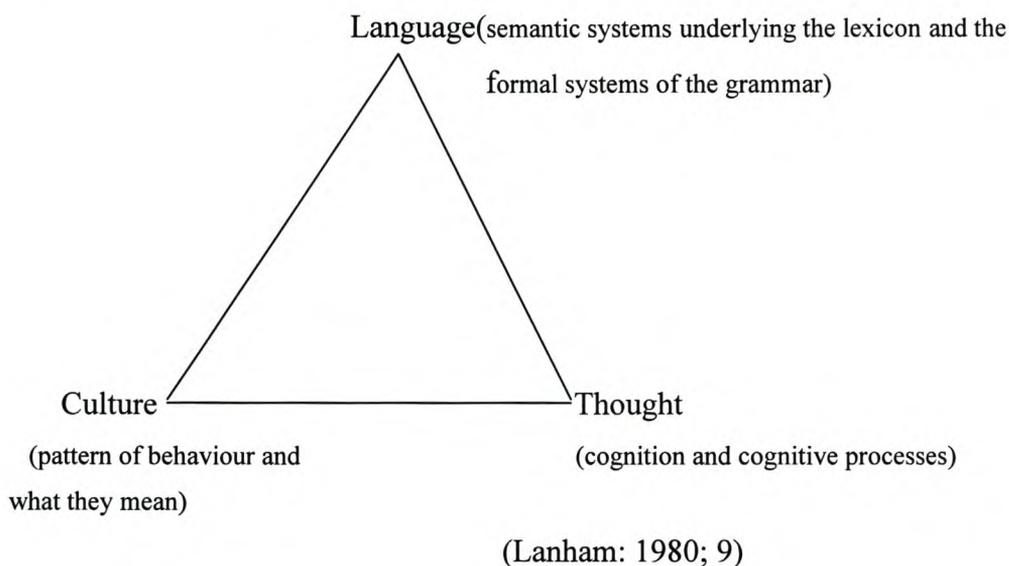
Figure 1.4: The interrelationship between language, culture and thought

Lanham propositioned that deep-seated differences exists between cultures in the manner in which they interpret, think and manipulate the world of their experience. He further argued that cultural differences in cognition reside more in the situation in which cognitive processes are applied, rather than in the existence of a particular process specific to a particular group.

1.14 Language policy and assessment in the National Department of Education (NDE)

In the South African education system, the matriculation examination has always served as a reliable barometer for the success of the system. Intrinsically intertwined with the matriculation results is the poor performance of learners who are taught and assessed through the medium of L2. This assertion is backed by the results of the various provinces when compared with each other. In eight of the nine Provinces, the overwhelming majority of learners are taught and assessed in L2. The only exception is the Western Cape where the majority of learners use L1 as MOI). The NDE has noted that "… in the Western Cape where 80% of pupils learn in their home language from grades 0 to 12 and write their final exams (*sic*) in their languages (i.e. English and Afrikaans)[8] the matric (sic) pass rate has been best of all nine provinces since 1996" (Sunday Times 22/07/2001).

In a response to the high failure rate in ex-DET schools where pupils learn through L2, the NDE is devising plans to bring those learners at par with learners who study in L1. One of the actions taken by the Department is to factor in 5% to the final marks of all pupils writing their matriculation examination in L2 or L3. In this way, the NDE tacitly agrees that L2 learners are disadvantaged in the classroom.

One other intervention strategy under discussion is that the matriculation examination should be made available in all official languages in all content subjects. There is no doubt about the *bona fides* of this suggestion. This suggestion carries a lot of implications for pedagogy in S.A. since the introduction of Bantu Education.

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[8] Emphasis mine

1.15 Organisation of the remainder of the study

In **chapter 2**, the experimental design of the study will be discussed. This will include aspects of data collection, methodology and the type of instruments used in collecting data. Also included in chapter 2 is the framework for analysing the results. Under the framework for analysing results, preliminary protocols will be used to explain concepts and terms to be applied in chapter 3 and 4.

Chapter 3 will comprise the qualitative analysis of the study. In the qualitative analysis, protocols will be used to compare learners' computational methods and quality of interpretation when they respond to word problems set in English and isiXhosa.

In **chapter 4**, a quantitative analysis of the study will be made. In the quantitative analysis, like the qualitative analysis, learners' responses will be compared in relation to the computational methods and quality of interpretation when they respond to word problems set in English and isiXhosa. However, unlike in chapter 3, the emphasis in chapter 4 will be on the numbers of learners responding in a particular language that could be classified under the categories under investigation.

The results of the study will be discussed in **Chapter 5**. The discussion will focus on the major undertakings of the study, i.e. are there any differences in the quality of interpretation and choice of computational methods when isiXhosa-speaking learners respond to word problems set in English and isXhosa.

Chapter 6 will provide a review of the study, its implications for assessment and conclusions.

CHAPTER 2 - DATA COLLECTION AND METHODOLOGY

2.1 Introduction

Data was collected in such a way as to find out whether there are any differences in the way learners respond to mathematical word problems when the word problems are presented in a primary language[9] and when they are presented in a second language. Studies performed elsewhere indicate that when learners' progress in class is evaluated in a language that they don't understand very well, they tend to perform very poorly. However, what most of those studies did not validate was whether failure on the part of learners in mathematical tasks was a result of deficiency in mastery of the language of learning or simply that learners could not demonstrate mathematical knowledge (NEPI; 1992). This study seeks to advance on previous similar studies and also make an attempt to control the variables that may have undue influence on its outcome like the one mentioned above.

In this study, four groups of learners in three different grades were isolated to form the sample. To each group, two sets of questions were administered. The two sets of questions were in two language versions, isiXhosa and English. The questions were administered in two sessions. Two groups wrote the isiXhosa question during the first session and the English question in the second session whilst the remaining two started with the English version in the first session and isiXhosa in the second session. For each of the groups writing in the same language, the questions were different i.e. if group 1 was answering question A group 2 would be answering question B but in the same language. Taking account of the language factor, no group wrote a question similar to that of the other group. The whole procedure for administering the instrument and other methodological considerations are explained later in the chapter.

The original questions in the instrument were in English and were translated into isiXhosa. Due to the problem that the meaning of words is usually lost during

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[9] Also erroneously called a mother tongue, this is the language that a learner uses most of the time for communication. A learner will be expected to be competent in a primary language.

translations, the questions were back-translated into English in order to track the original meaning. This was done with the assistance of four language teachers.

The study was done at a school where the author is also a teacher. This in itself was an advantage because of possible consequences of the Hawthorne effect[10] if author is a stranger to subjects. Learners were informed about the test in time and were also reminded a day before of the test.

2.2 Jurisdiction of the Study

The study was done in a township[11] school in the Western Cape, one of the nine provinces of the Republic of South Africa. The school has an enrollment of ±1400 learners and a staff complement of 40 educators. The school experiences bigger classes because the 1400 learners have to be accommodated in 27 classrooms, leaving 13 educators free at any given tuition time. From school statistics, the catchment area of the school has been shown to be, at any given moment, ±80% of surrounding informal settlements and hostels previously designated as same-gender residential areas, though at the moment used extensively as family units.

Though highly urbanised compared to the other provinces, there are however, sharp distinctions in the living conditions of the different population groups[12] in this province. The well structured railway network system has ensured that movement across the different residential areas designed for different population groups is made difficult. Even amongst the working class groups across the population divide, the "coloured labour preference regulations"[13] under the previous dispensation have always ensured that

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[10] People's natural reaction to something new
[11] An urban settlement planned for Africans
[12] Author concedes that the concept of population group is a social construct and therefore does not in any way, by referring to it, give credence to its existence.
[13] Law in the statues of the previous South African government giving preference to people classified as Coloureds when it came to job allocation.

Coloured[14] workers are better off than their African counterparts. In this way, the socio-political divide made it difficult for one group to establish social contact and learn the language of other groups.

The school at which the study was performed is one of the schools formerly classified as DET[15] schools. Though schools have been completely desegregated, under the present system of education, the school still caters for African learners. The official medium of instruction at the school is English. However, due to poor training teachers receive during training and the fact that learners have difficulties understanding English, most of classroom instruction takes place in learners primary language. Some of the teachers use a mixture of code-mixing and code-switching, particularly in the senior classes.

2.3 Profile of the subjects

Subjects in this study were all isiXhosa primary language speakers. The study was longitudinal cross-sectional, inclusive of samples from grades 8, 9 and 10. Only one class from each the selected grades was randomly selected. All classes selected took Mathematics as one of their subjects. From each of the three grades, four groups of learners were identified. The groups were assembled in a stratified random fashion using their English marks from June examinations. Learners' marks included continuous assessment portfolios, giving credibility to the assumption made about learners' command of English at that stage. Details of how learners were divided into groups are given under "Research Design" below.

The majority of learners in the sample originate from rural Eastern Cape and came to the Western Cape in search for better opportunities or because their parents are migrant labourers who still maintain contact with their rural villages during vacations. To all

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[14] Author does not necessarily agree with this constructs
[15] These were the schools in the old dispensation which were reserved for African learners.

intents and purposes, the learners have no sustained contact with English outside the classroom except on electronic media and very rarely on print media. Thus to them English is more or less a foreign language. In addition, their educators teach extensively in L1 (unofficially so) at school which in itself ensures that the distance between their L1 and MOI is maintained.

2.4 Rationale for the Research Design

A simplistic experimental design to study the effect of learners' interpretation of mathematical word problems would have been to split learners into two groups i.e. give an English version of a word problem to one group, and a isiXhosa version of the same word problem to another group of learners. However, such a design would be problematic for various reasons, including the following:

❑ The two sets of responses in such a design would not necessarily be directly comparable because other parameters, some of which are mentioned below, may have undue influence on their responses.

❑ The inherent difficulty of knowing to what extent two groups of learners are truly comparable in a small scale investigation like this.

❑ The problem of knowing to what extent English and isiXhosa versions of the same word problem may embody differences that are not linguistic in nature. In translating from one language to another, meanings may be changed in subtle ways.

❑ The novelty of being tested in isiXhosa, and hence a possible Hawthorne effect.

❑ It would most likely tell us that one group of learners performed better. It would however, not reveal the extent of the impact of language on the disparity in performance.

In an effort to mitigate and control the non-linguistic parameters suggested above, a more involved experimental design was utilised. The whole procedure of grouping and testing learners is described below in the research design.

2.5 Research Design

A two-stepped procedure was used to isolate the four groups from each of the selected grades to constitute the final sample.

The first step involved splitting learners into four groups. The grouping was based on learners' English marks obtained in the June examinations. The groups were obtained as follows.

1. Top group- the top group in the class (70% - 100%)
2. Second best group – the second best group in performance (50% - 69%)
3. Third best group – the third best group (35 – 49%)
4. Last group – the last group (less than 35%)

The second step involved splitting each of the four groups obtained above into further four groups so that in all sixteen groups were created (i.e. the first group was split into four groups, the second group was split into four and so were the third and fourth groups). The sixteen groups were then intermingled so that in the final sample each group was a cross-sectional representation of all the groups in the performance categories mentioned above. Thus each of the final groups in the sample was made up of top, middle, average and below average achievers. Table 2.1 below shows how each of the four groups were obtained.

Table 2.1:How learners were placed into each of the four groups

	Group 1	Group 2	Group 3	Group 4
Top group	25 %	25 %	25 %	25 %
Second best group	25 %	25 %	25 %	25 %
Third best group	25 %	25 %	25 %	25 %
Last group	25 %	25 %	25 %	25 %

2.6 The Research Instrument

The instrument comprised two questions, each with subsections, (a) and (b) as shown below. The questions shown are as in the order administered to Group 1. The isiXhosa translation of question 1 is given in appendix 1 and the English translation for question 2 is shown in appendix B.

Group 1, session 1

Question1

Henry wants to buy himself a bicycle. The bicycle that he wants costs R760. He already has R320. Now he starts saving R8 each week from the money he earns by working in a café on Saturdays.

(a) How much money will he have in total, 12 weeks after he started saving ?

(b) For how many weeks in total does he have to save before he will have the R760 that he needs ?

Question 2 for this group was offered in isiXhosa. The English version is as for Group 2, session 1 (Appendix A)

Group 1, Session 2

Question 2

Umakhi othile wacelwa ukuba agqibezele udonga olwalungagqitywanga. Olu donga lungagqitywanga lwalusele lusebenzise izitena ezingama- 3000. Lo makhi wacelwa ukuba asebenzise izitena ezingama-350 ngemini.

(a) Zingaphi zizonke izitene eziya kube selezisetyenziswe kule ndlu emva kweentsuku ezi-6, ukuba lo makhi usasebenzisa izitena ezingama-350 ngemini ?

(b) Kusemva kweentsuku e zingaphi apho le ndlu iya kube sele isebenzise ama-42000 ezitena ?

As shown above, both the questions were made available in isiXhosa and English. The test was divided into two sessions, each group writing question 1 during the first session and question 2 in the second session. There was a break of 5 minutes in between the sessions. Each session for each group was in a different language i.e. if session 1 was in isiXhosa, session 2 would be in English and *vice versa*. Table 2.2 below shows:

❑ The type of question written by a particular group
❑ The language in which the question was written
❑ The session in which a particular question was written.

Table 2.2: How groups were classified and the language in which they wrote each question

	Henry wants to buy himself a bicycle…	A bricklayer was asked to complete a building…
Group 1	Session 1 Language English	Session 2 Language isiXhosa
Group 2	Session 1 Language isiXhosa	Session 2 Language English
Group 3	Session 2 Language isiXhosa	Session 1 Language English
Group 4	Session 2 Language English	Session 1 Language isiXhosa

The two questions were developed to suit learners from an environmental-cultural point of view. Prins(*op cit*) noted that the socio-cultural background of learners plays an important role in meaning-making. The context and nature of both questions was fairly the same and would normally involve similar computational skills.

2.7 Procedure for administering the instrument

The instrument was administered during normal school hours. Each period at the school lasts for 45 minutes. The first question for each group was given during the first 15 minutes of the period. No extra time was allocated to learners. After the first 15 minutes, answer sheets were taken from learners and they were given a break of 5 minutes to allow everyone to settle. After the break the second question was administered. It also lasted for 15 minutes.

Learners were requested to write their answers on the spaces provided on the answer sheet. They were also asked to use the back of the page to provide answers if the space offered was insufficient. One important instruction was that all their workings and other scribbling be done on the answer sheet.

2.8 Framework for analysing results

Conventional methods used to determine learner understanding (and achievement) in Mathematics are based on whether learners produce right or wrong answers or follow predetermined algorithms when they are presented with questions. However, in this study, learners' understanding of questions was not based on whether they were able to produce "right" or "wrong" answers. To the contrary, their understanding was based on what they were able to do in their solutions, i.e. the type of algorithms they produced and the procedural methods they applied. Experience has proven that in responding to mathematical word problems, learners may consciously set up a model or do calculations with direct reference to elements of the given situation. It is in this context that learners were classified to have had a correct or false understanding of the questions.

The main framework for analysing the protocols was based on an unpublished previous study done by the author and a similar study done by Prins (1995). In the study performed by the author, the hypothesis was to establish whether there exists any

differential attainment between learners when answering mathematical word problems in English and when they answer the same questions in isiXhosa. Unlike in the present study, learners in the previous study were isolated into two groups, one group tested in English and the other group tested in isiXhosa. All questions were a direct translation of each other. In the study by Prins (*op cit*), three groups of learners were given questions. The three groups spoke English, Afrikaans and one of the African languages as L1. The results of this study showed that learners who spoke English L1 performed better compared to those who spoke English L2.

In the study by author, it emerged during the analysis of the protocols that the two groups of learners (isiXhosa and English) did not only achieve differently, but they also employed different strategies in answering the questions (examples are shown below). This is one aspect that is being investigated in the present study.

The study will therefore be set up in such a way that it compares the algorithmic methods and the way learners interpreted the given questions. The **qualitative** analysis will compare learner protocols as they attempted the problems. The **quantitative** analysis will compare the number of learners in each language group that could be classified in a particular category. Tables and figures will be used to achieve this end. A longitudinal comparison will also be done amongst the three grades.

Chapter 3 will look at the **qualitative analysis** of learners' responses.
Chapter 4 will look at the **quantitative analysis** of learners' responses.

2.9 Explanation of terms used in the qualitative and quantitative analyses

The qualitative and quantitative analyses will be benchmarked on:

1. the type of algorithmic methods employed by learners.
2. the way learners interpreted the questions.

Categories 1 and 2 above are fully explained in the following section in order to make the text in chapters 3 and 4 more accessible to the reader.

2.9.1 Type of algorithmic methods employed by learners.

From the previous unpublished study commissioned by author, it had emerged that learners who answered to isiXhosa questions applied different algorithmic methods compared to those who wrote the English version of the test. Further, the previous study provided support that learner strategies be grouped into the following three categories shown below. In order to demonstrate these categories, the following question that was asked in the present study will be used:

"A bricklayer was asked to complete a building that was unfinished. The unfinished building already had 3000 bricks laid on it. The bricklayer was asked to lay 350 bricks a day. How many bricks will the house have in total , 6 days after starting to build if the bricklayer continues to lay 350 bricks per day?".

2.9.1.1 Standard methods

This is the type of algorithm where learners used either the multiplication or division cross-product to arrive at the answer. This is the type of algorithm advocated by all textbooks that were surveyed. In answering the above question, **Bonga** used the following strategy:

3 5 0

x   6

2 100

Bonga' s strategy will be referred to as the standard method. This is because it does not deviate from the method used in all the textbooks. The method found in text-books advocates the following algorithm:

$$\frac{1}{350} = \frac{6}{x}$$

This method is comparable to the one employed by Bonga as shown above. The cross-product used by Bonga can also be expressed as: $1 \times x = 6 \times 350$.

Since 1 is identity element for multiplication, the cross-product can be transformed into:

$x = 6 \times 350$

This satisfies the definition of a standard algorithm as used in this context. Bonga's method was the most used standard method amongst learners who used the cross-product algorithmic method.

(In the next section on interpretation of questions, this will be classified as a partially correct answer)

In answering the same question, **Kuli** used the following method:

$350 \times 6 = 2100$

$2100 + 3000 = 5100$

This method was also classified as standard because it involved the cross-product.

(In the section on interpretation of questions, this will be classified as a fully correct answer)

2.9.1.2 Non-standard methods

The use of the term non-standard is almost a misnomer in this case. It refers to methods used by learners that were not advocated in all textbooks surveyed though algebraically accurate. In addition, methods classified as non-standard were the uneconomic types where learners repeatedly added numbers to arrive at an answer. The one most prominent method was based on repeated additions, where learners added the same number several times until they arrived at the answer. In response to the problem mentioned in 2.9.1 above, **Veliswa** applied the repeated addition method in the following way:

$$
\begin{array}{r}
3\ 5\ 0 \\
+\ 3\ 5\ 0 \\
\hline
=\ 7\ 0\ 0 \\
+\ 3\ 5\ 0 \\
\hline
=\ 1\ 0\ 5\ 0 \\
+\ \ \ 3\ 5\ 0 \\
\hline
=\ 1\ 4\ 0\ 0 \\
+\ \ \ 3\ 5\ 0 \\
\hline
=\ 1\ 7\ 5\ 0 \\
+\ \ \ 3\ 5\ 0 \\
\hline
=\ 2\ 1\ 0\ 0
\end{array}
$$

$2100 + 3000 = 5100$

Veliswa's computational method would be classified as non-standard. Though capable of producing correct answers for problems of this magnitude, it would probably prove inadequate for more cumbersome sums.

(In the next section on interpretation, this would be classified as a fully correct answer)

Bulelwa used a slightly different non-standard method to the one used by Veliswa:

35

$$350 + 350 + 350 = 1050$$
$$350 + 350 + 350 = \underline{1050}$$
$$2100$$

Bulelwa's method also hinges on the repeated addition strategy though a bit economic compared to the one used by Veliswa.

Unlike in the standard method where learners by and large used the same approach, a variety of approaches were employed in the non-standard methods. Some of the approaches used were:

700.......2 days
<u>700</u>.......2 days
1 400
<u>700</u>.......2 days
<u>2 100</u>.......6 days

Another method used in the same category by **Sindi** was:

350
350
<u>350</u>
1 050
<u>1 050</u>
<u>2 100</u>

2 100
<u>+3 000</u>
<u>5 100</u>

(This will be classified as a fully correct under interpretation answer in the next section).

Nontobeko used a step-wise method were she identified four stages in solving the problem.

(1) 350	(2) 350	(3) 350	(4) 700
<u>350</u>	<u>350</u>	<u>350</u>	700
700	700	700	<u>700</u>
			2 100

(This will be classified as a partially correct answer under the category interpretation)

2.9.1.3 Unidentifiable methods

Under this category of algebraic methods fell those algorithms which were haphazard, random and having no mathematical basis. Some of the responses in this category comprised answers only. All methods which befitted these descriptions were classified together under the code "unidentifiable methods". It is not in all instances that these methods produced faulty answers. Some of the answers without algorithms were indeed correct.

A typical example of unidentifiable methods is the one employed by **Fefe**. In response the question mentioned under 2.9.1 above, she used the following method:

9 8
<u>+ 3 2</u>
1 2 0
<u>5 4 8</u>
6 6 8
<u>1 0 0</u>
<u>7 6 8</u>

Though Fefe uses the addition operation, the numbers she uses are random and it might be thought she was responding to a different question. Fefe and others' methods that were of this haphazard nature, were referred to as unidentifiable methods.

(In the next section, this would be classified as false interpretation)

2.9.2 Interpretation of mathematical word problems

As indicated earlier, learners' responses were not marked on the basis of "right" or "wrong". They were however, judged on the way they interpreted the word problems and the algorithmic methods they used. For the sake of this study, the interpretation of the questions was divided into the following categories:

1. fully correct interpretation
2. partially correct interpretation
3. false interpretation

In order to give clarity to the three categories above, protocol responses to one of the questions asked is used. (For the sake of novelty, a different question to the one in 2.9.1 above will be used). The question used in the analysis read:

> " Henry wants to buy himself a bicycle. The bicycle he wants to buy costs R760. He already has R320. Now he starts saving R8 each week from the money he earns by working in a café on Saturdays. How much money will he have in total, 12 weeks after he started saving".

2.9.2.1 Fully correct interpretation

An interpretation was classified as being fully correct if there was evidence of an appropriate mechanism having been applied aimed at finding a solution. Each of the two questions given to learners comprised two statements which learners had to connect by

means of basic operations. In the question above, the first statement involved multiplying 8 by 12 and the last statement was about adding the product to the capital of R320. (The two questions administered were similar).

Thus for a learner's answer to be classified as fully correct, the inter-relationship between the elements of the given statements had to be reflected in their solutions.

One of the learners who provided a correct answer was **Nwabisa**. In answer to the question above, she set up the following algorithm:

R8 x 12 weeks
= R96 + 320 = R416

From her answer above, Nwabisa obviously had a grasp of the underlying mathematical issues involved. She was able to identify the first statement which involved finding out how much money will be made in 12 weeks and also adding this amount to the capital already accrued.
(Nwabisa's algorithmic method would be classified as standard method in the previous section)

In answering the same question, **Bongani** used the following method:

```
        8
    x 1 2
      9 6
    + 3 2 0
    1   2 8 0
```

If one were to track Bongani's method of dealing with the problem, it becomes clear that his interpretation is correct. Besides the fact that Bongani's final answer is incorrect, it

will however, fall under the category of correct interpretation because he did not commit any algorithmic errors. The mistake seen in his method was that in adding 96 to 320, he mistook 96 for 960.Bongani thus correctly identified the correct method of operation (algorithm) and also applied the correct operations (arithmetic). This may probably stem from the importance given to the number zero in the Mathematics classroom. Indeed many teachers never forget to mention that zero is equivalent to nothing. With zero being nothing, Bongani may have mentally added this nothing at the end of 96 to give 960 and hence the answer of 1280.

(In the category "type of method", this would be classified as standard method)

Monde, employed the following strategy:

$$
\begin{array}{r}
8 \\
8 \\
8 \\
8 \\
8 \\
8 \\
8 \\
8 \\
8 \\
8 \\
8 \\
\underline{8} \\
96 \\
+ \underline{320} \\
416
\end{array}
$$

Monde's method was also classified as a correct interpretation of the word problem.

This is because he also realised the interconnections between the two mathematical statements given.

(In the category "type of method", this would be classified as non-standard method)

2.9.2.2. Partially correct interpretation

There were instances where learners produced only half the answer required. This occurred particularly where the second part of the statement was overlooked in giving an answer. A partial interpretation of the problem thus refers to cases where learners gave a partial answer to the problem. In response to the question mentioned in 2.9.2 above, **Patrick** provides a better example of what was classified as partial understanding. In answering the question mentioned above he uses the following repeated addition approach:

$$8 + 8 = 16$$
$$16 + 8 = 24$$
$$24 + 8 = 32$$
$$32 + 8 = 40$$
$$40 + 8 = 48$$
$$48 + 8 = 56$$
$$56 + 8 = 64$$
$$64 + 8 = 72$$
$$72 + 8 = 80$$
$$80 + 8 = 88$$
$$88 + 8 = 96$$

Patrick correctly obtains the first part of the question, but ignores the fact that there was a sum of R320 that already existed. He thus failed to add the R96 to the R320 already accrued. The above interpretation was therefore classified as partial understanding.

(This would be classified as non-standard method in 2.9.1 above)

In the same problem, **Unam** produced an answer that fell in between fully interpretation and partial interpretation as shown below.

$$8 \times 12 = R96$$
$$96 \times 320 = R30\ 720$$

Unam correctly stated that the first part of the solution involves finding out how much money will be made in 12 weeks. In the second part, he however falsely states that the R96 should be multiplied to the capital of R320. Though the first statement is correct, the second one is false. Unlike Bongani (in 2.9.1.1), Unam did not apply the basic operations correctly as demanded by the problem hence this was classified only as a partial interpretation of the word problem.

(Under 2.9.1 above, this would be classified as a standard method)

Wendy as shown below exemplifies a partial understanding of the problem:

$$8 \times 12 = 123.$$

Though Wendy correctly states that for each of the 12 weeks R8 will be saved, she falters when it comes to calculating the correct amount. The answer 123 is incorrect, but the interpretation of the first part of the problem is correct. Wendy's method was therefore classified as a partial interpretation of the problem. Wendy could not identify the second part of the statement.

(Under 2.9.1 above, this would be classified as a standard method)

Sandile gave a rather contentious method. He managed to identify both statements but could not synchronise them in one mathematical statement. His method was:

Cost R 760   12 weeks

$$\begin{array}{cc} \underline{- \ 320} & \underline{x \ 8} \\ 440 & R \ 96 \end{array}$$

In the first part of his solution, Sandile identifies that R440 will be needed to add to R320 in order to make the R760 required. However, this statement was not part of the problem. In the second part of his solution, he correctly states that if R8 were to be saved in 12 weeks, R96 will be obtained. This statement is correct. His whole method was classified as being partially correct because he only managed one part of the problem i.e. R8 x 12 = R96 and he could not harmonise the two statements. (Under 2.9.1 above, this would be classified as a standard method)

In answer to the same problem, **Veliswa** uses the following approach:

$$8 + 8 = 16$$
$$8 + 8 = 16$$
$$8 + 8 = 16$$
$$8 + 8 = 16$$
$$8 + 8 = 16$$
$$8 + 8 = 16$$

Veliswa used a correct additive strategy for the first part of the problem but did not give the required sum. The method she used shows that she had correctly interpreted one part of the problem. Veliswa's type of interpretation was thus classified as a partial interpretation of the problem.
(Under 2.9.1 above, this would be classified as a non-standard method)

Ayanda used the following method.

$$320 + 440 = 760$$

Ayanda clearly has the understanding that an amount of 320 has already been accrued. Her only mistake was to assume that after the 12-week period the total amount of 760 would be made. What comes to the fore however, is that she managed to identify one part of the problem i.e. that R320 already exists in the coffers even though the crucial part of the question was lost (8 x12). An algorithm was classified as partially correct if only one part of the problem statement was correctly identified. Ayanda' algorithm was therefore classified as a partial understanding of the problem.

(Under 2.9.1 above, this would be classified as a non-standard method in that it only applies the addition operation)

2.9.2.3. False interpretation

A false interpretation was obtained in instances where learners showed a complete lack of understanding of the problem statement or in cases where learners did not know which method to use in their solution. In answering the question mentioned in 2.9.1 above, **Noxolo** used the following approach:

$$+ \ 760$$
$$+ \ 760$$
$$1420$$
$$+ \ 320$$
$$1 \ 7 \ 4 \ 0$$
$$+ \ 8$$
$$1748$$

Noxolo desperately threw figures around in search for a correct answer. However, her strategy is nowhere closer to executing what is required of her. Noxolo' s method was thus classified under false interpretation.

(Under 2.9.1 above, this would be classified as unidentifiable method)

In answer to the same problem, **Sipho** uses the following method:

```
    7 6 0
  x 1 2
  9 1 2 0
  x     8
  7 2 9 6 0
 x   3 2 0
 2 3 3 4 7 2
```

Sipho's method also represents a situation where numbers a randomly thrown about without any evidence of an understanding of the problem situation. It therefore fell under the category of false interpretation of the problem.

(Under 2.9.1 above, this would be classified as an unidentifiable method)

Similar solutions, which showed lack of understanding of the problem, were classified under false interpretation.

2.10 Chapter Summary

In this chapter, methodological aspects of data collection were discussed. Also discussed in this chapter were the instruments, the research design and the framework used in the analysis of results. Finally, the concepts and terms to be used in chapter 3 were explained. **Chapter 3** will present the qualitative data obtained from protocols.

CHAPTER 3-

PRESENTATION

AND ANALYSIS

OF

QUALITATIVE

DATA

3.1 Introduction

This chapter gives a systematic analysis of the way learners interpreted questions and the type of algorithmic methods that they employed when presented with mathematical word problems set in English and isiXhosa. The premise of this study was to establish if any correlation exists between the degree of understanding the language in which mathematical word problems are presented on one hand and the level of interpretation of the questions and use of algo-heuristic methods on the other.

In **paragraph 3.2**, an explanation of the framework used to present learner protocols will be explained. In **paragraph 3.3**, individual learner responses will be presented and a comparison made between responses made in English and those made in isiXhosa. Conclusions will be made in **Paragraph 3.4.**

3.2 Framework used in presenting qualitative data

The two questions presented to learners will be referred to as Question A and Question B (see paragraph 2.6, 'The Research instrument'). The language of the question will be shown in brackets. Thus "Question A (isiXhosa)" will mean that the question mentioned as A was answered in isiXhosa.

Question A: Henry wants to buy himself a bicycle. The bicycle he wants to buy costs R760. He already has R320. Now he starts saving R8 each week from money he earns by working in a café on Saturdays. How much money will he have in total, 12 weeks after he started saving?

Question B: A bricklayer was asked to complete a building that was unfinished. The unfinished building already had 3000 bricks laid on it. The bricklayer was asked to lay 350 bricks a day. How many bricks will the house have in total, 6 days after starting to build if the bricklayer continues to lay the 350 bricks per day?

In order to make the study more readable, the protocols given below are only those for part (a) of each question. However, the trend discussed below will also apply to part "b" of the question.

After the presentation of each protocol, an analysis will be done. The analysis of each protocol will be done initially in terms of the way the question was interpreted and finally in terms of the type of method used.

3.3 Presentation of learners' protocols

Sikhumbuzo, a grade 9 learner, gave the following responses:

Question A (isiXhosa)

> Iveki (week)[16] 8
> Iveki 8
> Iveki 8
> Iveki 8
> Iveki 8
> Iveki 8
> Iveki 8
> Iveki 8
> Iveki 8
> Iveki 8
> Iveki 8
> Iveki 8

---

[16] Translation my own

$$1\ 2$$
$$\underline{x\ 8}$$
$$8\ 16$$
$$\underline{+320}$$
$$\underline{1136}$$

Question B (English)

$$350 \times 6 = 2100$$

Question A in isiXhosa was correctly answered. However, Sikhumbuzo committed a mistake when trying to multiply 12 by 8. The most probable way in which he could have carried out his calculation was to first multiply 8 by 1 obtaining 8, followed by multiplying 8 by 2 obtaining 16. His final answer was thus 816. He thus correctly added the amount he obtained (816) to 320 thus obtaining 1136 as the answer. However, what counted in his favour was that he identified the two main steps which were necessary to carry out the problem. He first identified that the first step was to find out how much money will be accumulated in 12 weeks and finally adding this amount to the money that he already had. In addition, Sikhumbuzo only committed arithmetic errors in this question, but no algorithmic errors. His answer was thus classified as a correct interpretation of the question.

In the isiXhosa question, Sikhumbuzo relies heavily on the non-standard method of repeated additions though at the end he notices that the easiest way is to multiply 12 by 8. His algorithmic method was referred to as non-standard because he primarily sets up his calculation using repeated additions.

In question B which he answered in English, Sikhumbuzo gave half the answer required. He ignored the fact some bricks had already been laid to the foundation. This was classified as a partial understanding of the problem.

In terms of the method of computation, Sikhumbuzo used the standard method which required multiplication of 6 by 350.
(Sikhumbuzo wrote the English question during the first session and the isiXhosa question in the second session).

Neliswa also wrote the English question during the first session. Besides the fact that she is in grade 9, she applied a basic arithmetic principle when given a question in isiXhosa. Her working is shown below.

Question A (isiXhosa)

11111111	11111111	11111111	11111111
11111111	11111111	11111111	11111111
11111111	11111111	11111111	11111111

imali enayo R96 (The money he will have is R96)[17]

Question B (English)

$$6 \times 350 = 2100$$

Like Sikhumbuzo, Neliswa also gave a half answer in the English question. In addition, she also gave a half answer in isiXhosa. Her understanding would thus be classified as a partial understanding in both the isiXhosa and English questions. Neliswa and Sikhumbuzo were both in the same grade 9.

When given a question in English, Neliswa relied on the multiplicative strategy which was classified as a standard method. However, in her answer to the question presented in

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[17] English translation mine

isiXhosa, she applied repeated additions, a strategy classified as a non-standard method.

Khuselwa, a grade 8 learner, answered the English question during the first session.
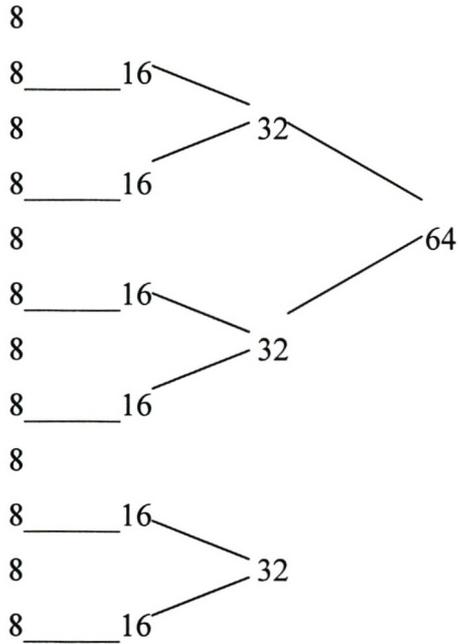
Question A (isiXhosa)

8

8_____16

8

8_____16

8

8_____16

8

8_____16

8

8_____16

8

8_____16

8

8_____16

8

8_____16

32

32

32

32

64

```
  6 4
+ 3 2
  9 6
```

Question B (English)

```
      6
x 3 5 0
2 1 0 0
```

In both the English and isiXhosa questions, Khuselwa showed a partial understanding of the problems because she was able to identify the first part of the statements.

Looking at the type of strategy she uses, Khuselwa sets up her isiXhosa method based on repeated additions. This she did by breaking up her sum in a meticulous way, adding the 8's in a stepwise fashion. In the English question, she used the multiplicative strategy. In the question set in isiXhosa, Khuselwa used the non-standard method and in the question set in English she used the standard method.

Thabo, a grade 10 learner, was in the group that answered the English question first. He was one of the learners who correctly interpreted the questions in the both languages as shown below.

Question A (English)

     R8 x 12 weeks

     = R96 +320

     = 416

Question B (isiXhosa)

     6 x 350

     2100 + 3000

     = 5100

Thabo showed arithmetic maturity in the way he handled the questions in both languages. In the English version of the test which he wrote first, he correctly identified the two statements in logical and correct way. Both of his answers were classified as correct. In addition, Thabo used standard methods in both of his calculations.

Sabelo, also a grade 10 learner, followed the same method employed by Thabo albeit with some slight differences in the way he sets up his calculations. Sabelo wrote the isiXhosa question during the first session. His method follows below.

Question A (isiXhosa)

(1) R8 x 12

= R96

(11) R320 + R96

= 416

Question B (English)

350 x 6

= 2100 bricks

In the isiXhosa question, Sabelo gave a fully correct answer whereas his English answer was partially correct. Most interesting was in the way he set up his algorithm when answering the isiXhosa question. In the Mathematics classroom and mathematical texts, steps to a solution are seldom numbered the way he did. This can only imply that he read the problem and concluded that it was made of two different statements which needed to be combined in the way he did.

Sabelo employed standard methods in both of his solutions. In the isiXhosa question, he correctly identifies the two statements and breaks them apart in his solution. In the English question, he was able to identify the first statement of the problem.

Zithi was in grade 9 and he also wrote the isiXhosa version of the test during the first session.

Question A (isiXhosa)

[8 8][8 8][8 8][8 8][8 8][8 8]

$96 + 320 = 416$

Question B (English)

350
350
350
350
350
350
185

Zithi correctly identified in the isiXhosa question that there are two statements that need to be joined. He used a stepwise method of first adding all the R8's and finally adding them to the R320. His interpretation was fully correct for the isiXhosa question. In the English question, he was able to identify the first part of the problem statement which required that he add up all the 350's. He, however, obtained a wrong answer when trying to add the R350's. Since he was able to correctly identify that the first step to be done was to add R350 six times his solution was classified as a partial understanding of the problem.

.

In both the English and isiXhosa version, Zithi used the non-standard method of repeated additions.

Veliswa, in grade 9, also wrote the isiXhosa version of the word problems during the first session.

<u>Question A (isiXhosa)</u>

$$8 + 8 = 16$$
$$8 + 8 = 16$$
$$8 + 8 = 16$$
$$8 + 8 = 16$$
$$8 + 8 = 16$$
$$8 + 8 = 16$$

<u>Question B (English)</u>

$$
\begin{array}{r}
3\,5\,0 \\
\times\quad 6 \\
\hline
2100
\end{array}
$$

In both of her solutions, Veliswa gave half the answer required. Her level of understanding was thus classified as partial understanding for both the isiXhosa and English questions.

In the isiXhosa question, Veliswa employed a non-standard method similar to the one used by Zithi above. For the question presented in English, she used the standard method.

Nontobeko, a grade 8 learner, wrote the English version of the test first.

<u>Question A (English)</u>

$$8 \times 12$$
$$= 96$$

Question B (isiXhosa)

3 5 0	3 5 0	3 5 0
3 5 0	3 5 0	3 5 0
7 0 0	7 0 0	7 0 0

7 0 0

7 0 0

7 0 0

2 100

Nontobeko gave incomplete answers in both of her solutions. Her understanding in both questions was thus only partial.

In the English version, Nontobeko used the cross-product (standard) and in the isiXhosa version she used a building up additive strategy(non-standard).

Andiswa, a grade 8 learner set up her solutions as follows.

Question A (isiXhosa)

Ngeveki izintatu uzakuba ne R24.(In three weeks he will have R24)[18]

2 4

+ 2 4

+ 2 4

+ 2 4

9 6   →   in 12 weeks

---

[18] English translation mine

Question B (English)

6 x 350

6 days = 2100

In both of her solutions, Andiswa gave one part of the solution (partial understanding of the problem).

Looking at the type of method she used, for the isiXhosa question she started by mentally calculating how much money will be saved in three weeks. The first statement she penned down was to say that R24 would be saved every three weeks. Having worked out that in twelve weeks there are 4 times three weeks, she thus added R24 four times. Andiswa's solution for the isiXhosa problem was classified as a non-standard method since it involves a breaking down repeated additions method. In the English solution, she used the standard method.

Lulama, a grade 10 learner, set up her working as follows:

Question A (isiXhosa)

8 x 6 = 4 8
8 x 6 = 4 8
    9 6

Question B (English)

3 5 0 x 6
= 2 1 0 0

Lulama gave half the required answer in both of her solutions. In both the English and isiXhosa tests, she thus had only a partial understanding of the problem.

In the type of method she employed, Lulama used a rather condensed form of repeated addition method in the isiXhosa question. A case like this was difficult to classify in that it incorporates both the standard and non-standard methods. However, noting that her method involved multiplying R8 by 6 two times, thus breaking the 12 in two sixes, his method was classified as a standard method. In the English version, she also relied on the standard method.

Lindiwe, in grade 9, wrote the English version of the test first.

Question B (English)

350
350
350
350
350
350
2100

Question A (isiXhosa)

R 8

R 8   160

R 8

R 8   160

R 8

R 8   160

R 8

R 8   160

R 8

R 8   160

R 8

R 8   160

960

Lindiwe gave half-answers in both of her solutions (partially correct answers). She also relied mostly on non-standard methods in her solutions. Besides the fact that she was in grade 9, she experienced some problems with the zero in the units column. She correctly identified that the first thing one needs to do is to add all the money accumulated (isiXhosa question) or the bricks laid (English question), but ignored what already existed.

In the isiXhosa question, Lindiwe may have underestimated the small figures she had to work with as a Grade 9 learner. Grade 9 learners seldom work with figures in the range of single digits. This may have caused a slip in her mind to think that she was working with 80s instead of 8's. However, her interpretation has been partial because she identified that one needs to add the R8 twelve times for one to know how much money will be accumulated in the 12 weeks period.

Lindiwe was one of the exceptions who used non-standard methods in both the English and isiXhosa answers. Looking at her answer sheet for the isiXhosa question, Lindiwe started by showing how much money will be accumulated on a daily basis before canceling out and settling for the answer shown above. What she cancelled out was:

Monday	R8
Tuesday	R8
Wednesday	R8
Thursday	R8
Friday	R8
	40
Monday	R8
Tuesday	R8
Wednesday	R8
Thursday	R8
Friday	R8
	40

Lindiwe repeated the steps above forgetting that the R8 was a weekly saving and not a daily saving. Interesting also was the assumption she made that the money will only be saved from Monday to Friday, excluding Saturday and Sunday. This only goes on to reinforce the notion of the important role played by socialisation at school. For many working people in South Africa, Saturday and Sunday are not working days.

In another case, **Vuyani**, a grade 8 learner, carried out his calculations in the following way:

Question A (English)

$$R\,8 + R\,8 + R\,8 + R\,8 + R\,8 + R\,8 + R\,8 + R\,8 + R\,8 + R\,8 + R\,8 + R\,8$$
$$= 98$$

$$\begin{array}{r} 9\,8 \\ +\,3\,2\,0 \\ \hline 4\,1\,8 \end{array}$$

Question B (isiXhosa)

$$350 + 350 + 350 + 350 + 350 + 350 = 2100$$

In the English question, Vuyani also correctly interpreted the problem. The only snag lay in the computational mistake he committed in adding the R8s together. However, since he correctly identified that the first step was to find out how much money will he make in 12 weeks and the second step to add to the capital already accrued, his method for the English question was classified as constituting a fully correct interpretation of the problem. In the isiXhosa question, his interpretation was partial.

Vuyani relied also on the non-standard method of repeated additions in both of his solutions.

Mdu also used standard methods in both of his solutions and also showed a fully correct interpretation of the English question and a partially correct interpretation of the isiXhosa question. Mdu wrote the English question during the first session.

Question A(English)

R8 x 12 weeks = R96
R96 + R320 = R416

Question B (isiXhosa)
= 2100
6 x 350

Mdu had a correct understanding in the English question and a partial understanding in the isiXhosa question. As a grade 10 learner, the language of the question probably had little impact on his understanding.

He applied standard algorithm in both of his answers. The fact that he was in a higher standard probably played a role also in this regard.

Nombusi , a grade 9 learner, used condensed form of repeated additions in both of her solutions. Her approach to the problems was:

Question A (English)

8 x 2 + 8 x 2+ 8 x 2+ 8 x 2+ 8 x 2+ 8 x 2
= 32 + 32
= 64 + 64
= 128 + 320
= 448

Question B (isiXhosa)

350

350

<u>350</u>

1050

<u>1050</u>

<u>2100</u>

In the English question, Nombusi correctly identified the first and second parts of the word problem. She however, got confused in the second statement as to the number of 32's she had. For the fact that she initially identified that the first part of the problem involves adding the R8s for 12 weeks and the second part involves adding that money accumulated in the 12 weeks to the R320 already accumulated, Nombusi's method was also classified as a correct interpretation of the problem. In the isiXhosa question, she had only a partial understanding of the question.

Nombusi used non-standard methods in both of her solutions.

Unam, a grade 8 learner, had a partial understanding of both the questions. Her solution for the isiXhosa solution proved difficult to classify in that it embraced elements of both partial and correct interpretation.

Question A (isiXhosa)

8 x 12 = R96

96 x 320 = R30 720

Question B (English)

350 x 6 = 350

In the first part of the isiXhosa solution, Unam recognised the fact that one needs to first find out how much money will be saved in 12 weeks. In the second part, she however, multiplied the money saved in 12 weeks to the one she already had. Hers is therefore not a case of algorithmic error, but a poor understanding of the second part of the question. This was thus classified as a partial interpretation of the problem. Her English solution was also classified as a partial understanding of the problem.

In both of her solutions, Unam applied standard methods.

Sabelo, in grade 8, used non-standard method in both his English and isiXhosa questions.

Question A (English)

8
8
8
8
8
8
8
8
8
8
8
_8_
9 6

Question B (isiXhosa)

350

350

350

350

350

350

2100

Sabelo was a typical mathematically unsophisticated grade 8 learner who relied mostly on the additive strategy. In both of his questions, like many of his peers in grade 8, he produced only half the required answer.

Sibongile a grade 9 learner, wrote the English question first.

Question A (English)

$8 + 8 = 16$

$16 + 8 = 24$

$24 + 8 = 32$

$32 + 8 = 40$

$40 + 8 = 48$

$48 + 8 = 56$

$56 + 8 = 64$

$64 + 8 = 72$

$72 + 8 = 80$

$80 + 8 = 88$

$88 + 8 = 96$

Question B (isiXhosa)

$$350 + 350 = 700$$
$$350 + 350 = 700$$
$$\underline{350 + 350 = 700}$$
$$2100$$

Sibongile showed a great deal of organisation in the way she worked out the sum, though at a much lower level for a learner in grade 9. She worked out both of her problems with the same style, giving partially correct answers. She used the non-standard method in her methods.

Nomaphelo, a grade 10 learner, started with the isiXhosa question during the first session followed by the English question in the second session.

Question A (isiXhosa)

1st week – 8
2nd week – 16
3rd week – 24
4th week – 32
5th week – 40
6th week – 48
7th week – 56
8th week – 64
9th week – 72
10th week – 80
11th week –88
12th week – 96

R760
- R320
R440

Question B (English)

1. 350
2. 350
3. 350
4. 350
5. 350
6. 350
    2100

When one looks at the correctness of answers, it seems Nomaphelo made a little bit of advancement in the isiXhosa question. In the English question, she gave a partially correct answer. In the isiXhosa question, Nomaphelo had an almost correct answer. Her only problem was to make the assumption that in 12 weeks, the amount of 720 would have been fundraised. Thus in her conclusion, she indicates that R760 – R320 = R440. Like the solution given for the English question, her isiXhosa solution was also classified as a partially correct answer.

In both questions Nomaphelo used the non-standard method in her answers.

Bongani, also in grade 10, used the non-standard method in the isiXhosa question and the standard method in the English question.

<u>Question A (English)</u>

320

\+ 8

<u>x 12</u>

= 416

<u>Question B (isiXhosa)</u>

350

350

350

350

350

<u>350</u>

2100

<u>+3000</u>

5100

In the English question, Bongani used the standard method whereas in the isiXhosa question he used the non-standard method. His choice of method in the second session could not have been influenced by his choice of method in the first session. Bongani gave correct answers in both of the problems given.

Sibusiso, is a learner in grade 10. He obtained a fully correct answer in the isiXhosa question and a false answer in the English question.

Question A (English)

$$760 + 320$$
$$= 1080$$

Question B (isiXhosa)

$$350 \times 6 = 5100$$
$$5100 + 3000 = 8100$$

From the way Sibusiso went about the English question, one is left convinced that he had no clue as to what was asked. Instead of finding out how much money will be generated in 12 weeks, he added the target to the money already accrued. In the isiXhosa question, he correctly identified that the first statement will be to find out the number of bricks to be laid in 6 days. He however, incorrectly says that $350 \times 6 = 5100$. He then correctly says that the amount of 5100 should be added to the number of bricks already laid (3000). This was therefore judged to be a totally correct answer in that Sibusiso was able to make a connection between the statements.

Sibusiso used the standard method in the isiXhosa question. His English solution was difficult to classify as either standard or non-standard. Such methods that were difficult to classify were labeled as unidentifiable methods.

Nandi, in grade 8, used the non-standard and unidentifiable methods in the isiXhosa and English questions respectively. (She wrote the English question during the first session).

Question B (English)

$$3000$$
$$+\ 350$$
$$3350$$

Question A (isiXhosa)

$$320 + 320 + 320 + 320 + 320 + 320 + 320 + 320 + 320 + 320 + 320 + 320 = 3200$$

Nandi's solutions for both questions were classified as false. Her solution for the English was classified as being unidentifiable because it possessed neither evidence of the cross-product or repeated additions. In the isiXhosa question, she used the non-standard repeated additions.

Bongiwe a grade 8 learner who wrote the English question during the first session, used the following methods in her answers.

Question B (English)

350

Question A (isiXhosa)

8

8_____16

8

8_____16

8

8_____16

8

8_____16

64

In the question set in siXhosa, Bongiwe was able to identify a correct strategy for dealing with the problem though she got an incorrect answer. This was classified as a partially correct interpretation of the question. In the English question, Bongiwe gave a false answer (false interpretation).

The method she used in the isiXhosa question was the repetitive addition strategy whereas in the question set in English, she gave an answer only (unidentifiable method).

In grade 9, **Lukhanyo** used an unidentifiable method in his English solution and repeated additions in the isiXhosa solution. (Lukhanyo wrote isiXhosa question in the first session)

Question A (isiXhosa)

$$8 + 8 + 8 + 8 + 8 + 8 + 8 + 8 + 8 + 8 + 8 + 8 = 96 + 320 = 416$$

Question B (English)

2100

Lukhanyo obtained a correct answer in the question set in isiXhosa. This represents a fully correct interpretation of the question. In the English question, he gave a partially correct answer (partially correct interpretation). In the English question, he however did not show any evidence of how he arrived at the answer, thus his method was classified as unidentifiable even though it produced a half answer. The instruction was made clear that learners should justify all the answers by showing calculations. In the isiXhosa question, he used the repeated addition strategy.

3.4 Chapter Summary

In this chapter, learner protocols were presented and analysed. Not all learner protocols could however, be included here, due to the scope of the study in relation to the sample i.e. small scope, big sample. The rest of the results obtained from the samples will be given in **chapter 4.** This will be done quantitatively in the form of tables and figures.

CHAPTER 4 - PRESENTATION AND ANALYSIS OF QUANTITATIVE DATA

4.1 Introduction

As in the previous chapter, a look will be taken at learners' interpretation of situations and the type of computational methods they apply when they respond to mathematical word problems presented in English and isiXhosa. This chapter will however, compare learner responses quantitatively in the form of tables and figures. The previous chapter had captured learner protocols, comparing their interpretative styles and algorithmic. However, due to the scope of the work undertaken, not all protocols were presented in chapter 3. The present chapter will give the results for all learners, comparing the <u>numbers</u> of learners with English and isiXhosa responses who were classified under the five categories below.

The following five comparisons will be made in this chapter:

<u>Comparison of the quality of learners' interpretation of the situations described in the questions</u>

1. The responses to problems set in English will be compared with the responses to the problems set in isiXhosa. The comparison will be carried out for all learners in grades 8, 9 and 10 put together. Each learner responded to a question set in English and to another question set in isiXhosa. The relevant data is presented in table 4.1 and figure 4.1.
2. The responses to problems set in English will be compared with the responses to the problems set in isiXhosa. The comparison will be done separately for all the grades i.e. separately for learners in grade 8, separately for learners in grade 9, and separately for learners in grade 10 (3 comparisons). The objective of this is to investigate whether possible effects of the language in which questions are given change as learners progress through grades 8 to 10. The relevant data is presented in tables 4.2, 4.3 and 4.4 and figures 4.2, 4.3 and 4.4.
3. The responses of learners who first responded to problems set in English will be compared to the responses of learners who first responded to problems set in isiXhosa. The relevant data is presented in tables 4.7 and 4.8.

Comparison of the algorithmic methods used by learners

4. The algorithmic methods used by learners when responding to problems set in English will be compared with the algorithmic methods used by learners when responding to problems set in isiXhosa. This will be inclusive of all the learners in grades 8, 9 and 10. The relevant data is presented in table 4.9 and figure 4.5.

5. The algorithmic methods used by learners when responding to problems set in English will be compared with the algorithmic methods used by learners when responding to problems set in isiXhosa. The comparison will be done separately for learners in grade 8, separately for learners in grade 9, and separately for learners in grade 10 (3 comparisons). The relevant data is presented in tables 4.10, 4.11 and 4.12 respectively and figures 4.6, 4.7 and 4.8 respectively.

Table 4.1 and figure 4.1 give the comparison between the quality of interpretation to questions set in English and quality of interpretation to questions set in isiXhosa. This is done for all learners put together.

Tables 4.2; 4.3 and 4.4 and figures 4.2; 4.3 and 4.4 give the comparison between the quality of learners' interpretation to questions set in English and quality of interpretation to questions set in isiXhosa. This is done separately for learners in grades 8, 9 and 10.

Tables 4.5 and 4.6 show the differences in the quality of interpretation when learners respond to questions set in English and isiXhosa.

Tables 4.7 and 4.8 compare the responses of learners who first responded to questions set in English and those who first responded to questions set in isiXhosa.

Table 4.9 and figure 4.5 compare the algorithmic methods of learners when they respond to questions set in English and when they respond to questions set in isiXhosa. This will be done for all learners put together.

Tables 4.10, 4.11 and 4.12 and figures 4.6, 4.7 and 4.8 compare the algorithmic methods of learners when they respond to questions set in English and when they respond to questions set in isiXhosa. This is done separately for learners in grades 8, 9 and 10.

4.2 Framework used in presenting the results

In order to enhance readability, the tables and figures above will compare responses to part (a) of each question separate from part (b). This is done in order to show how language may impact on learners when they evaluate a function (sub-question a) and when they solve an equation (sub-question b). Evaluation of a function will be made in reference to sub-question (a) and solution of an equation in reference to sub-question (b). Part (a) will be referred to as "evaluation of a function" because it involves problems of the type:

$$f(x) = 8x + 320 \text{ (Question A)}.$$

Given the value of x (12 in case of Question A), learners should be able to evaluate the function at x. Part (b) will be referred to as "solution of an equation" because it involves problem of the type:

$$760 = 8x + 320$$

Given the value function (760), learners should be able to evaluate x. In this case learners had to evaluate the equation.

In all, 109 learners participated in the study. This in itself makes the difference between the raw scores and percentages negligible, thus giving more credence to the numbers shown in the figures and tables below.

In the figures, the following codes will be used:

    E(a) – refers to subquestion (a) of the English question (evaluation of a function).

    E(b) – refers to subquestion (b) of the English question (solution of an equation)

    X(a) – refers to subquestion (a) of the isiXhosa question (evaluation of a function).

    X(b) – refers to subquestion (b) of the isiXhosa question (solution of an equation)

4.3 Comparisons 1 and 2: The quality of learners' interpretation of questions set in English compared to the quality of learners' interpretations of questions set in isiXhosa.

The tables and figures below compare the quality of learners' interpretations of situations described in the word problems. First the results for all the grades combined will be given and then the results will also be presented separately for the three grades. The presentation of the results will be followed by the analysis.

4.3.1 Presentation of results for comparisons 1 and 2

	Evaluation of a function required (a)		Solution of an equation required (b)	
	Question set in English	Question set in isiXhosa	Question set in English	Question set in isiXhosa
Table 4.1: Grades 8, 9 and 10 combined				
Totally false interpretation	29 27%	20 18%	74 68%	48 44%
Partially correct interpretation	70 64%	76 70%	31 28%	59 54%
Totally correct interpretation	10 9%	13 12%	4 4%	2 2%
Total number of learners	109 100%	109 100%	109 100%	109 100%
Table 4.2: Grades 8 only				
Totally false interpretation	17 39%	13 29%	40 91%	27 61%
Partially correct interpretation	26 59%	29 66%	4 9%	17 39%
Totally correct interpretation	1 2%	2 5%	0 0%	0 0%
Total number of learners	44 100%	44 100%	44 100%	44 100%
Table 4.3: Grades 9 only				
Totally false interpretation	6 21%	3 10%	21 72%	12 41%
Partially correct interpretation	22 76%	24 83%	8 28%	17 59%
Totally correct interpretation	1 3%	2 7%	0 0%	0 0%
Total number of learners	29 100%	29 100%	29 100%	29 100%
Table 4.4: Grades 10 only				
Totally false interpretation	6 17%	4 11%	13 36%	9 25%
Partially correct interpretation	22 61%	23 64%	19 53%	25 69%
Totally correct interpretation	8 22%	9 25%	4 11%	2 6%
Total number of learners	36 100%	36 100%	36 100%	36 100%

The results above are captured in the figures below. The figure below depicts the results for learners in all the grades.
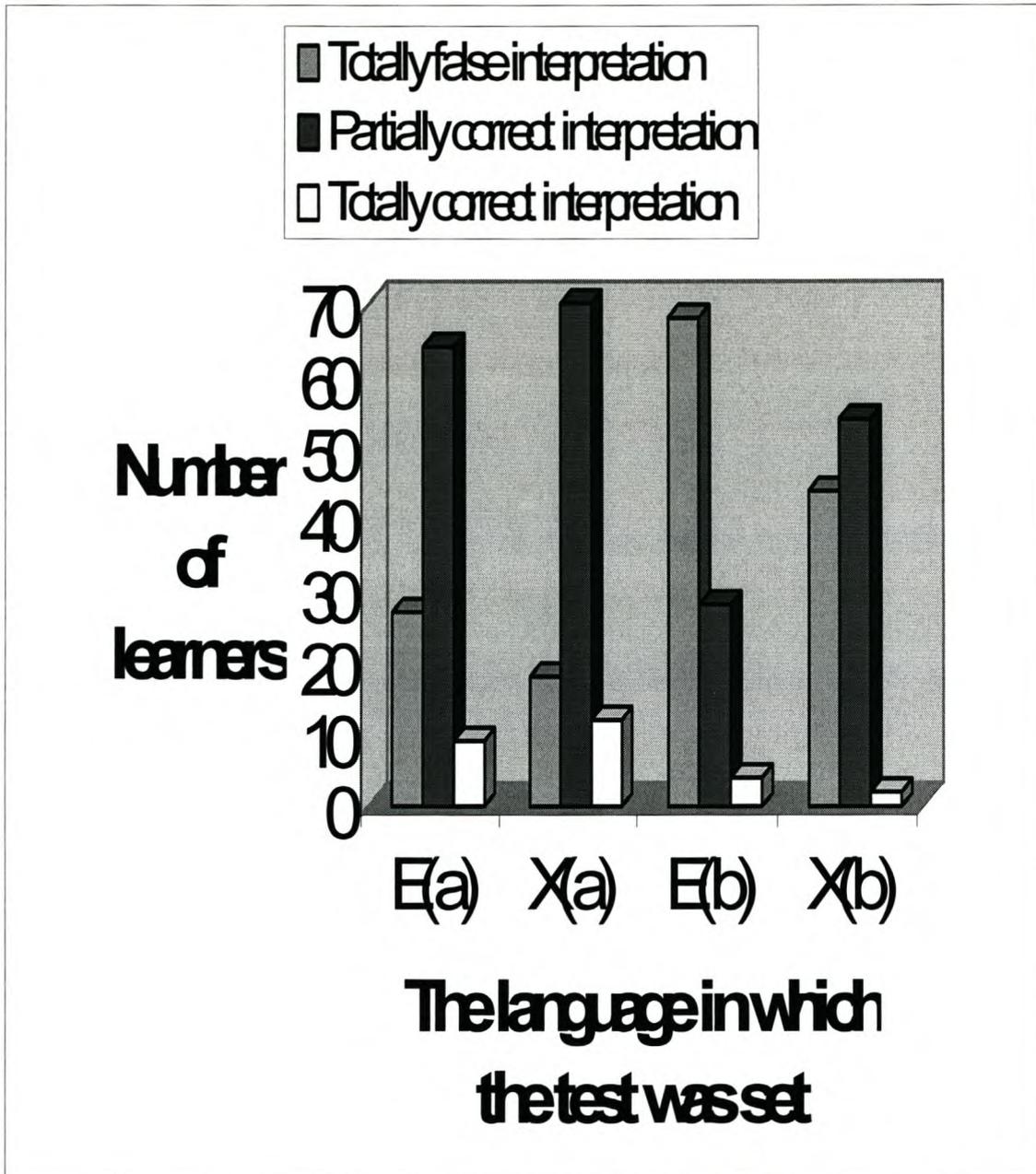
Figure 4.1: Grades 8, 9 and 10 combined

Figure 4.2 below shows the results for grade 8 learners only.
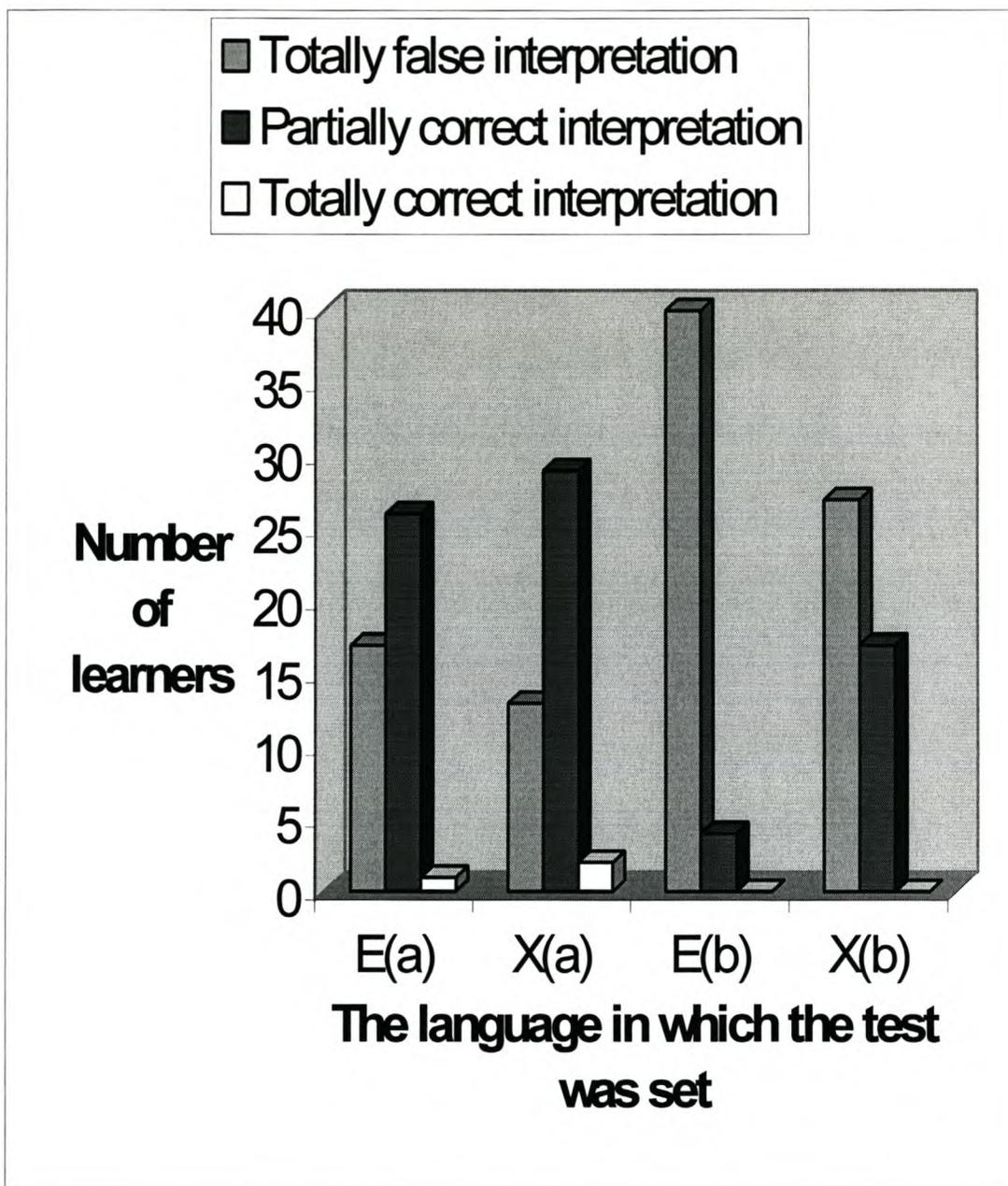

Figure 4.2: The results of grade 8 learners only

Figure 4.3 shows the results for grade 9 learners only.
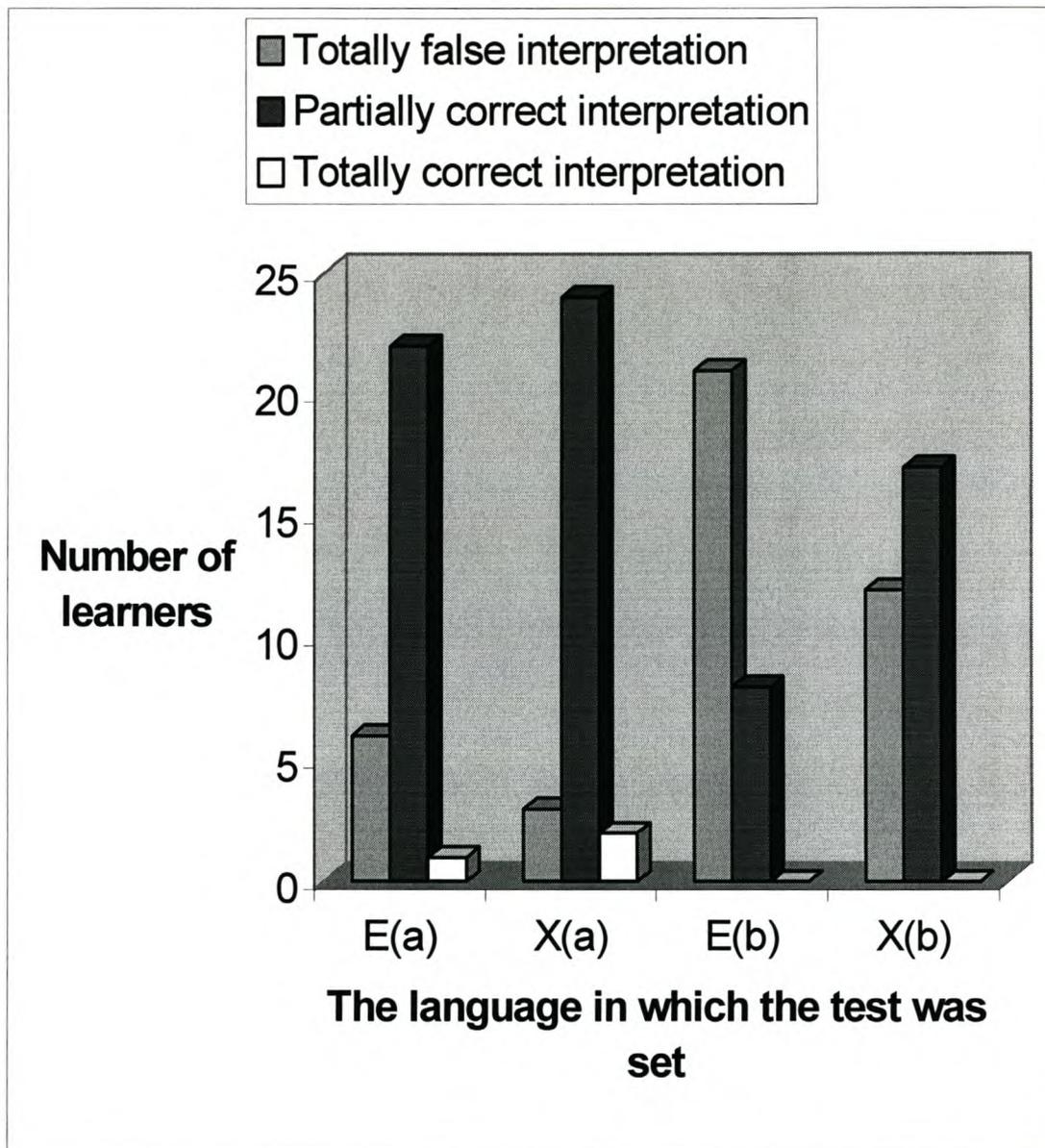
Figure 4.3: The results of grade 9 learners only

Figure 4.4 depicts the results for grade 10 learners only.
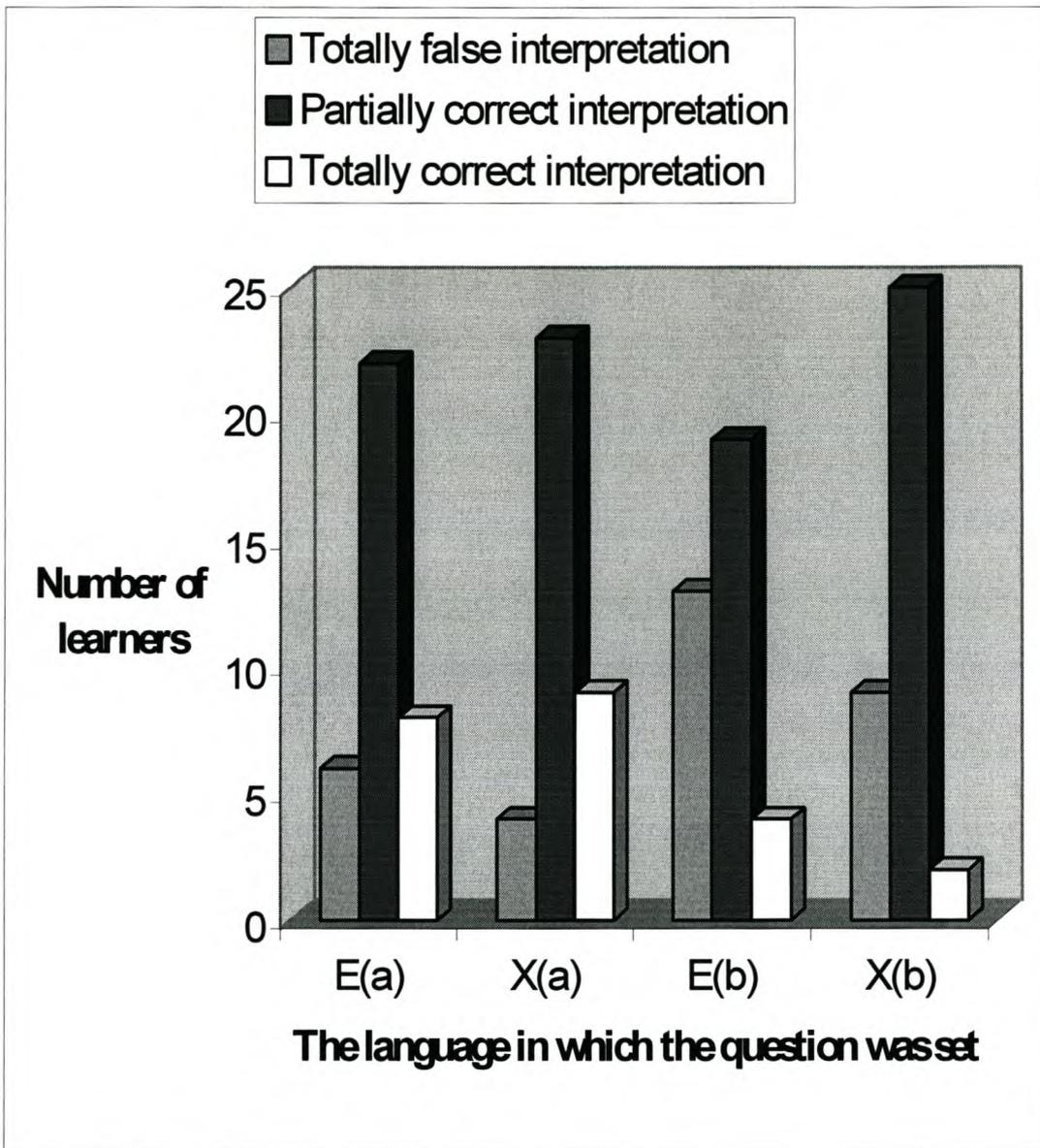
Figure 4.4: The results of grade 10 learners only

4.3.2 Analysis of comparisons 1 and 2

Grades 8, 9 and 10 combined

The quality of interpretation is somewhat better for responses to questions set in L1. In the questions that required evaluation of a function, totally false interpretation is 9% lower for responses to questions in isiXhosa, partially correct interpretation is 6% higher for responses in isiXhosa and totally correct interpretation is 3% higher for responses made in isiXhosa.

For the questions that require solution of an equation, totally false interpretation is 24% lower for responses to questions in isiXhosa, partially correct interpretations is 26% higher for responses made in isiXhosa and totally correct interpretation is 2% higher in favour of responses made in English.

In all the above categories, save for the category totally correct interpretation for the solution of an equation, responses made in isiXhosa were better compared to responses made in English.

Grade 8 only

The quality of interpretation for learners in grade 8 is almost a true reflection of the one presented above for grades 8, 9 and10 learners combined. In the questions that required evaluation of a function, totally false interpretation is 10% lower for responses to questions in isiXhosa, partially correct interpretation is 7% higher for responses in isiXhosa and totally correct interpretation is 3% higher for responses in isiXhosa.

For the questions that required solution of an equation, totally false interpretation is 30% lower for responses to questions in isiXhosa, partially correct interpretation is 30% higher for responses made in isiXhosa and totally correct interpretation is the same for all the languages, with no correct response in the category totally correct interpretation.

All in all, the results for the grade 8 learners mirror the overall results for grades 8, 9 and 10. The disparity in interpretation is however, more acute in the categories totally false interpretation and partially correct interpretation where the differences are 30% in both cases. This may suggest that the language factor is felt more acutely in grade 8 than in grades 9 and 10.

Grade 9 only

The quality of interpretations for learners in grade 9 also duplicates that for the grade 8 learners. For the questions that require evaluation of a function, totally false interpretation is 11% lower for responses to questions in isiXhosa, partially correct interpretation is 7% higher for responses in isiXhosa and totally correct interpretation is 4% higher for responses made in isiXhosa.

In the questions that require solution of an equation, totally false interpretation is 31% lower for responses to questions in isiXhosa, partially correct interpretation is 31% higher for responses made in isiXhosa and totally correct interpretation is the same for all the languages with none to be classified as being totally correct.

There was no observable difference in the quality of interpretation between learners in grade 8 and 9. Like the pattern observed for the grade 8 learners, the number of learners obtaining a totally correct answer is minimal. Also similar in the manner of interpretation between the two grades is that learners do not do well when it comes to finding the solution to an equation. No learner in both grades gave a totally correct interpretation for the solution of an equation.

Grade 10 only

In the questions that require evaluation of a function in grade 10, totally false interpretation is 6% lower for responses to questions in isiXhosa, partially correct interpretation is 3% higher for responses given in isiXhosa and totally correct interpretation is 3% higher in isiXhosa.

For the questions that require solution of an equation, totally false interpretation is 11% lower for responses to questions in isiXhosa, partially correct interpretation is 16% higher in isiXhosa and totally correct interpretation is 5% higher in English.

A look at the results for grade 10 learners shows a clear pattern emerging quite different from the one for grades 8 and 9 learners. In all the categories under investigation, the gap between responses made in English and isiXhosa is being bridged. Worthy of note also is that the number of learners in the category totally correct interpretation has increased significantly in both groups. Under the same category for the solution of an equation, responses made in English were higher compared to responses made in isiXhosa.

The information above is summarised in tables 4.5 and 4.6 below. The tables show differences in interpretation of questions set in English and isiXhosa. A positive number will indicate a higher percentage for questions set in isiXhosa and a negative number will indicate a higher percentage for questions set in English.

Table 4.5: Differences in interpretation for questions that require evaluation of a function.

	Grades 8, 9 and 10	Grade 8	Grade 9	Grade 10
Totally false interpretation	— 9%	— 10%	— 11%	— 6%
Partially correct interpretation	+ 6%	+ 7%	+ 7%	+ 3%
Totally correct interpretation	+ 3%	+ 3%	+ 4%	+ 3%

The minuses in the category totally false interpretation confirm that learners had a problem interpreting questions when they were set in English. The plusses also give an indication that learners understood questions better when they were set in a L1. In the category totally false interpretation, the differences were more glaring as in partially correct interpretation.

Table 4.6: Differences in interpretation for questions that require solution of an equation.

	Grades 8, 9 and 10	Grade 8	Grade 9	Grade 10
Totally false interpretation	— 24%	— 30%	— 31%	— 11%
Partially correct interpretation	+ 26%	+ 30%	+ 31%	+ 16%
Totally correct interpretation	— 2 %	+ 0%	+ 0%	— 5%

Tables 4.5 and 4.6 show that the gap in interpretations widen more in grades 8 and 9 whereas in grade 10 it stabilises. The minus sign in the category totally correct interpretation for the solution of an equation in grade 10 shows that the effect of answering in L2 is minimal in grade 10. In addition, the difference between English and isiXhosa responses is higher when learners solve equations than when they evaluate functions.

4.4 Comparison 3: Comparison of learners who first responded to questions set in English and those who first responded to questions set in isiXhosa

4.4.1 Presentation of results for comparison 3

The study was designed in such a way as to determine if learners' quality of interpretation and computational methods are in any way affected or not affected when they first have to respond to questions set in one language followed by a different language in the second session. The results below track the results of the same learners, when they respond to questions in a particular language during the first session and a different language during the second session.

	Question set in English		Question set in isiXhosa	
	Evaluation of a function required	Solution of an equation required	Evaluation of a function required	Solution of an equation required
Table 4.7 Results for learners who responded first to questions set in English				
Totally false interpretation	26%	65%	24%	41%
Partially correct interpretation	57%	28%	61%	55%
Totally correct interpretation	17%	7%	15%	4%
Total number of learners	54	54	54	54
Table 4.8 Results for learners who responded first to questions set in isiXhosa				
Totally false interpretation	27%	71%	13%	47%
Partially correct interpretation	71%	29%	78%	53%
Totally correct interpretation	2%	0%	9%	0%
Total number of learners	55	55	55	55

4.4.2 Analysis of results for comparison 3

Figure 4.7 (English responses first) reveals only two major differences in the interpretation of questions for this group depicted during the first and second sessions. In the category totally false interpretation for the solution of an equation, there was a gap of 24%. Learners had a better interpretation during the second session when they responded to a question in L1. In the category partially correct interpretation for the solution of an equation there was also a gap of 25% in favour of the second session. In both cases, learners did better when they were responding in a L1. In the other categories, there were no major differences in the quality of interpretation.

Figure 4.8 (isiXhosa responses first) also reveals a similar pattern where the only differences are in the categories totally false interpretation and partially correct interpretation for the solution of an equation. The difference in the category totally false interpretation was 24% and in the category partially correct interpretation was 24% both in favour of responses made in isiXhosa. In both cases, this reinforced the observation made that learners showed a better understanding when responding to questions set in a L1.

From figures 4.7 and 4.8, it can be deciphered that no group of learners were advantaged or disadvantaged by having to respond first in any of the two languages. Learners responded to questions as they were presented, without trying to make a link between the two questions. What the tables reinforce is what was revealed earlier that learners do better when presented with questions in a L1.

4.5 Comparisons 4 and 5: The algorithmic methods used by learners when responding to questions set in English are compared with the algorithmic methods used by learners when responding to questions set in isiXhosa.

Comparisons 4 and 5 look at the algorithmic methods of learners when they respond to questions set in English and questions set in isiXhosa. As stated earlier, all learners were given an opportunity to respond to the two questions in both languages. The tables and figures below investigate whether learners may be influenced by language to incline towards a particular algorithmic method. The results are presented below in the tables and figures.

4.5.1 Presentation of results for comparison 4 and 5

	Evaluation of a function required		Solution of an equation required	
	Question set in English	Question set in isiXhosa	Question set in English	Question set in isiXhosa
Table 4.9: Algorithmic methods for learners in grades 8, 9 and 10 combined				
Standard methods	70 64%	43 39%	55 51%	29 27%
Non-standard methods	21 19%	55 51%	6 5%	47 43%
Unidentifiable methods	18 17%	11 10%	48 44%	33 30%
Total number of learners	109	109	109	109
Table 4.10: Algorithmic methods for learners in grade 8				
Standard methods	24 55%	13 30%	16 36%	8 18%
Non-standard methods	9 20%	25 57%	2 5%	22 50%
Unidentifiable methods	11 25%	6 13%	26 59%	14 32%
Total number of learners	44	44	44	44
Table 4.11: Algorithmic methods for learners in grade 9				
Standard methods	16 55%	9 31%	13 45%	5 17%
Non-standard methods	10 35%	19 66%	3 10%	17 59%
Unidentifiable methods	3 10%	1 3%	13 45%	7 24%
Total number of learners	29	29	29	29
Table 4.12: Algorithmic methods for learners in grade 10				
Standard methods	30 83%	20 56%	26 72%	15 42%
Non-standard methods	2 6%	12 33%	1 3%	9 25%
Unidentifiable methods	4 11%	4 11%	9 25%	12 33%
Total number of learners	36	36	36	36

The results above are captured in the figures below. Figure 4.5 below depicts the algorithmic methods preferred by learners in all the grades.
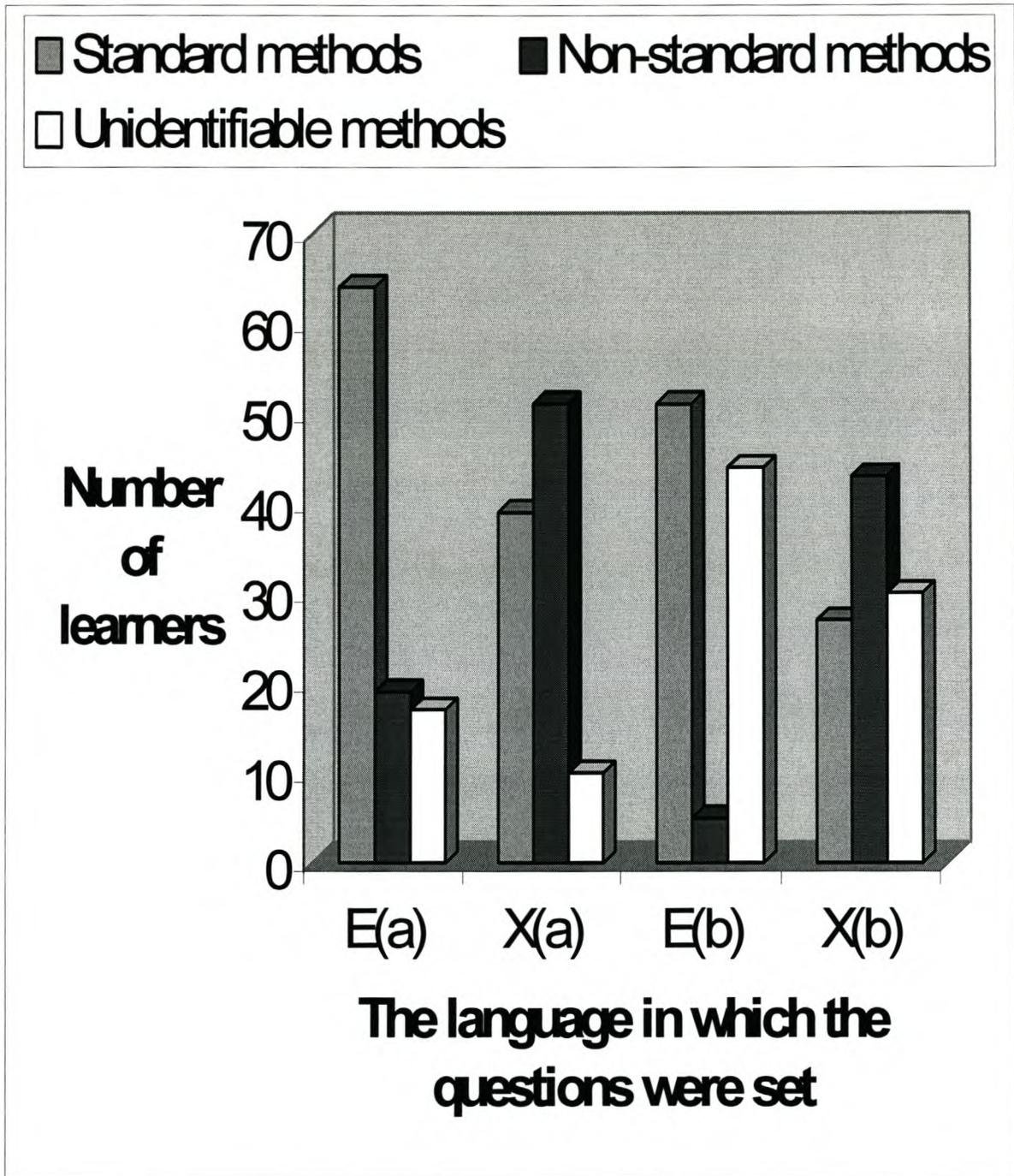
Figure 4.5: The algorithmic methods used by all the learners

Figure 4.6 depicts the algorithmic methods for learners in grade 8
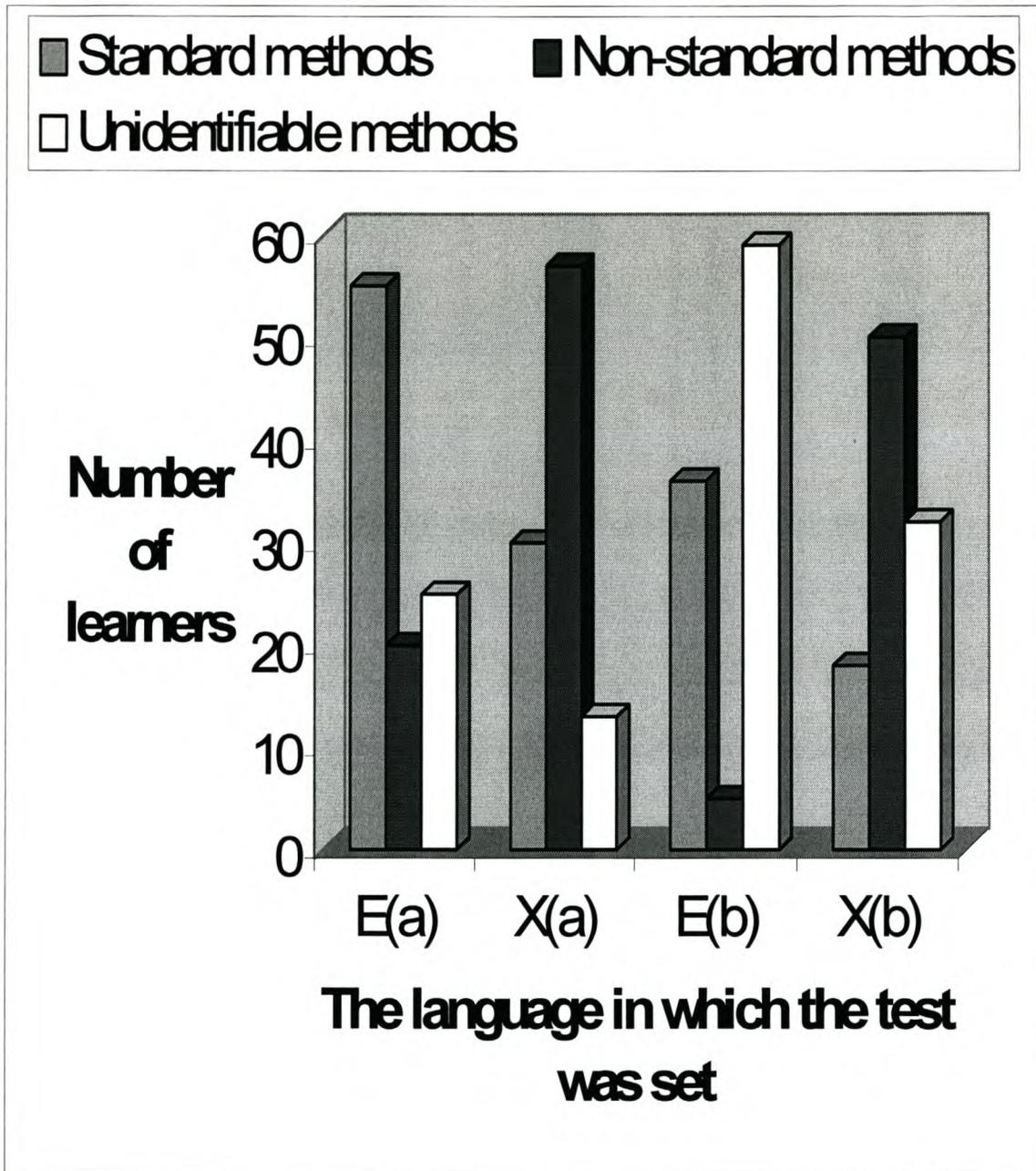
Figure 4.6: The algorithmic methods used by learners in grade 8

Figure 4.7 shows the algorithmic methods for learners in grade 9
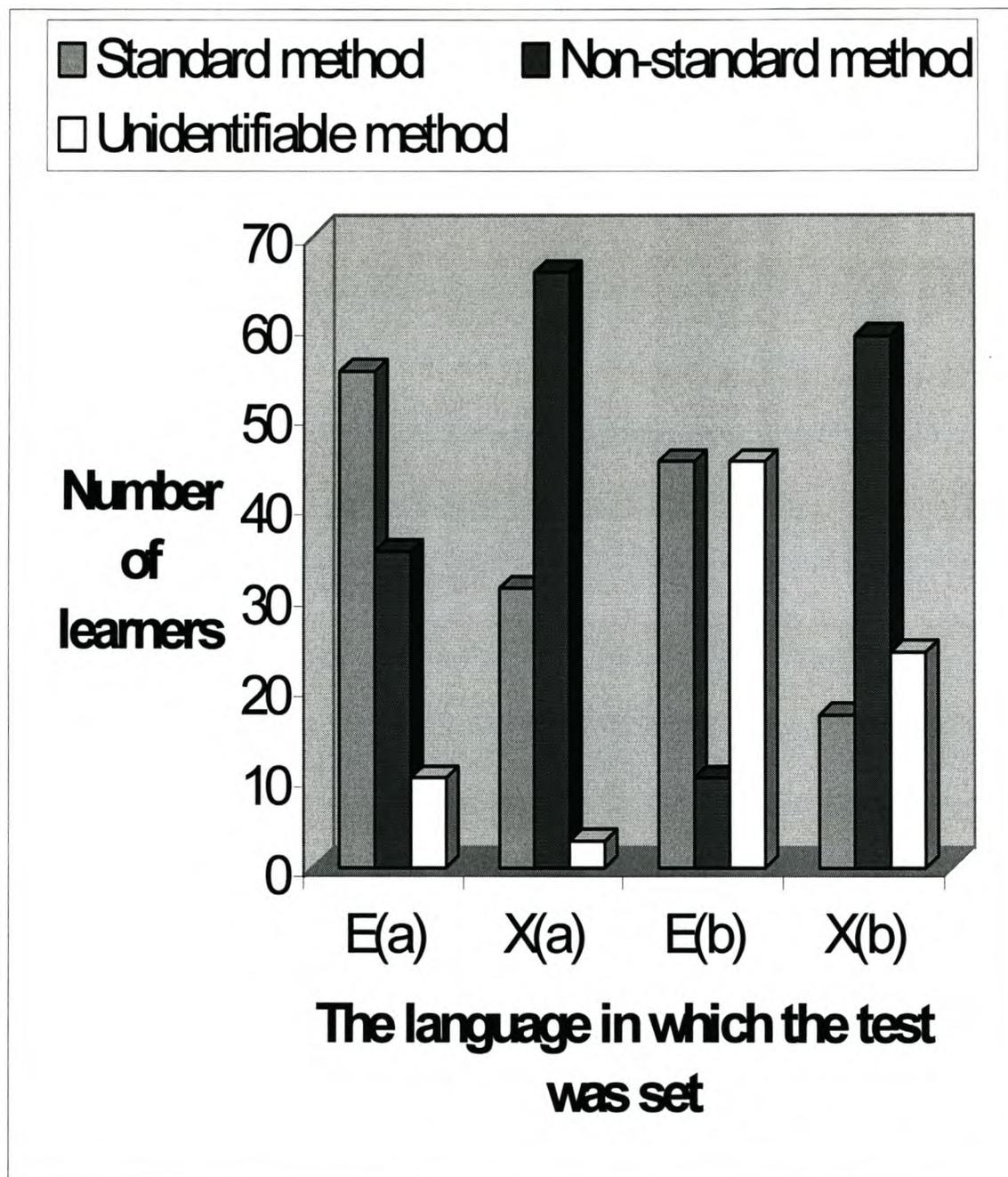
Figure 4.7: The algorithmic methods used by learners in grade 9

Figure 4.8 shows the algorithmic methods for learners in grade 10.
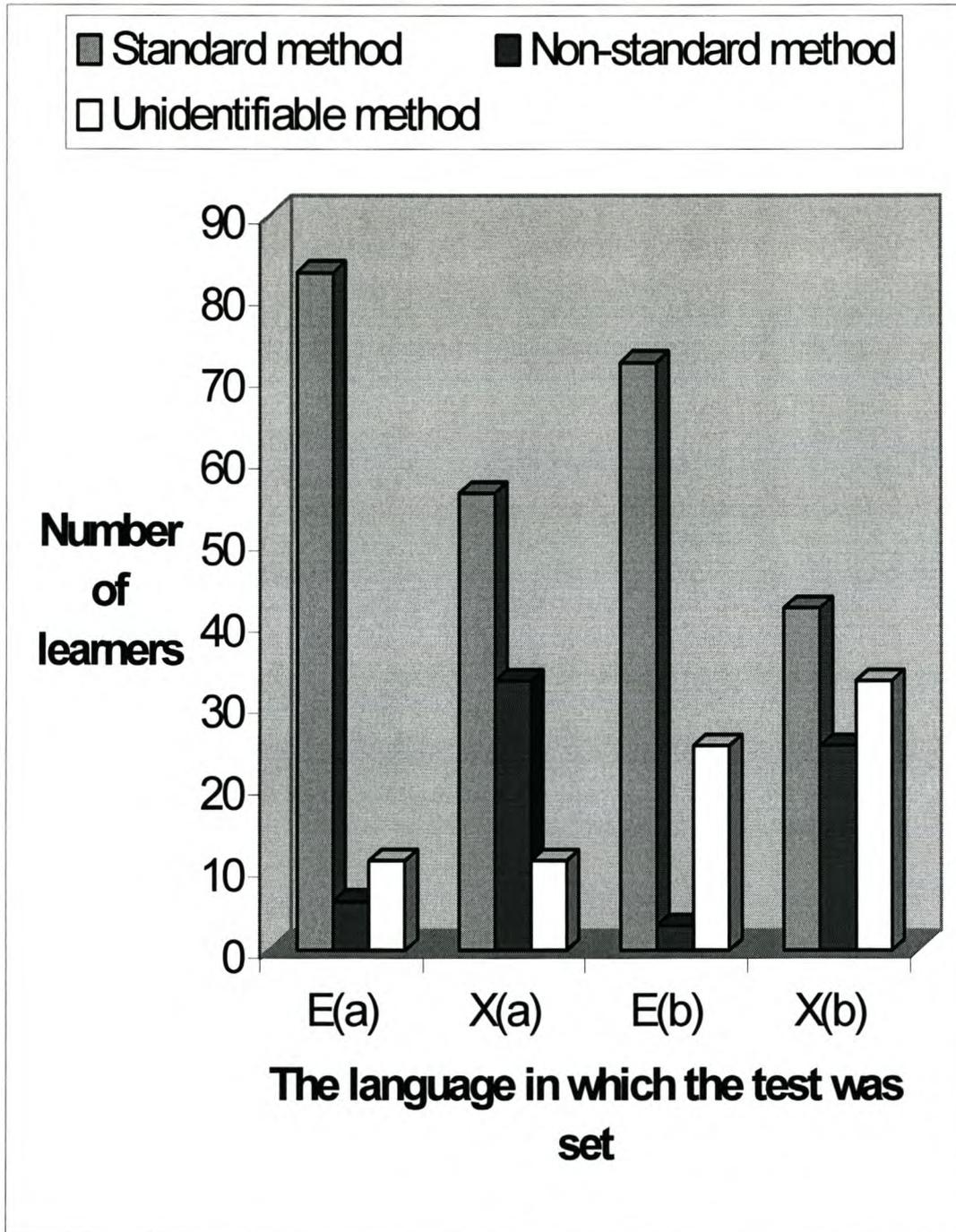
Figure 4.8: The algorithmic methods used by learners in grade 10

4.5.2 Analysis of comparisons 4 and 5

Grade 8, 9 and 10 combined

The results for all the grades combined show that learners have a preference for a particular algorithmic method when they respond to questions set in a particular language. In the questions that require evaluation of a function, the following differences were recorded:

- 25% more learners used standard methods when they responded to questions set in English.

- 31% more learners used non-standard methods when they responded to questions set in isiXhosa.

- 7% more learners used unidentifiable methods when they responded to questions set in English.

In the question that required solution of an equation, the following differences were recorded:

- 24% more learners used standard methods when they responded to questions set in English.

- 38% more learners used non-standard methods when they responded to questions set in isiXhosa.

- 14% more learners used unidentifiable methods when they responded to questions set in English.

The percentage of learners in the category unidentifiable methods shows that in the both questions (a) and (b), more learners falsely interpreted questions when they were set in English than when they were set in isiXhosa.

Grade 8 results

There were differences recorded in the type of algorithmic methods used when learners responded to questions in English and isiXhosa. The following differences were captured for grade 8 learners: In the question that required evaluation of a function:

- 25% more learners used standard methods when they responded to questions set in English.

- 37% more learners used non-standard methods when they responded to questions set in isiXhosa.

- 12% more learners used unidentifiable methods when they responded to questions set in English.

In the question that required solution of an equation:
- 28% more learners used standard methods when they responded to questions in English.
- 45% more learners used non-standard methods when they responded to questions set in isiXhosa.
- 27% more learners used unidentifiable methods when they responded to questions set in English.

The results for grade 8 learners are a replica of the overall results for all the grades. The only exception can be seen in the category unidentifiable methods. In both questions (a) and (b), the number of learners in this category for grade 8 learners is almost double that of all the grades combined. In addition, more learners employed non-standard methods when questions were posed in isiXhosa.

Grade 9 results

The following differences were captured for grade 9 learners:
In the question that required evaluation of a function
- 24% more learners used standard methods when they responded to questions set in English.
- 31% more learners used non-standard methods when they responded to questions set in isiXhosa.
- 7% more learners used unidentifiable methods when they responded to questions set in English.

In the question that required solution of an equation:
- 28% more learners used standard methods when they responded to questions set in English.
- 49% more learners used non-standard methods when they responded to questions set in isiXhosa.
- 21% more learners used unidentifiable methods when they responded to questions set in English.

Grade 9 results follow the pattern already established for grade 8 learners. The only deviation from the overall results can be seen in the category non-standard methods for the solution of an equation. In this category, the differences between responses made in English and isiXhosa increased from 38% (overall results) to 45% (grade 8) to 49% (grade 9). The results for unidentifiable methods are similar to those for grade 8 learners.

Grade 10 results

The results for grade 10 learners show that the differences recorded earlier in some categories have stabilised whereas in others the gap has been bridged considerably.
In the question that required evaluation of a function
- 27% more learners used standard methods when they responded to questions set in English.
- 27% more learners used non-standard methods when they responded to questions set in isiXhosa.
- The same number of learners used unidentifiable methods when they responded to questions set in English and isiXhosa.

In the question that required solution of an equation:
- 30% more learners used standard methods when they responded to questions set in English.
- 22% more learners used non-standard methods when they responded to questions set in isiXhosa.
- 8% more learners used unidentifiable methods when they responded to questions set in English.

In both questions (a) and (b), the number of learners using the standard method has stabilised for grade 10 learners compared to grade 8 and 9 results. In contrast, the number of learners using the non-standard method has dropped noticeably. In the question that required solution of an equation for the category non-standard method, the difference dropped by more than half in comparison to grade 9. For the equation that required evaluation of a function in the same category, the difference between isXhosa responses and English responses also narrowed for grade 10 learners. A conclusion can thus be made that as learners mature, their level of mathematical literacy also matures.

In the equation that required evaluation of a function for the category unidentifiable methods, no differences were recorded in the algorithmic methods employed by learners for both the responses made in English and isiXhosa. In the solution of an equation for the same category, the difference between isiXhosa and English responses was 8%. This is also a remarkable improvement compared to responses from grades 8 and 9.

4.6 Chapter Summary

Whereas chapter 3 compared only some of learner protocols, Chapter 4 compared the results of all learners quantitatively in the form of figures and tables. The following learner categories were compared:

- ❑ The responses to questions set in English were compared to the responses to the questions set in siXhosa. The comparisons were carried out for all learners in grades 8, 9 and 10.

- ❑ The responses to questions set in English were compared to the responses to the questions set in isiXhosa. The comparison was done separately for all the grades i.e. separately for learners in grade 8, separately for learners in grade 9, and separately for learners in grade 10.

- ❑ The responses for learners who first responded to questions set in English were compared to the responses for learners who first responded to questions set in isiXhosa.

- ❑ The algorithmic methods used by learners when responding to questions set in English were compared to the algorithmic methods used by learners when responding to questions set in isiXhosa for all the grades combined.

- ❑ The algorithmic methods used by learners when responding to questions set in English were compared to the algorithmic methods used by learners when responding to questions set in isiXhosa. The comparisons were done separately for learners in grade 8, separately for learners in grade 9, and separately for learners in grade 10.

Based on the results above, differences in the quality of interpretation and algorithmic styles were highlighted. In **chapter 5**, the results presented in chapters 3 and 4 will be discussed.

CHAPTER 5 - DISCUSSION

5.1 Introduction

This chapter discusses the results of the empirical study as reported in chapters 3 and 4. In chapters 3 and 4, differences in the quality of interpretation and choice of algorithmic methods were diagnosed and reported when learners responded to questions set in English and isiXhosa. In this chapter, an attempt will be made to account for those differences observed. The specific focus of the discussion will therefore lie on the salient points embraced within the conceptual framework of the study, i.e. the quality of interpretation of the situations described in the word problems and the choice of algorithmic methods used as a result.

Paragraph 5.2 will discuss the quality of interpretation of the situations described in the word problems and paragraph 5.3 will discuss the choice of algorithmic methods used by learners in response to the word problems. Paragraph 5.4 will give a summary of the whole of chapter 5.

5.2 The quality of interpretation of the situations

The results of the empirical study suggest that the language in which mathematics word problems are posed plays a critical role in learner interpretation of the word problems. This is highlighted in the quality of interpretation observed when a comparison is made between the English and isiXhosa responses. The results are also consistent with the results of the study as reported in Prins (1995) and other relevant literature cited earlier.

Interesting in the study was the way in which the quality of interpretation of the word problems was manifested across the three grades in the two languages. A comparison amongst the grades for the category false interpretation shows the following pattern:

- in the question based on the evaluation of a function, the gap between English and isiXhosa responses for grade 8 was 10%, for grade 9 it was 7% and for grade 10 it was 6% all in favour of isiXhosa.

- In the question based on the solution of an equation, the difference between English and isiXhosa for grade 8 was 30%, for grade 9 it was 31% and for grade 10 it was 11%.

In all the above comparisons, the responses made in isiXhosa were better compared to responses made in English. Even amongst grade 10 learners who had the advantage of exposure to this type of problems, there was a gap between responses made in the two languages under scrutiny, with responses made in isXhosa being better. This shows that learners fare better in mathematical word problems when the questions are posed in a language that they understand better.

The pattern of responses observed for the categories partially correct interpretation and totally correct interpretation mirror the ones shown in the category false interpretation shown above. A conclusion may thus be reached that language discriminates incrementally amongst learners on word problems set in L1 and L2, with the severity of discrimination being felt in the lower classes. The improvement in the quality of interpretation for English questions in grade 10 bears testimony to the diminishing factor of discrimination as one moves across from grade 8 to 10. Grade 10 learners have been exposed to L2 learning for more years compared to grades 8 and 9 learners. Another advantage enjoyed by grade 10 learners is the fact that they are more mathematically mature and may have found the problems to be within their range of abilities. In addition, Mathematics is a choice subject from grade 10 onwards, ensuring that only learners who have a keen interest in the subject and some ability follow it at that level. Not withstanding this advantage, the isiXhosa responses were still better on the categories false interpretations and partially correct interpretations amongst grade 10 learners.

In an OBE mathematics classroom where the understanding of word problems may form part of the critical outcomes of learning, the objectives of learning may be obfuscated if

learners were to be asked word problems in a language they do not fully understand. Also, if the important role to be played by OBE is to substitute the "alienating" type of education with the "self-discovery" type which will be demonstrated by outcomes, then L2 learning will hamper the actualisation of the curriculum. Also based on the results in the previous two chapters, it emerges that learners who responded to word problems in L1 enjoyed a higher cognitive advantage compared to those who responded in L2. Learners with a higher cognitive advantage enjoyed the capacity to fully utilise their intuitive faculty. In a problem-solving didactic environment where learners apply prior learned experiences and gut feeling in solving problems, intuition comes to the fore as the most important component of cognition.

5.3 Choice of algorithmic methods

The results of all the learners show that a substantial number of them used standard methods when presented with questions in English and that when the same questions were given in isiXhosa, they reverted to non-standard methods. Data gathered thus suggests that when responding to questions set in L2, learners prefer algorithmic methods that are normally taught to them at school but when they respond to questions set in L1, they follow basic low-level forms of mathematics which constitute the genesis of numeracy at primary school. Two questions that follow from this observation are:

- Why would learners apply standard algorithmic methods when presented with questions in L2 and at the same time apply non-standard algorithmic methods when presented with similar questions in L1?

- Why would learners apply methods taught at school when given questions in L2 and then revert to common sense and basic numerical logic when the same questions are presented in L1?

The immediate answer to both these questions may be that when learners have to answer to questions set in L2, only one aspect of cognition may be triggered, and that is memory whereas answering in L1 may trigger another dimension of cognition; such as intuition. Intuition, as part of cognition, plays an important role in learning, particularly in a problem-solving classroom environment where learners apply experience and common logic in looking for mathematical solutions. On the other hand memory skills have a limited space in an OBE learning environment. In an OBE classroom, memory skills are shelved and substituted with the demonstration of knowledge in the ability to manipulate numbers in a variety of contexts.

The fact that when they respond to questions set in L1 and L2 learners use different algorithmic styles, seems to suggest that knowledge held in two language systems is disparate and incongruent. This can be deduced from the observation made that different types of cognitive schema were triggered when learners responded in L1 and L2. Kaplan(1980) demonstrated in which ways cultural thought patterns may be linked to language. He went further to illustrate that if learners were induced to think in L1, their thought patterns were completely different from when they were induced to think in L2.

The results also showed a close correlation between the language used in the word problem, the grade of the learner and the type of algorithmic method applied. In the category unidentifiable methods, there was an improvement in learner responses as one moved up from grade 8 to 10. Consistent in all cases was that the majority of cases falling under this category were the responses made in English. In grade 10, there was a considerable narrowing of the gap between English and isiXhosa responses in the same category whereas in grades 8 and 9 the gap was more acute. This is probably due to the fact that grade 10 learners are more mathematically matured and had a superior understanding of the problem situations.

The current mathematics syllabus demands of learners to be able to mathematise. Specific Outcome 9 states that learners should be able to "…use mathematical language

to communicate mathematical ideas, concepts, generalizations and thought processes." In addition, learners should be able to "… construct models and use mathematical notations and symbols" (Human, Olivier, Le Roux, Bennie, Sasman, Liebenberg and Sethole; p60). Mathematisation is a process whereby learners translate mathematical texts into symbols and equations. Also, mathematisation is described as the process by which reality is trimmed to the mathematician's needs and preferences and a process by which the organizing ability of the mathematician, whether it affects mathematical content and expression or more naïve intuitive lived experience is expressed in everyday language (Freudenthal; 1994). Learners expressed different capacities for mathematisation when they were presented with word problems presented in L1 and L2. Is it because other languages are best suited to enhance learner mathematising capacities than others or is it a matter of experience that when question are set in a particular language certain specific mathematical procedures should be followed? From the manner in which learners organised their algorithms, there was a definite pattern of thought which seemed to predominate when they were faced with questions in a specific language. Mathematisation in upper classes will demand of learners to demonstrate their capacity for abstract thinking by setting up models than merely to use repetitive additions.

Learners were unable to show capacity for abstract thinking when presented with questions in L1 but were able to demonstrate a better understanding of the given problem situations. When presented with questions in L2, they showed some amount of higher order thinking by setting up mathematics models but they could not demonstrate a better understanding of the described situations. The probable explanation for this is that when questions were presented in L2, which is MOI, classroom experiences were triggered which made learners use methods they were taught at school. On the other hand, when questions were given in L1, "street-acquired" skills were triggered which made learners apply methods that are usually used in the field of play and home environments. Following from this argument, it may be as well that were learners to be instructed in L1, they are likely to employ higher-order thinking skills if questions are to be presented in L1.

5.4 Chapter Summary

The results of the study were discussed in this chapter. The discussion focused on the quality of interpretation of the situations described in the given word problems and the choice of algorithmic methods used by learners.

In **chapter 6**, a review of the study, followed by its implications for assessment and major conclusions reached will be discussed.

CHAPTER 6- REVIEW, IMPLICATIONS FOR ASSESSMENT AND CONCLUSIONS

6.1 Introduction

In this chapter, a review of the whole study will be commissioned. This will be followed by the implications the study carries for the assessment of word problems in L2. Conclusions will also be drawn from the findings.

In the review, a synopsis of the study will be done. This will focus on the literature study, data collection and methodology, qualitative and quantitative analyses and conclusions.

The conclusions and implications will be deciphered from the main focus of the study. The major pivot points of the study are:

- ❑ Do isiXhosa-speaking learners' quality of interpretation of Mathematics word problems differ when they respond to similar word problems posed in English and isiXhosa.

- ❑ Do isiXhosa-speaking learners apply different algorithmic methods when they respond to similar word problems set in English and isXhosa.

6.2 Review

The first chapter included an introductory section and a survey of relevant literature. A survey of the literature was influenced by the main inclination of the study. The study is about establishing whether learners' quality of interpretation and algoritmic methods differ when they respond to similar word problem set in English and isiXhosa. The major influence of this study was a previous similar one done by Prins (1995). Prins' study was an ethnographic one and focused on learners who spoke English as L1, Afrikaans as L1 and African languages as L1. The focus of the present study is on learners who speak isiXhosa as L1 and English as L2. The broad focus is on the ways in which language affect learners when they respond to mathematical word problems. The literature survey

included other linguistic parameters such as culture, the language register, distance between MOI and L1, role of keywords in reading mathematical text and bilingualism.

A unique empirical research design was done in order to realise the objects of the study. Instead of dividing learners into two groups, one group responding to the word problems in L1 and the other in L2, the design was arranged differently. Each learner was given the opportunity of responding to the word problems in both English and isiXhosa. The data was collected in such a way that learners reflected their thoughts on paper. From learner algorithmic methods and heuristics, data was collated.

Data was analysed in two forms, i.e. qualitatively and quantitatively. The qualitative analysis looked at learner protocols and compared learner algo-heuristic methods. The quantitative analysis looked at the number of learners responding in the two languages who could be classified under the categories mentioned earlier. The two broad categories under which learners were classified were; the quality of interpretation of the given word problems and the algorithmic methods that they employed in response to the word problems.

The following conclusions were drawn based on the analysis of the results:
- ❏ When isiXhosa-speaking learners are given word problems set in English and isiXhosa, their interpretation of the word problems set in isiXhosa are qualitatively better compared to those set in English.
- ❏ When isiXhosa-speaking learners are given word problems set in English and isiXhosa, they consistently preferred repetitive additions when the word problems were posed in isiXhosa and the cross-multiplication algorithmic method similar word problems were set in English.

6.3 Implications for assessment

Despite the limitations of the study, particularly as it relates to its scope and breadth, it is however, a miniature true reflection of the realities as obtained in ex-DET schools. With OBE to be introduced in grade 9 in 2002 as the final year of GETC, there is no doubting the significance of this study.

The fact that learners performed under par in word problems when they were posed in L2 as compared to when posed in L1 suggests an overhaul of assessment criteria in problems that require some form of mathematisation. This also carries huge implications for pedagogy since assessment methods as relates to the language of the test instrument can never be looked in isolation to the language of instruction in general. The Bantu Education Act of 1953 followed by the 1976 student uprising was a culmination of a groundswell triggered by a system of education that fostered Afrikaans as MOI on African learners. The introduction of indigenous languages seems not to be a likely substitute for L2 learning. Should L1 be introduced in ex-DET schools as MOI, this is likely to elicit a response reminiscent of the 1976 student revolt. Many African parents are not likely to welcome L1 learning for their children as they regard English as the gateway to success into the world of business and commerce.

Education practitioners need to be aware of the implications of assessing learners in a language they have not fully mastered. In that respect, their assessment methodologies should be informed by the practicalities as obtains in L2 classroom. Learner deficits in language should be scaffolded and supported, and were needs be, code-switching and code-mixing should be applied appropriately as support mechanisms. Prins (1995) argues that readability problems are often the result of a mismatch between assessment and teaching practice. Examiners should therefore ensure that examination questions are in line with instructional objectives. Instructional objectives cannot be realised if learners are assessed in a language they do not comprehend, particularly in a situation that demands some form of mathematisation.

Alexander (1989) suggests that in order to alleviate the problem of assessing (and teaching) in L2, a Swahili-type of Creole languages should be introduced in order to accommodate the majority of African learners. He suggests that a system of two languages should be developed. One of these language systems he calls the Sotho group and the other the Nguni group. The Sotho group should include Sepedi, Setswana and Sesotho whereas the Nguni group should include isiXhosa, isiZulu, isiNdebele and Siswati. Notwithstanding this genuine proposal, I believe its major shortcomings are:

- ❑ it is silent on what should happen to Tshivenda and Xitsonga learners. In addition, there is a majority of other South Africans (about 25%) whose languages are not necessarily related to either of the "Sotho" or Nguni languages. These are people whose languages are not considered as official languages. Some of these languages may actually be a combination of two or more of the so-called official languages.
- ❑ One other shortcoming of this proposal is that it assumes that all of the so-called Sotho or Nguni languages are semantically related. This is not necessarily the case. As a matter of fact, isiSwati and isiNdebele are more structurally related to some of the Sotho languages than they may be to isiXhosa. The languages grouped also differ in syntax and morphology which renders this suggestion rather than untenable.

The major pedagogic outcome of the study was to reveal that when assessed in L1, learners employ unique algorithmic strategies than when assessed in L2. One may be prompted to say that learners use methods that come from the "heart" when assessed in L1 and methods that come from the "head" when assessed in L2. This goes on to give credence to the notion that assessing learners in L2 does not involve them intuitively and emotionally. The component of cognition that is activated the most in L2 learning seems to be that of memory. If questions are asked in L1, other components of cognition, including intuition and reasoning are called upon.

6.4 Conclusions

The major conclusions coming from this study can be summarised as follows:

- IsiXhosa-speaking learners understand mathematics word problems better when they are set in isiXhosa rather than English.
- IsiXhosa-speaking learners employ repetitive additions when they respond to word problems set in isiXhosa and cross-multiplication when they respond to similar word problems set in English.

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APPENDIX

A

Name_____

Surname_____   Class_____

Date_____

Umbuzo 1

UHenry ufuna ukuzithengela ibhayisikile. Ibhayisikile ayifunayo Ibiza ama-R760.
Imali anayo ngama-R320. Ngoku umana agcina ama-R8 ngeveki kwimali
ayifumanayo ngokusebenza ekhefi ngemgqibelo.

(a) Yimalini iyonke imali azakube selenayo kwiiveki ezili-12 eqalile ukugcina
imali?

(b) Zingaphi iiveki ekufuneka agcine imali kuzo ukuze abe unawo lama-R760
awafunayo?

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APPENDIX

B

Name_____

Surname_____   Class_____

Date_____

Question 2

A bricklayer was asked to complete a building that was unfinished. The unfinished building already had 3000 bricks laid on it. The bricklayer was asked to lay 350 bricks a day.

     (a) How many bricks will the house have in total 6 days after starting to build if the bricklayer continues to lay 350 bricks per day?

     (b) After how many days will the building have 42000 bricks in total?