"GRADE 10 ENGLISH SECOND LANGUAGE PUPILS' DIFFICULTIES WITH PARADOXICAL JARGON AND TECHNICAL TERMS COMMONLY USED IN THEIR MATHEMATICS CURRICULUM"

Tsepo Poni

A research report submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science

Johannesburg, 2000

DECLARATION

I declare that this research report is my own, unaided work. It is being submitted for the Degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

Signature ....

...09...... day of ...March...... 2000

ABSTRACT

This study investigates the extent of the difficulty that Grade 10 English second language learners have with some of the mathematics terms which are commonly used in their curriculum A selection of twenty technical terms and thirteen paradoxical jargon terms was extracted from four different textbooks used for their syllabus. A multiple-choice test was constructed and given to them. A huge and disturbing percentage of the learners writing the test could not choose the correct meaning of both the technical and paradoxical jargon terms tested. Although the learners performed better on the paradoxical jargon section than on the technical section of the test, the difference was shown to be not significant. These results have serious implications for the teaching and learning of mathematics.

To my wife, Nosidima, and children, my whole loving family, for their continued support and encouragement.

ACKNOWLEDGEMENTS

I would like to thank the following people:

My supervisor, Mr. John Blay, for his intelligent ideas, advice and encouragement

Professor Jill Adler, for her encouragement during the initial phase of the research work

Brian, for making his facilities available for me to write the report

I owe my greatest debt to my wife, for her continued support and encouragement.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The study is set against a background of concern over language-related problems in mathematics education. The personal experiences of the researcher, both as high school student (the medium of instruction was English, which is not my mother tongue) and as a mathematics teacher, regarding language-related problems in mathematics education, largely motivated the present study.

Many students, for whom English is the second language, experience a lot of difficulty in adequately expressing themselves in English, the medium of instruction. Likewise, they find a great deal of difficulty in understanding instructions given in English. This difficulty is aggravated in subjects like "Mathematics" where a number of mathematics terms are commonly used, which may reduce the students' success in mathematics. Mathematics vocabulary is highly specialised and seems difficult to assimilate when compared with the vocabulary of everyday language.

Austin and Howson (1979) mention that it has been argued that the extra effort required to acquire a working knowledge of mathematical language is a significant factor in deterring children from pursuing their study of mathematics with enthusiasm or beyond the compulsory stage. They further point out that many students, including many university students of analysis, never achieve such knowledge and abandon their studies still confused by the strangeness of the concepts which have been thrusted upon them

1.2 PURPOSE OF THE STUDY

The purpose of the study is to identify the extent of English second language students' difficulties caused by certain terms commonly used in grade 10 mathematics curriculum. The understanding of technical terms used in mathematics, as well as paradoxical jargon terms, each embedded in sentences in a mathematical context, was tested.

1.3 IMPORTANCE OF THE STUDY

The study will throw some light on the extent of the difficulty grade 10 English second language pupils have with some of the mathematics terms which are commonly used in their curriculum. Some teachers take for granted the understanding of these terms. The findings of this study will not only make teachers aware of the problems learners face, but make them realise that the teaching of mathematics terms is an important part of mathematics teaching.

1.4 RESEARCH QUESTIONS

The following research questions were addressed by the study:

1.4.1 What is the extent of the difficulty that English second language grade 10 pupils have with some of the terms commonly used in their mathematics text books, including

(a) paradoxical jargon, and
(b) technical terms ?

1.4.2 Do pupils experience significantly greater difficulty with paradoxical jargon or with technical terms?

1.5 PROCEDURES FOLLOWED

The initial phase of the study involved an extensive literature review to establish what language-related problems had been identified by researchers in mathematics education. Having established that, the study was carried out in phases:

(a) Phase One : Developing and administering the probe
(b) Phase Two : Developing and piloting the multiple-choice test designed for the main study.
(c) Phase Three : Administering the multiple-choice test for the main study.
(d) Phase Four : Analysis of data.

1.6 THE SAMPLE

The study was done in one of the school in Soweto. All the grade 10 pupils, who were taking mathematics as one of their subjects were involved in the study. There were 112 such pupils at the school. The age of the pupils raged from 14 to 20 years. The choice of subjects was based on convenience sampling.

Breakdown of learners was as follows:

(a) Phase One - Probe (Pilot) = 19 learners

- Probe (Real) = 44 learners

(b) Phase Two- Test (Pilot) = 21 learners

(c) Phase Three - Test (Real) = 112 learners

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Several studies have been done on the usage of technical and paradoxical jargon terms in scientific subjects. However, where mathematics is concerned, all these investigations were done in schools where English is the mother tongue of the pupils. Studies that involve English second language pupils have been done, but in other science subjects, for example, Nhlapho (1993) and Mokuku (1993) in biology. This study investigates the effect of usage of technical terms and paradoxical jargon in the learning of mathematics where English is used as a second language.

Technical terms are specialised words of mathematics, which have a meaning only in mathematical English (Shuard and Rothery, 1984), for example, *hypotenuse*, *parallelogram*, etc.

Aiken (1972) brings to our attention studies conducted by, for example, Hansen (1944) and Treacy (1944), which indicate that knowledge of technical vocabulary is important in solving mathematics problems and consequently should be a goal of mathematics instruction. He also cites Johnson (1944) that the findings of his studies showed gains in problem-solving ability when pupils were given specific training in mathematics vocabulary. Shuard and Rothery (1984) point out that mathematical words are unlikely to be used at home or in the child's everyday speech, and so they cause problems simply because they are rare in the child's experience. They also point out that one source of difficulty is that many mathematical words have Greek origins, for example, the word isosceles, which derives from the Greek words *isos* (equal) and *skelos* (leg).

Otterburn and Nicholson (1976) did a small-scale investigation of how well each of a list of technical words used in mathematics was understood by a group of 300 pupils following a Certificate of Secondary Education (CSE) course in Northen Ireland. The results showed serious difficulty with many of these words. A similar study carried out by Nicholson (1977) with students following the CSE course in Northen Ireland gave the same result. Hardcastle and Orton (1993) carried out an experiment modelled on the work of Otterburn and Nicholson, the exception being that the pupils were 12 years old, that is, several years younger than in the earlier study, and the results indicate that the problem of whether our students know what we are talking about is still with us.

Paradoxical jargon terms are words which have more than one meaning. These are words which occur in both ordinary English and mathematical English, but which have a different meaning in mathematics from their meaning in English (Shuard and Rothery, 1984). Examples of such paradoxical jargon include *product*, *parallel*, etc.

Shuard and Rothery (1984) point out that the main cause of their difficulty is the confusion which can arise when a word has a variety of meanings, and when the required meaning has to be inferred from the context. Pimm (1987, 8) states *"mathematical discourse is notorious for involving both specialised terms and different meanings attached to everyday words."*

There are instances where the mathematical usage of a certain term has resulted in an alteration in meaning or connotation of an ordinary English word. In many cases everyday meaning of words is carried over to the mathematical setting, resulting in a number of difficulties. Pimm (1987) also points out that many confusions occur as a result of differing linguistic interpretations, where the teacher, for instance, might be employing terms from what has been loosely called a mathematical 'dialect', with the pupils interpreting everything they hear as ordinary English, thus trying to use non-mathematical meanings in a mathematical context. He cites an instance where in a response to the written question, *"what is the difference between 24 and 9?"* one pupil replied, *"One's even and the other's odd"*, whereas another said, *"One has two numbers in it and the other has one."* These responses suggest a failure to comprehend the term *difference* as being used in a mathematical sense whose meaning involves the notion of subtraction.

2.2 LANGUAGE AND THOUGHT

Vygotsky (1971) relates language development to the learning of mathematics, and points out that there is a link between thought and language and, therefore, concept formation and language development go hand in hand. For Vygotsky, *"word meanings are dynamic rather than static formations. They change as the child develops; they change also with the various ways in which thought functions"* (Vygotsky, 1971, 124). It seems reasonable to conclude from this that the relation of thought to word is a continuous process. This implies that the complicated meanings involved in mathematics will have to be negotiated very carefully with children, as the attempt simply to impose could give rise to much confusion and misunderstanding.

Mercer (1985) points out that successful retention and comprehension by children depends very largely on such matters as (1) the motivation of both teacher and child to attend to and communicate with each other, and (2) the extent to which teacher and child have a shared understanding, a common framework of language and concepts whereby new information can be related to matters already understood and remembered. In mathematics this involves the process mentioned above, that is, that of negotiation of meaning.

Brodie (1989) summarized that Vygotsky's research and explanation of his findings argue that:

1. The primary way in which our experience and learning are mediated is through language, particularly spoken language or speech;

2. Our cultural and social knowledge and ways of thinking develop through the use of language and other sign systems;

3. People use language to communicate with each other in social contexts, that is, people's communication is mediated by language. The individual

internalizes the social use of language, and internalized language then mediates the individual's thinking.

So, Vygotsky saw language as playing a special role in the development of thought. He argues that, "the specifically human capacity for language enables children to provide for auxiliary tools in the solution of difficult tasks, to overcome impulsive action, to plan a solution to a problem prior to its execution, and to master their own behaviour. Signs and words serve children first and foremost as a means of social contact with other people. The cognitive and communicative functions of language then become the basis for a new and superior form of activity in children, distinguishing them from animals" (Vygotsky, 1978, 28-29).

2.3 ROLE OF LANGUAGE IN THE MATHEMATICS CLASSROOM

Chapman (1997) makes the point that Wittgenstein (1978) regarded mathematics as a functional form of communication; people play "language-games" and "sign-games" to invent, rather than discover, mathematics. Chapman also cites Watson (1989) who discusses the implications for teachers of a Wittgensteinian view of mathematics: "Recognising mathematics as a functional form of communication is to identify the purposeful and shared activity of a mathematics lesson as the making of meaning explicit; the practice of using words in the right patterns of discourse; the illumination of the role that words play when we do something either with material objects or with graphic symbols. In mathematics lessons we are inducting children into the use of a range of mathematics registers, we arrange things so that the words with more complex meanings build upon those words not so deeply embedded in the theoretical structure. In mathematics lessons children are appropriating a schema of meaning; a schema which grows from the semantic structure of Indo-European languages; a set of concepts which are the historical product of the Western form of life. Recognizing mathematics as a social product helps us identify that it is socially situated, and children as social agents, no less than their teachers, stand in a certain social disposition towards its meanings" (pp. 25-26).

Chapman (1997) charges that learning mathematics is a matter of being socialised into the culture of school mathematics. This culture includes many social systems, one of which is language. Language can be considered the primary social or semiotic system in the sense that it is the most readily "seen" and "heard" in the classroom. However, it works alongside other semiotic systems, such as graphic, ordering and constructing angles, and cannot be understood in isolation. One can readily say, therefore, that enculturation into mathematics requires facility with the use of language.

Chapman also argues that learning school mathematics involves learning to operate its "language system" and "meaning system" together. The meaning system of mathematics includes its content matter and specific ways of thinking and meaning. The content can be described as cultural knowledge and the ways of speaking and acting as cultural behaviour. Language is a fundamental part of culture, and being socialized into the culture of mathematics necessarily involves learning its language.

It is evident, therefore, that in most classroom interactions, teachers and learners are engaged in a discourse in which they draw on language and other semiotic resources to construct and share mathematical meanings. In other words, teachers and learners use language as a resource with which to negotiate and communicate mathematical meanings.

Adler (1998) further emphasizes that school mathematics needs to be understood as a discursive subject or as a set of discourses, where "discourse" means open language as it is used to carry out a social and intellectual life of a community where the mathematical register is part of the discourse. From this perspective, learning mathematics entails acquiring, recognising and developing specific ways of using a language or, in Lave and Wanger's terms, learning to talk.

Furthermore, Adler (1998) charges that school mathematics is learned through discourse, through language use in the classroom. Mercer (1995) distinguishes between educational discourse, which is the discourse of teaching and learning in the classroom, and educated discourse, which is the new ways of using language, ways with words which will enable learners to become active members of wider communities of educated discourse (p. 82). In other words, language is being used to "talk mathematics", that is, both to talk about mathematics and to talk mathematically.

Anghileri (1995) argues that limitations in learners' understanding of the symbols and language of mathematics may inhibit choice of appropriate solution procedures for certain problems. She further argues that the teacher's role in developing understanding should involve negotiation of new meanings for words and symbols to match extensions to the procedures that become appropriate for solving problems. Anghileri (1995, 13) suggests that in order to develop the skills needed to solve arithmetic problems, (a) learners need to:

1. realise that some words and symbols have multiple meanings;

2. become aware of the limitation of some meanings attached to words and symbols;

3. be convinced of the need to progress from naïve interpretations to new terminology;

4. be aware that teachers' and other learners' meanings may differ from their own;

5. be able to select appropriate interpretations of words and symbols and adapt procedures to match different types of problems.

and (b) teachers need to:

1. listen to learners to access existing meanings associated with words and symbols;

2. be aware that there may be discrepancies between teacher meanings and learner meanings of words and symbols;

3. provide experiences that illustrate a diversity of meanings for words and symbols;

4. use language that has meaning for individual learners as well mathematical correctness.

Therefore, teachers need to devise strategies for classroom interactions, being both responsive to the learner's existing understanding and proactive in negotiating new meanings. Opportunities to share their thinking with others will encourage learners to reflect on the method and language they themselves use and become aware of alternative interpretations and strategies.

In the foregoing discussion, it is evident that language is central to the social practice of school mathematics. It is a semiotic system, or resource, with which teachers and learners construct and share mathematical meanings. Language is one of multiple semiotic resources deployed in the classroom to produce meaning constructions. Further, learning mathematics involves learning its characteristic patterns of language use, its register and its genre forms.

In summary, two points are being made about the complex and pervasive part that language plays in mathematics. First, within the culture of the mathematics classroom, language is a fundamental social process. In any mathematics classroom, one inevitably sees teachers and students reading, writing and talking mathematics and about mathematics.

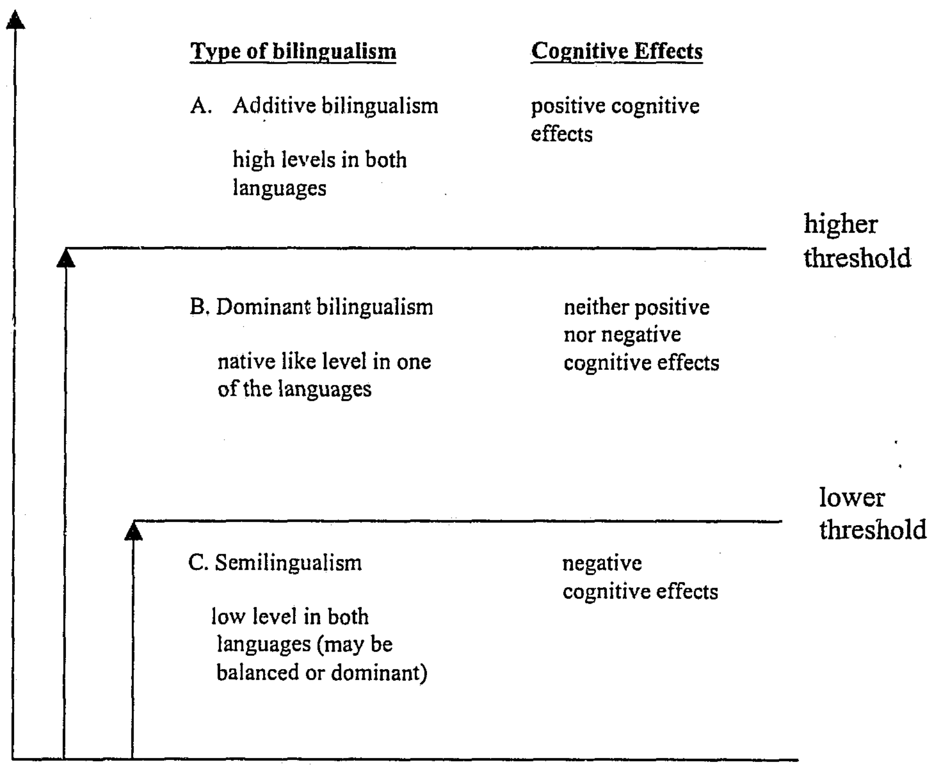
Second, language works together with many other social practices to constitute school mathematics. Mathematical meanings make use of multiple semiotic resource systems, one of which is language. Others include for example drawing, gesturing and measuring. The primacy of language in teaching and learning mathematics is evident. Nevertheless, it cannot be understood apart from the many other semiotic practices of school mathematics, nor can it be understood outside the social context in which it occurs.

2.4 BILINGUALISM IN THE LEARNING OF MATHEMATICS

Austin and Howson (1979) point out that the most obvious problem encountered in developing countries is that caused by learners having to learn mathematics in a language other than their mother tongue. Dawe (1983) maintains that whatever the medium of instruction it would seem likely that mathematical reasoning in the deductive sense is closely related to the ability to use language as a tool for thought, and in the case of bilingual children this involves competence in both languages. The implications of this in mathematics education is that incompetence in the language in which mathematics is taught could potentially affect the ability of pupils in the formation of mathematical concepts.

Brodie (1989, 44) cites Cummins (1979) who claims that "the key to understanding educational outcomes of a variety of bilingual education programs operating under very different conditions lies in recognising the functional significance of the child's mother tongue in the developmental process".

Cummins further proposes two hypotheses that explain the interaction of language and cognitive development in the bilingual learner. One of them is the threshold hypothesis that consists of two thresholds of linguistic competence that are important in explaining cognitive growth and academic achievement. Learners whose linguistic competence places them below the lower threshold might be said to be semi- lingual; that is they have less than native-like skill in both languages. This can lead to negative academic and cognitive effects. Learners who attain the upper level achieve a high level of competence in both languages and this can lead to positive academic and cognitive effects. Learners in between achieve a high level of competence in one language and this can lead to neither positive nor negative academic and cognitive effects. The threshold hypothesis is described in the diagram below.



Threshold levels and cognitive effects of different types of bilingualism (adapted from Brodie, 1989,44)

In a study comparing Grade 6 bilingual and monolingual students of mathematics, Clarkson (1992) found clear evidence for regarding bilingual students with low competence in both languages as being disadvantaged in mathematics when compared to the other groups. The results of his study further supported the notion that competence in both languages can bring advantages for bilingual students in the classroom.

Clarkson's (1992) research suggests that the influence of the student's original language is cognitively important right through primary school. Therefore, the potential advantage of encouraging students to use their original language in academic situations needs to be explored sensitively. These results also point out that the use of the student's original languages could be used to good effect in the classroom in accessing the mathematical ideas of local cultures in the local language, without the fear of disadvantaging students.

Keeping in mind that differing types of bilinguals revealed different obstacles in solving mathematics word problems, Whang (1996) suggests the need to identify the type of bilingualism and grades before getting into mathematics lessons. In the case of English dominant and additive bilinguals, teachers need not be overly concerned about student's language related difficulties in solving mathematics word problems written in English. In case of mother tongue dominant bilingual, teachers need to be careful in teaching and assessing mathematics word problems since these bilingual learners could not understand word problems because of their lack of knowledge of English language. Teachers need to pay special attention to bilinguals who are in the transition as it is unstable and changing.

2.5 PROBLEMS ENCOUNTERED BY ENGLISH SECOND LANGUAGE LEARNERS IN MATHEMATICS

Learners who speak English as a second language could be expected to have more difficulties in solving Mathematics problems because of their potential lack of knowledge of the English language (Whang, 1996).
Aiken (1972, 359) states *"It is generally recognised that not only do linguistic abilities affect performance in mathematics, but that mathematics itself is a specialised language"*. Part of learning mathematics is learning to speak like a mathematician, that is, acquiring control over the mathematics register. Halliday (1975, 65) describes the term *register* as a *"set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings."* He refers to a *"mathematics register"*, in the sense of the meanings that belong to the language of mathematics (that is, the mathematical use of natural language, not mathematics itself), that a language must express if it is used for mathematical purposes.

Adetula (1990) conducted an investigation on the effect of language on Grade 4 children's performance on mathematical word problems. English is their second language, although it is the medium of instruction. The findings of this study indicate that performance was better both in skills and strategies when mathematics word problems were presented in children's native language than when presented in English. Adetula claims that her findings are in accord with other research studies in this field. In an attempt to understand this finding, Adetula referred to Newman's (1983) hypothesis, which asserts that a person confronted with a written verbal problem has:

(1) to read it,

(2) to comprehend what he has read,

(3) to carry out the transformation from the words to the selection of an appropriate mathematical model,

(4) to apply the necessary process skill and finally,

(5) to encode the answer.

From this hypothesis, it is clear that the poor performance (both in skills and strategies) of English second language children on problems presented in English was not because of lack of intelligence. Rather it was due to the stumbling block created by the language of the problem presentation, which led to faulty problem transformation.

Brissenden (1988) points out that mathematical talk is felt to be extremely important in its own right, and suggests that making it a major element in our mathematics lessons will provide many opportunities to contribute to language development. It is, of course, part of the teacher's role to inject mathematical terminology and usage into discussions with his or her students.

Nhlapho (1993) cites Dolan and Clarke (1979), who claim that science teachers have serious problems introducing technical and scientific terms, because pupils often just commit definitions to memory without understanding what these terms mean.

Brissenden (1988), however, maintains that the process of introducing mathematical terminology should be seen as one of *negotiation of meaning* between teacher and pupils rather than one of *imitation* by the pupils of what the teacher says. In the former, formal definitions evolve as outcomes, not as dogmatic starting points which pupils struggle to accept without being able to appreciate the underlying reasons for the choices which have been made.

Barrass (1979) argues therefore that technical terms may aid clear thinking and communication, but may also be a barrier to effective communication if they are not understood by the teacher or pupil. The care with which terms are introduced, defined and employed will, therefore, be crucial to the child's understanding of them.

In another attempt to find a remedy for language-related problems in a multilingual classroom, Setati (1998) proposes the notion of code-switching. Code-switching, as Setati cites Barker (1993, 76-77), "is when an individual (more or less deliberately) alternates between two or more languages. [...] Code-switches have purposes. [... There] are important social and power aspects of switching between languages, as there are between switching between dialects and registers". She also cites Merritt *et al* (1992) who argue that code-switching provides an additional resource for meeting classroom needs. "Apart from being an educational resource, the use of the learner's first language is a key to the world and culture of the learners involved. It enables the participants to make relevant connections with their lives beyond the school" (Setati, 1998, 40).

Research findings have also shown that where the first language is promoted and valued at school and at home, English second language pupils achieve success at school. For instance, Cleghorn and Dube (1998) quote Carey (1991), Cummins (1994) and Wong-Filmore (1985; 1991) who charge that learning via a second language is facilitated when the first language is allowed to develop further in, as well as out of, school.

2.6 CONCLUDING REMARKS

In this chapter, the relation between thought and language has been outlined, highlighting the role of language within the social process in the mathematics classroom. Interaction processes between the teacher and learner and between learner and learner in the classroom were also analysed, and some possible solutions to related problems were explored.

Particular focus was paid to the challenges posed by learning and teaching mathematics in a multilingual classroom. Code-switching and the need to identify the types of bilingualism before undertaking a lesson were cited as possible remedies for this problem.

CHAPTER THREE

A DESCRIPTION OF THE METHODS FOLLOWED

3.1 OVERVIEW OF THE RESEARCH

A literature review was carried out in order to determine what research had been done and what language-related problems in mathematics education had already been identified. Having done this, the study was carried out in four distinct phases:

(a) Phase One : Developing and administering the probe
(b) Phase Two : Developing and piloting the test
(c) Phase Three : Administering the test
(d) Phase Four : Analysis of data

3.2 PHASE ONE

(A) DEVELOPING THE PROBE

This phase involved a preliminary study in which 44 pupils were given open-ended questions, that was, questions that required explanations or descriptions, on paradoxical jargon and technical terms used in grade 10 mathematics syllabus. 20 paradoxical jargon and 20 technical terms were selected from grade 10 mathematics textbooks for this task. These Mathematics textbooks were Classroom Mathematics, Mathematics for Today, Active Mathematics and Mathematics in Action (see Appendix One).

The purpose of the probe was to determine each pupil's understanding of the meaning of each term. Following the method of Nhlapho (1993), each term was embedded in a sentence in a mathematical context, and the pupils were asked to explain what they thought the term meant. They were requested to answer in one of the following ways:
(a) by giving an explanation
(b) by giving a synonym
(c) by illustrating with a diagram
(d) by giving a combination of any of the above

To make the length of the test suitable for the pupils, each pupil wrote either the technical or paradoxical jargon section of the probe. That is, half the class wrote the technical section, and the other half, the paradoxical jargon section.

After developing, the test was given to two people (experts) for face validation, and there were some modifications that had to be done.

The terms that were selected, listed alphabetically, may be found in Table 1 below.

Table 1: List of technical and paradoxical jargon terms selected

TECHNICAL	PARADOXICAL JARGON
Abscissa	Closed
Asymptote	Compliment
Axiom	Cube
Binomial	Difference
Equation	Exponent
Hypotenuse	Face
Integers	Fraction
Isosceles	Function
Numerator	Odd number
Ordinate	Parallel
Percentage	Prime number
Perimeter	Product
Perpendicular	Proper Fraction
Quadratic	Range
Quadrilateral	Rational
Ratio	Reciprocal
Rectangle	Right angle
Square root	Root
Triangle	Sum
Trinomial	Term

(B) PILOTING THE PROBE

The probe test was piloted with 19 pupils, mainly to check problems with the clarity of the language used, and in the time allocated to write it. No difficulties were observed or reported.

(C) ADMINISTERING THE PROBE

The researcher administered the probe and he emphasized to the pupils that they should try to do their best and they should be as honest as they can. They were also told that the test would help future pupils as it would help teachers to understand problems that pupils were experiencing.

(D) RESULTS OF THE PROBE

The responses of the pupils were analysed for frequencies of responses. Those that appeared most often were used to provide distracters for the multiple-choice test to be developed for the main study.

3.3 PHASE TWO

(A) DEVELOPING THE MULTIPLE-CHOICE TEST

A multiple-choice question was developed for the main study. As pointed out by Nhlapho (1993), the reasons for choosing to use a multiple-choice test are that:
(a) they are easy to mark and analyse,
(b) they are quicker to complete so less school time is required by the researcher, and
(c) multiple-choice tests penalise English second language learners less than tests using an open-ended format where these learners have to express themselves in a second language.

Following the method of Nhlapho(1993), for each question in this test, learners were requested to indicate how confident they were about their chosen answers. They were provided with three choices to mark: sure (if absolutely sure); not so sure (if not sure); guessing (if do not know, but has chosen an answer). This gives some information on whether or not some of the correct answers were guessed.

(B) VALIDATING THE TEST

After developing, the test was given to two people for face validation. As in the case of Nhlapho (1993), they were asked to check mainly that :
(a) the language and grammar were correct;
(b) the instructions were clear and unambiguous;
(c) the items were independent of the other items in the test, that is, the answer to one item did not give away the answer to a later item; and
(d) only one correct answer had been provided

As a result of the experts' scrutiny and careful assessment of the terms featured in the probe test, seven items from the paradoxical jargon section were dropped from the multiple choice test.

(C) PILOTING THE TEST

After face validation, the test was piloted with 21 learners, each learner writing both sections of the test, which were combined into a single test. The main purpose of this pilot test was to check the feasibility of administering the test, including the time allocated to write it, problems with the clarity of instructions and understanding of the language used. No difficulties were observed or reported.

3.4 PHASE THREE

ADMINISTERING THE MAIN STUDY

A different school from the one used for piloting participated in this main study. All the Grade 10 learners who were taking mathematics as one of their subjects were involved in this phase. The researcher was assisted by the mathematics teachers from the school with administering the test. They were requested to emphasise to the learners the importance of honesty in answering the questions and the purpose of the test.

No problems were reported with the administration of the test.

3.5 PHASE FOUR

ANALYSIS OF DATA

(A) DATA FROM THE PROBE

The piloting of the probe was used mainly to check problems with the clarity of the language used, and in the time allocated to write it. No problems were reported.

The data from the main probe was analysed for frequencies of responses. Those that appeared most often were used to provide distracters for the multiple-choice test that was developed for the main test.

(B) DATA FROM THE PILOT STUDY

The pilot study was mainly used to check the feasibility of administering the test and problems with the clarity of instructions. No analysis of data was done.

(C) DATA FROM THE MAIN STUDY

After testing, the scripts were "marked". Basic descriptive statistics are used to report on the frequency of problems experienced with each of the terms tested. Mean scores of each group of terms are analysed by means of the t-test to determine whether any significant differences exist between the groups.

(D) RELIABILITY OF THE TEST

The reliability coefficient of the test was found to be 0.90 using the Kuder-Richardsons 20 (K-R 20) method of calculating reliability.

CHAPTER FOUR

RESULTS AND DATA ANALYSIS

4.1 INTRODUCTION

This chapter presents the learners' responses to the main test. Tables of percentage scores have been drawn up. Each table indicates the options that were given and the percentage of learners who chose each answer. In each case the sentence in which each technical or paradoxical jargon term was embedded is given. The correct answer to each question is presented in bold

4.2 THE PERFORMANCE OF LEARNERS ON TECHNICAL TERMS

The percentages of learners choosing the correct answer on the technical section of the test are given in table 2 below.

Table 2: Percentage of learners choosing correct answers on the technical section of the test.

TERM	PERCENTAGE
1. Quadrilateral	57.1
2. Binomial	50.0
3. Percentage	21.4
4. Equation	20.5
5. Perimeter	6.3
6. Integers	14.2
7. Hypotenuse	20.5
8. Ordinate	25.9
9. Rectangle	20.5
10. Theorem	11.6
11. Numerator	54.4
12. Ratio	13.3
13. Trinomial	52.7
14. Quadratic	11.6
15. Asymptote	25.0
16. Abscissa	23.2
17. Isosceles Triangle	22.3
18. Square Root	25.9
19. Perpendicular	15.2
20. Axiom	18.8

The performance of learners was very weak on this section. There were only four terms in which 50% or more of the learners chose the correct answer. These terms were "binomial"(50%), "trinomial"(52.7%), "numerator"(54%) and "quadratic"(57%). In all the other terms, less than 30% of the learners chose the correct answer. Of these terms, there were five in which less than 15% of the learners chose the correct answer.
Table 3 below shows the percentages of learners choosing the correct and incorrect answers for each technical term. The table also indicates, for each correct and

incorrect answer, how sure learners were that their chosen answers were correct. *The figures in brackets indicate the actual number of learners that responded in relation to each given percentage.*

Table 3: Percentage of learners choosing the correct and incorrect answers and how sure they were.

TERM	CORRECT / INCORRECT	PERCENTAGE	SURE	NOT SO SURE	GUESSING
1. Quadrilateral	Correct	57(64)	88(56)	12(8)	0(0)
	Incorrect	43(48)	54(26)	35(17)	11(5)
2. Binomial	Correct	50(56)	71(40)	22(12)	7(4)
	Incorrect	50(56)	68(38)	27(15)	5(3)
3. Percentage	Correct	21(24)	63(15)	33(8)	4(1)
	Incorrect	79(88)	80(70)	15(13)	5(5)
4. Equation	Correct	21(23)	22(5)	56(13)	22(5)
	Incorrect	79(89)	47(42)	36(32)	17(15)
5. Perimeter	Correct	6(7)	57(4)	29(2)	14(1)
	Incorrect	94(105)	44(46)	39(41)	17(18)
6. Integers	Correct	14(16)	19(3)	37(6)	44(7)
	Incorrect	86(96)	28(27)	45(43)	27(26)
7. Hypotenuse	Correct	21(23)	26(6)	30(7)	44(10)
	Incorrect	79(89)	24(21)	36(32)	40(36)
8. Ordinate	Correct	26(29)	72(21)	21(6)	7(2)
	Incorrect	74(83)	35(29)	43(36)	22(18)
9. Rectangle	Correct	21(23)	74(17)	22(5)	4(1)
	Incorrect	79(89)	82(73)	13(12)	5(4)
10. Theorem	Correct	12(13)	54(7)	38(5)	8(1)
	Incorrect	88(99)	63(62)	30(30)	7(7)
11. Numerator	Correct	54(61)	87(53)	11(7)	2(1)
	Incorrect	46(51)	69(35)	27(14)	4(2)
12. Ratio	Correct	13(15)	20(3)	47(7)	33(5)
	Incorrect	87(97)	33(32)	49(48)	18(17)
13. Trinomial	Correct	53(59)	86(51)	14(8)	0(0)
	Incorrect	47(53)	68(36)	26(14)	6(3)
14. Quadratic	Correct	12(13)	15(2)	15(2)	70(9)
	Incorrect	88(99)	27(27)	49(48)	24(24)
15. Asymptote	Correct	25(28)	18(5)	25(7)	57(16)
	Incorrect	75(84)	8(7)	49(41)	43(36)
16. Abscissa	Correct	23(26)	31(8)	50(13)	19(5)
	Incorrect	77(86)	20(17)	38(33)	42(36)
17. Isosceles Triangle	Correct	22(25)	56(14)	32(8)	12(3)
	Incorrect	78(87)	47(41)	38(33)	15(13)
18. Square Root	Correct	26(29)	59(17)	31(9)	10(3)
	Incorrect	74(83)	76(63)	18(15)	6(5)
19. Perpendicular	Correct	15(17)	41(7)	24(4)	35(6)
	Incorrect	85(95)	47(45)	35(33)	18(17)
20. Axiom	Correct	19(21)	43(9)	38(8)	19(4)
	Incorrect	81(91)	22(20)	38(35)	40(36)

Each term was scrutinized and the following information was evident.

Table 4: Responses of learners to the term "QUADRILATERAL"

1. Quadrilaterals are some of the figures studied in geometry. What is a quadrilateral?

	OPTIONS	%
a.	A figure with equal sides	9
b.	A figure with equal angles	14
c.	A figure with two equal sides	13
d.	**A figure with four sides**	**57**
e.	A figure with two equal angles	7

57% of the learners chose the correct answer. This means that 57% of the learners tested understand the precise meaning of the term "quadrilateral". 54% of the learners who chose an incorrect answer were absolutely sure that their chosen answer was correct.

Table 5: Responses of learners to the term "BINOMIAL"

2. Binomials are studied extensively in algebraic mathematics. What is a binomial?

	OPTIONS	%
a.	A term that includes two numbers	20
b.	**An expression of two terms**	**50**
c.	Another word for "two"	14
d.	Two parts of a triangle	3
e.	A multiple of two	13

50% of the learners chose the correct answer. This implies that half of the learners tested understand the precise meaning of the term "binomial". 68% of the learners choosing an incorrect answer were absolutely sure that their chosen answer was correct.

Table 6: Responses of learners to the term "PERCENTAGES"

3. We usually use percentages when we talk about examination marks. What are percentages?

	OPTIONS	%
a.	Profits that one gets	13
b.	Fractions consisting of two whole numbers	6
c.	**Parts per hundred**	**21**
d.	Numbers not more that hundred	20
e.	Numbers that have been divided	40

21% of the learners chose the correct answer. Most learners(40%) chose distracter (e), which is not a correct definition of the term "percentage". 80% of the learners choosing an incorrect answer were absolutely sure that their chosen answer was correct, which is disturbing.

Table 7: Responses of learners to the term "EQUATION"

4. A straight line can be expressed by an equation. What is an equation?

	OPTIONS	%
a.	Another word for "a problem"	10
b.	**A statement of equality between two expressions**	**21**
c.	Another word for "a formula"	26
d.	The arrangement of an expression according to order	21
e.	The addition or subtraction of numbers	22

21% of the learners chose the correct answer. 56% of the learners, who chose the correct response, were not sure that their chosen answer was correct. At the same time, 22% of the learners who chose the correct answer were just guessing. This implies that the learners tested have a great difficulty with the term "equation". There was no distracter which attracted a significantly more number of responses than the others.

Table 8: Responses of learners to the term "PERIMETER"

5. The perimeter of a tennis court is significantly smaller than that of a soccer field. What is a perimeter?

	OPTIONS	%
a.	The distance between two points	28
b.	The size of a circle	9
c.	The size of a field	48
d.	**The length of a closed curve**	**6**
e.	The shape of a triangle	9

Only 6% of the learners chose the correct answer. Most learners(48%) chose distracter (c) which is not a correct mathematical meaning of the term "perimeter". The term "perimeter" is dealt with in the Grade 8 syllabus and the alarmingly large number of learners who did not understand the precise meaning of this term is hugely disturbing.

Table 9: Responses of learners to the term "INTEGER"

6. When one integer is divided by another, the answer is not always an integer. What are integers?

	OPTIONS	%
a.	They are whole numbers which, when divided by others, leave a remainder	38
b.	They are whole numbers and decimal numbers	11
c.	They are whole numbers that are even numbers	5
d.	**They are positive whole numbers, negative whole numbers and zero**	**14**
e.	They are whole numbers which, when divided by others, leave no remainder	32

14% of the learners chose the correct answer. Of these learners only 19% were absolutely sure that their chosen answer was correct. 37% of these learners were not sure about their chosen answer and a large proportion (44%) were just guessing. This has some serious implications with regard to (a) the understanding of the term "integer" and (b) the understanding of numbers in general.

Table 10: Responses of learners to the term "HYPOTENUSE"

7. The word hypotenuse, used mainly in mathematics, originates from the Greek language. What is a <u>hypotenuse?</u>

	OPTIONS	%
a.	Longest side of a triangle	13
b.	**The side opposite the right angle in a right-angled triangle**	**21**
c.	One of the sides of a triangle	6
d.	A side which is always positive when measured	16
e.	A side which is adjacent to the right angle in a right-angled triangle	44

21% of the learners chose the correct answer. A large proportion(44%) of these learners were guessing and 30% were not sure about their chosen answer. The term "hypotenuse" is first encountered at senior primary level of schooling and one, therefore, would expect a better understanding of the precise meaning of this term. It is also important to note that a large proportion(40%) of the learners choosing an incorrect answer were also guessing and 36% were not sure about their chosen answer. This implies that more than 70% of the learners were either guessing or were not sure about their chosen answer.

Table 11: Responses of learners to the term "ORDINATE"

8. A straight line can have negative ordinates. What is an <u>ordinate?</u>

	OPTIONS	%
a.	A number that is on a straight line	22
b.	A coordinate that has a negative sign	21
c.	The midpoint of a line	18
d.	A number that is different from other numbers	13
e.	**A coordinate measured from the x-axis parallel to the y-axis**	**26**

26% of the learners chose the correct answer. Although this term is not frequently used by the teachers in the classroom, it does appear in most Grade 10 textbooks and it is an important part of the mathematics vocabulary. It is, therefore, vitally essential that learners understand the precise meaning of this term.

Table 12: Responses of learners to the term "RECTANGLE"

9. In the olden days, most swimming pools had the shape of a rectangle. What is a <u>rectangle?</u>

	OPTIONS	%
a.	A four-sided figure with two opposite sides equal	36
b.	A four-sided figure with two opposite sides and angles equal	27
c.	**A four-sided figure whose angles are all equal to 90^0**	**21**
d.	A four-sided figure with opposite angles equal	6
e.	A four-sided figure with all sides equal	10

The term "rectangle" is one of the most commonly used term in Euclidean Geometry and yet only 21% of the learners tested understand its precise meaning. 82% of the learners choosing an incorrect answer were absolutely sure that their chosen answer was correct.

Table 13: Responses of learners to the term "THEOREM"

10. The theorem of Pythagoras is one of the most famous theorems in geometry. What is a theorem?

	OPTIONS	%
a.	**A general conclusion which has been proved**	**12**
b.	A way of solving a problem	13
c.	A law or rule used in geometry	37
d.	An explanation of the angles in a geometric diagram	13
e.	A method of calculating angles in geometry	25

12% of the learners chose the correct answer and 38% of these learners were not sure that their chosen answer was correct. A large proportion(37%) of the learners chose distracter (c), which might suggest that they associate the word "theorem" with the word "law" or "rule".

Table 14: Responses of learners to the term "NUMERATOR"

11. All fractions have a numerator. What is a numerator?

	OPTIONS	%
a.	The line that separates two expressions in a fraction	7
b.	An expression below the line in a fraction	21
c.	A number divisible by 2	6
d.	A number that is part of a fraction	12
e.	**An expression above the line in a fraction**	**54**

The term "numerator" is first encountered in senior primary school and it is one of the most widely used term in algebra. It is, therefore, most surprising that only 54% of the Grade 10 learners tested understand the precise meaning of this term. 21% of the learners chose distracter (b), which gives a definition for a denominator. This might suggest that these learners are unable to differentiate between a numerator and a denominator.

Table 15: Responses of learners to the term "RATIO"

12. When sampling, the ratio of the data found in the sample is assumed to be equal to that of the data found in the entire population. What is a ratio?

	OPTIONS	%
a.	A number that is unknown	35
b.	A number that is a result of a calculation	26
c.	**The relative sizes of two quantities**	**13**
d.	The result of a division	9
e.	A solution to an equation	17

13% of the learners chose the correct answer and only 20% of them were absolutely sure that their chosen answer was correct. This implies that about 80% of the learners tested either do not understand or are not sure of the precise meaning of the term "ratio".

Table 16: Responses of learners to the term "TRINOMIAL"

13. The study of trinomials is not new in mathematics. What is a trinomial?

	OPTIONS	%
a.	A three-sided figure	22
b.	An expression that is divisible by three	2
c.	Another word for "three"	17
d.	**An expression of three terms**	**53**
e.	A triangle with three equal angles	6

This is one of the four terms in which more than 50% of the learners chose the correct answer. The exact percentage is 53% which is, in actual fact, not satisfactory due to the frequent use of the term "trinomial" in Algebra. Further, 68% of the learners choosing an incorrect answer were absolutely sure that their chosen answer was correct.

Table 17: Responses of learners to the term "QUADRATIC"

14. Some solutions of quadratic equations can be represented graphically. What is a quadratic equation?

	OPTIONS	%
a.	An expression in which one solves for two unknowns	16
b.	**An equation of the second degree, containing the unknown raised at most to the second power**	**12**
c.	An equation containing x as an unknown	25
d.	A four sided geometric figure with four equal angles and four equal sides	18
e.	A four sided figure with two opposite and equal sides	29

Only 12% of the learners chose the correct answer. However, a large proportion(70%) of these learners were just guessing and 15% were not sure about their chosen answer. The implies that the bulk of the learners do not understand the precise meaning of the term quadratic. Also, it is interesting to note that 29% of the learners chose distracter (e), which is close to a definition of the term "quadrilateral". This might seem that the learners were associating the term "quadratic" with the term "quadrilateral"

Table 18: Responses of learners to the term "ASYMPTOTE"

15. Most of the trigonometric graphs have no asymptotes. What is an asymptote?

	OPTIONS	%
a.	**A line which is approached by a curve infinitely close, but never meet**	**25**
b.	A straight line that moves away from a curve	11
c.	A straight line that touches a curve at only one point	27
d.	A straight line that lies next to the x-axis	23
e.	A never-ending line that moves away from the origin	14

25% of the learners chose the correct answer, but only 18% of them were absolutely sure that their chosen answer was correct. Close to 60% of these learners choosing the correct answer were guessing. The implication of this is that the learners writing the test poorly understand the precise meaning of the term "asymptote".

Table 19: Responses of learners to the term "ABSCISSA"

16. Some points on the straight line have the same abscissa. What is an abscissa?

	OPTIONS	%
a.	A series of points that join together to form a circle around the origin	16
b.	A point that is on a straight line	30
c.	**The co-ordinate measured from the y-axis parallel to the x-axis**	**23**
d.	A group of co-ordinates that fall in the quadrant	8
e.	A set of lines that have the same length but different gradients an never meet	23

23% of the learners chose the correct answer, but only 31% of them were absolutely sure that their chosen answer was correct.

Table 20: Responses of learners to the term "ISOSCELES TRIANGLE"

17. It is well known that the word isosceles has Greek origins. What is an isosceles triangle?

	OPTIONS	%
a.	A four sided diagram with two equal sides	9
b.	A triangle with all sides equal	22
c.	A triangle with sides that are all unequal	34
d.	A set of two adjacent circles	13
e.	**A triangle with two equal sides**	**22**

Only 22% of the learners chose the correct answer, and 56% of them were absolutely sure that their chosen answer was correct. Isosceles triangles are some of the triangles that are encountered frequently in the Grade 10 syllabus. Further, isosceles triangles are commonly dealt with from the Grade 8 curriculum. It is, therefore, very concerning that a very large proportion of the learners tested did not understand the precise meaning of the term "isosceles triangle".

Table 21: Responses of learners to the term "SQUARE ROOT"

18. Square roots are widely used by engineers. What is a square root?

	OPTIONS	%
a.	A point where two diagonals of a square meet	7
b.	The result we get when we multiply a number by two	17
c.	The result we get when we multiply a number by itself	31
d.	The result we get when we divide a number by two	19
e.	**A number which, when multiplied by itself, produces the given number**	**26**

26% of the learners chose the correct answer and 10% of them guessed the answer. 76% of those choosing an incorrect answer were absolutely sure that their chosen answer was correct, which is worrying. It is interesting to observe that most learners(31%) chose distracter (c), which gives a definition of a square. It seems, therefore, that they are confusing the definition of the term "square root" with that of the term "square".

Table 22: Responses of learners to the term "PERPENDICULAR"

19. Most buildings have walls that are perpendicular to each other. What does word <u>perpendicular</u> mean?

	OPTIONS	%
a.	When two straight lines are parallel and equal to each other	54
b.	**When two straight lines intersect so as to form an angle of 90 degrees**	**15**
c.	When a line cuts another straight line at an obtuse angle	9
d.	When a line is opposite the right angle in a right-angled triangle	3
e.	When a line divides another line into two equal halves	19

Only 15% of the learners chose the correct answer and only 41% of them were sure that their chosen answer was correct. 35% of these learners choosing the correct answer were guessing. The term "perpendicular" is a term that is widely used, not only in the mathematics classroom, but in the general community as well. It is, therefore, very worrying that a large proportion of Grade 10 learners tested, and who take mathematics as one of their subjects, do not understand the precise meaning of this term.

Table 23: Responses of learners to the term "AXIOM"

20. Axioms are very useful in the teaching and learning of mathematics. What are <u>axioms?</u>

	OPTIONS	%
a.	Diagrams used when explaining concepts of algebra	14
b.	**Statements accepted as true without further proof**	**19**
c.	Instruments used to draw mathematical objects	31
d.	Special exercises used for testing beginners in mathematics.	25
e.	Calculations that involve only two variables.	11

19% of the learners chose the correct answer, but only 43% of them were absolutely sure that their chosen answer was correct.

4.3 THE PERFORMANCE OF LEARNERS ON PARADOXICAL JARGON

The percentages of learners choosing the correct answers on the paradoxical jargon section of the test are given below.

Table 24: Percentage of learners choosing correct answers on the paradoxical jargon section of the test.

TERM	PERCENTAGE
21. Product	29.5
22. Exponent	42.9
23. Difference	43.8
24. Odd Number	33.0
25. Sum	63.4
26. Closed	15.2
27. Face	17.9
28. Complement	15.2
29. Right Angle	61.6
30. Range	7.1
31. Prime Number	18.8
32. Reciprocal	19.6
33. Function	6.3

The performance of learners was also very weak on this section. There were only two terms in which 50% or more of the learners chose the correct answer. These terms were "right angle"(62%) and "sum"(63%). There were seven terms in which less than 20% of the learners chose the correct answer.

Table 25 below shows the percentage of learners choosing the correct and incorrect answers for each paradoxical jargon term. The table also indicates, for each correct and incorrect answer, how sure learners were that their chosen answers were correct.

Table 25: Percentage of learners choosing the correct and incorrect answers and how sure they were.

TERM	CORRECT / INCORRECT	PERCENTAGE	SURE	NOT SO SURE	GUESSING
21. Product	Correct	29(33)	73(24)	18(6)	9(3)
	Incorrect	71(79)	56(44)	34(27)	10(8)
22. Exponent	Correct	43(48)	65(31)	27(13)	8(4)
	Incorrect	57(64)	38(24)	39(25)	23(15)
23. Difference	Correct	44(49)	82(40)	16(8)	2(1)
	Incorrect	56(63)	67(42)	24(15)	9(6)
24. Odd Number	Correct	33(37)	54(20)	30(11)	16(6)
	Incorrect	67(75)	44(33)	48(36)	8(6)
25. Sum	Correct	63(71)	90(64)	8(6)	2(1)
	Incorrect	37(41)	71(29)	24(10)	5(2)
26. Closed	Correct	15(17)	24(4)	71(12)	5(1)
	Incorrect	85(95)	41(39)	38(36)	21(20)
27. Face	Correct	18(20)	15(3)	55(11)	30(6)
	Incorrect	82(92)	29(27)	37(34)	34(31)
28. Complement	Correct	15(17)	29(5)	42(7)	29(5)
	Incorrect	85(95)	29(28)	53(50)	18(17)
29. Right Angle	Correct	62(69)	93(64)	6(4)	1(1)
	Incorrect	38(43)	51(22)	40(17)	9(4)
30. Range	Correct	7(8)	63(5)	25(2)	12(1)
	Incorrect	93(104)	45(47)	38(39)	17(18)
31. Prime Number	Correct	19(21)	33(7)	33(7)	33(7)
	Incorrect	81(91)	34(31)	36(33)	30(27)
32. Reciprocal	Correct	20(22)	50(11)	41(9)	9(2)
	Incorrect	80(90)	50(45)	30(27)	27(18)
33. Function	Correct	6(7)	14(1)	14(1)	72(5)
	Incorrect	94(105)	42(44)	35(37)	23(24)

Analysis of each term yielded the following information.

Table 26: Responses of learners to the term "PRODUCT"

21. The product of zero and another number is zero. What is a product?

	OPTIONS	%
a.	A quantity that is raised to the power of zero	27
b.	The result of dividing one quantity by another	16
c.	The result of factorizing	18
d.	**The result of multiplying two or more quantities**	**29**
e.	A quantity that multiplies another quantity	10

There were 29% of the learners choosing the correct answer. 56% of the learners choosing an incorrect answer were absolutely sure that their chosen answer was correct.

Table 27: Responses of learners to the term "EXPONENT"

22. In algebra, exponents are widely used. What is an exponent?

OPTIONS		%
a.	A special name for a number that has similar qualities as another number	26
b.	A characteristic of agreement between two sets of objects	4
c.	**A figure showing the number of times a quantity must be multiplied by itself**	**43**
d.	A symbol that denotes numbers that are usually too big	12
e.	An abbreviation of a long expression	15

43% of the learners chose the correct answer but only 65% of them were absolutely sure that their chosen answer was correct.

Table 28: Responses of learners to the term "DIFFERENCE"

23. The difference of two non-equal numbers is non-zero. What is a difference?

OPTIONS		%
a.	The result of dividing one quantity by another	12
b.	A result that is not the same as others	24
c.	A quantity that has a negative sign	8
d.	**The result of subtracting one quantity from another**	**44**
e.	A quantity that is different from another quantity	12

44% of the learners chose the correct answer, but 67% of those choosing an incorrect answer were absolutely sure that their chosen answer was correct. 24% of the learners chose distracter (b), which gives a definition that is similar to that of the term "difference" in ordinary English.

Table 29: Responses of learners to the term "ODD NUMBERS"

24. Some mathematicians have labelled odd numbers as masculine. What are odd numbers?

OPTIONS		%
a.	Numbers that are small	12
b.	**Numbers that are not evenly divisible by 2**	**33**
c.	Numbers that are non-real	13
d.	Numbers with remainders	16
e.	Numbers that are multiples of 3	26

33% of the learners chose the correct answer but 30% of them were not sure that their chosen answer was correct and 16% guessed. This has some serious implications about their understanding, not only of the term "odd numbers", but of the number system in general.

Table 30: Responses of learners to the term "SUM"

25. The sum of zero and zero is zero. What is a sum?

	OPTIONS	%
a.	A result of subtracting more than one quantity	4
b.	**A result of adding one or more quantities**	**63**
c.	A set of numbers	20
d.	A mathematical equation normally given to students for solving	11
e.	A portion of a bigger quantity of objects	2

Learners writing the test performed better on this term than on all the other terms in the test. 63% of them understand the precise meaning of the term "sum".

Table 31: Responses of learners to the term "CLOSED"

26. On the number line, a solution set can be represented by a closed interval. What does the phrase closed interval mean?

	OPTIONS	%
a.	A point where the number line stops	24
b.	Last number of an interval	14
c.	**Interval that contains both of its end points**	**15**
d.	Not being able to add further than one has done	18
e.	A number that is inside a bracket	29

15% of the learners chose the correct answer, but only 24% of them were absolutely sure that their chosen answer was correct. Most (29%) chose distracter (e), which defines the term "closed" as a number inside a bracket. It seems, therefore, that these learners are linking "closed" with "something inside", which is more Ordinary English than Mathematical English.

Table 32: Responses of learners to the term "FACES"

27. Most solids have faces. What are faces?

	OPTIONS	%
a.	Front views of quantities	41
b.	the ways polyhedrons appear	12
c.	different types of quantities	23
d.	**plane surfaces that bound a polyhedron**	**18**
e.	Quantities that can be changed	6

18% of the learners chose the correct answer and only 15% of them were absolutely sure that their chosen answer was correct. A large proportion of the learners tested chose distracter (a), which defines the term "face" as a "front view". It would appear that these learners are linking a "face" with a "front view", which is more metaphoric than mathematical.

Table 33: Responses of learners to the term "COMPLIMENT"

28. The compliment of an angle A can be found without using a diagram. What is a compliment of an angle A?

	OPTIONS	%
a.	The size of angle A	34
b.	**The angle 90^0-A**	**15**
c.	The solution of angle A	30
d.	The angle A+90^0	12
e.	The angle A+180^0	9

15% of the learners chose the correct answer and only 29% of them were absolutely sure that their chosen answer was correct. 29% of these learners choosing the correct answer were guessing. This means that the learners tested are having serious difficulties with the term "compliment".

Table 34: Responses of learners to the term "RIGHT ANGLES"

29. Right angles are some of the special angles in trigonometry. What are right angles?

	OPTIONS	%
a.	Angles between 0^0 and 90^0	12
b.	Angles between 90^0 and 180^0	10
c.	**Angles of 90^0**	**62**
d.	Angles that are equal	15
e.	Angles that are not equal	3

Learners did better on this term as well, but slightly more than half of those learners choosing an incorrect answer were absolutely sure that their chosen answer was correct, which is worrying.

Table 35: Responses of learners to the term "RANGE"

30. The range of most graphs is determined by inspection. What is a range?

	OPTIONS	%
a.	The size of a graph	20
b.	**The set of values that a function takes on**	7
c.	The shape of a graph	12
d.	The arrangement of a graph	20
e.	The set of numbers which corresponds to another set	41

Only 7% of the learners chose the correct answer and 12% of them guessed the answer. This implies that vast majority of the learners tested do not understand the precise meaning of the term "range".

Table 36: Responses of learners to the term "PRIME NUMBERS"

31. Prime numbers form part of the number system. What are prime numbers?

	OPTIONS	%
a.	Numbers that are small	13
b.	Numbers which start from 2 and which are divisible by 2	13
c.	**Numbers, excluding 0 and 1, which are divisible by 1 and themselves only**	**19**
d.	Numbers that are not evenly divisible by 2, like 1;3;5;7;9;	35
e.	Numbers that have no square roots	20

19% of the learners chose the correct answer but only one third of these learners were absolutely sure that their chosen answer was correct, and another one third guessed the answer. Most learners chose distracter (d), which gives a definition of odd numbers. So, it appears that they are confusing prime numbers with odd numbers.

Table 37: Responses of learners to the term "RECIPROCAL"

32. Not all numbers have reciprocals. What does the word reciprocal mean?

	OPTIONS	%
a.	Undefined	22
b.	**Multiplicative inverse**	20
c.	Opposite	41
d.	Exponent	6
e.	Number in front of a variable	11

20% of the learners chose the correct answer and half of them were absolutely sure that their chosen answer was correct. A large proportion of the learners tested chose distracter (c). It is possible, however, that their interpretation of "opposite" is the same as "up-side-down", which is frequently used by teachers to explain the term "reciprocal".

Table 38: Responses of learners to the term "FUNCTION"

33. Functions are widely studied in algebra. What is a function?

	OPTIONS	%
a.	The work performed by one or more objects	28
b.	The method that one applies when solving a problem that involves mathematical expressions	42
c.	Something that a problem is based on	14
d.	**An association of exactly one object from one set with each object from another set**	**6**
e.	A single valued relation	10

Only 6% of the learners chose the correct answer and more than 70% of them were guessing. This result indicates that more than 90% of the learners tested do not understand the precise meaning of the term "function".

4.4 SUMMARY OF THE RESULTS

Table 39 and 40 below present technical and paradoxical jargon terms in rank order of "correct" response.

Table 39: Ranking of technical terms according to correct response.

TERM	PERCENTAGE
Quadrilateral	57.1
Numerator	54.4
Trinomial	52.7
Binomial	50.0
Ordinate	25.9
Square root	25.9
Asymptote	20.0
Abscissa	23.2
Isosceles triangle	22.3
Percentage	21.4
Rectangle	20.5
Equation	20.5
Hypotenuse	20.5
Axiom	18.8
Perpendicular	15.2
Integers	14.2
Ratio	13.3
Theorem	11.6
Quadratic	11.6
Perimeter	6.3

Table 40: Ranking of paradoxical jargon terms according to correct response.

TERM	PERCENTAGE
Sum	63.4
Right angle	61.6
Difference	43.8
Exponent	42.9
Odd number	33.0
Product	29.5
Reciprocal	19.6
Prime number	18.8
Face	17.9
Closed	15.2
Compliment	15.2
Range	7.1
Function	6.3

Tables 39 and 40 can also serve as indicators of the level of difficulty of the terms for the learners who wrote the test. That is, the term appearing at the top would be the least difficult term, and the term appearing at the bottom would be the most difficult term. This ranking would be very useful to teachers as they can see at a glance which terms are giving more problems to the learners.

4.5 CONCLUDING REMARKS

The performance of learners was generally very weak on both the technical and paradoxical jargon sections of the test. On both sections, there was not a single term where 65% or more of the learners investigated knew the correct answer. It is also worth noting that for 75% of the technical terms and 62% of the paradoxical jargon terms in which less than 30% of the learners chose the correct answer, many of the learners who answered incorrectly were absolutely sure that their chosen answers were correct. This observation may suggest that in some cases learners do not know that they lack an understanding of the meanings of some terms.

The prevailing situation is not healthy for teaching and learning of mathematics. For a better environment, learners need to grasp the precise meaning of technical and paradoxical jargon, and it is part of the teacher's duty to ensure that learners understand the precise meaning of these terms. Judging from the above results, it would appear that the teacher's task is more challenging when learners who have English as their second language are taught.

CHAPTER FIVE

FINDINGS AND DISCUSSION

5.1 INTRODUCTION

The main objective of this study was to investigate the extent of the difficulty experienced by English second language learners in understanding selected paradoxical jargon and technical terms commonly used in their Grade 10 Mathematics curriculum. The findings which emerged from the data collected are dealt with in the order in which they appear as research questions put forward in section 1.4 of Chapter One.

5.2 SUMMARY OF THE FINDINGS

Question One: What is the extent of the difficulty that Grade 10 English second language learners have with some of the terms commonly used in their mathematics textbooks, including

(a) technical terms, and
(b) paradoxical jargon?

(A) TECHNICAL TERMS

The results that emerged from the data suggest that a large percentage of the learners tested are having enormous difficulties comprehending the correct meaning of the various technical terms used in their textbooks. The mean score of these learners on this section of the test was only 5.11 out of a possible 20 (25.6%).

(B) PARADOXICAL JARGON

The mean score of the learners tested on this section of the test was 3.74 out of a possible 13 (28.8%). This result indicates that, similar with technical terms, a large percentage of the learners tested are having enormous difficulties comprehending the correct meaning of the various paradoxical jargon terms commonly used in their textbooks.

Question Two: Do learners experience significantly greater difficulty with paradoxical jargon or with technical terms?

A comparison of the performance of learners on the technical and paradoxical sections of the test was performed using the t-test to compare the mean scores.

Table 41: A comparison of the performance of learners on the technical and paradoxical sections of the test.

Word Type	N	Means	Std. dev.	t-value
Technical	112	5.11	4.89	0.743
Paradoxical jargon	112	3.74	2.56	

Learners do not experience significantly more problems with one section than with the other section. In other words, although learners performed better on the paradoxical jargon section, the extent of difficulty experienced between paradoxical jargon and technical terms tested was not significant.

5.3 ANALYSIS OF LEARNERS' CONFIDENCE IN THE CORRECTNESS OF THEIR ANSWERS

It is interesting to note that a large proportion of learners did not actually seem to know when they did not know the correct meaning of a given paradoxical jargon or technical term. As indicated in Chapter Four, for 75% of the technical terms and 62% of the paradoxical jargon terms in which less than 30% of the learners chose the correct answer, many of the learners who answered incorrectly were absolutely sure that their chosen answers were correct. It would seem, therefore, that this problem is worse in technical terms than in paradoxical jargon terms.

5.4 CONCLUDING REMARKS

The results of learners on the test as a whole are a cause for serious concern. The apparent lack of competence in the English language could have adverse effect on the understanding of mathematics.

CHAPTER SIX

CONCLUSION, IMPLICATIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

The conclusions that may be drawn from this study may have some implications for the teaching and learning of mathematics.

6.2 CONCLUSIONS AND RELATIONSHIPS WITH PREVIOUS WORK

The tentative conclusions that may be drawn from this study are as follows:

(1) Understanding of technical terms tested:

The majority of learners investigated are experiencing huge difficulties with technical terms commonly used in their Mathematics Curriculum.

(2) Understanding of paradoxical jargon terms tested:

The majority of learners tested are experiencing enormous difficulties also with paradoxical jargon terms that are commonly used in their Mathematics Curriculum.

(3) Comparison of difficulty in the terms:

There is no significant difference in difficulty experienced by learners between paradoxical jargon and technical terms tested.

In a study reviewed earlier, Otterburn and Nicholson (1976) concluded that many of the technical words used in mathematics were causing serious difficulties for pupils following a Certificate of Secondary Education course in Northern Ireland. Similar studies carried out by Nicholson (1977) and by Hardcastle and Orton (1993) gave the same results.

With regard to the difficulty of the specialist terms used in mathematics, the results of this study are in line with the results of the above-mentioned studies. However, as the investigation of both the paradoxical jargon and technical terms used in mathematics is unique to this study, no studies to be corroborated with were found.

6.3 IMPLICATIONS AND RECOMMENDATIONS

This study indicates that learners are experiencing enormous difficulties with the mathematical terms commonly used in their curriculum. It is therefore significantly important that teachers should be aware of the difficulties their learners may have, and work continuously for better understanding. It is also recommended that teachers need to pay particular attention to the mathematical terms used in the mathematics curriculum.

Hardcastle and Orton (1993) suggest that helping pupils with the language of mathematics should be an important part of mathematics teaching. The researcher is also in full agreement with Nicholson (1977) who suggests that teachers should continuously devise and administer short diagnostic tests. This would help teachers stay aware of the problems their learners may have, and strive for appropriate remedies.

It would also appear that the bulk of learners investigated are having significant problems with the language of mathematics. One possible solution to this problem could lie in encouraging learners to communicate as much as possible in the English language in their discussions, and mathematics discussions in particular.

6.4 CONCLUDING REMARKS

The language of mathematics and other factors not investigated in this study, may be serious contributing factors to the problems of learning mathematics. It is hoped that this study has served to highlight some of the language-related problems in mathematics, and that mathematics teachers and other concerned parties would be made aware of the extent of the difficulty that English second language learners are having with some of the terms commonly used in the mathematics curriculum.

CHAPTER SEVEN

CRITIQUE OF THE RESEARCH METHODS USED AND SUGGESTIONS FOR FURTHER RESEARCH

7.1 INTRODUCTION

This chapter highlights some of the limitations of the current study and suggests ways in which some of these limitations could be alleviated in further similar studies.

7.2 CRITIQUE OF THE RESEARCH METHODS USED

A multiple-choice format was used in this study and the reasons for using it were briefly outlined in section 3.3 of Chapter Three. It was recognized that guessing might occur, and as an attempt to reduce the chances of getting an item correct through guessing, five distracters were used. However, guessing did occur and that has implications for the validity of the test.

The analysis of this study showed that in some of the terms many learners guessed answers, and got them correct. This implies that a correct answer on the test does not necessarily mean that the learner understands the meaning of the term tested.

7.3 SUGGESTIONS FOR FURTHER RESEARCH

This study has highlighted serious problems related to language in mathematics. It is therefore worth recommending that more studies of this nature be undertaken, but using larger samples. It is also suggested that in further research an interview component be incorporated in this type of study as it might yield valuable information that might shed some light on some of the problems that learners are experiencing with some of the mathematical terms.

The open-ended probe yielded immensely important information which was not taken advantage of in this study. It is, therefore, also recommended that further similar studies analyze the responses to open-ended questions.

7.4 CONCLUDING REMARKS

In South Africa today, English is the medium of instruction right through senior primary and secondary school. It is therefore vitally essential that language-related problems experienced by English second language learners be addressed as a matter of urgency.

APPENDIX ONE

LIST OF GRADE 10 MATHEMATICS TEXTBOOKS USED

Dekker, A.J., Visser, D.P. and van Rensburg, J. (1984) Mathematics for Today Standard 8 Kenwyn: Juta & Co, Ltd.

Dreyer, C.B. and Gildenhuys, D.G. (1987) Active Mathematics Standard 8 Pretoria: De Jager-HAUM.

Roos, R.C., Dekker, A.J., Visser, D.P. and van Rensburg, J. (1986) Mathematics in Action Standard 8 Kenwyn: Juta & Co, Ltd.

Laridon, P.E.J.M., Brink, M.E., Burges, A.G., Jawurek, A.M., Kitto, A.L., Myburgh, M.J., Pike, M.R., Rhodes-Houghton, R.H. and van Rooyen, R.P. (1984) Classroom Mathematics Standard 8 Johannesburg: Lexicon.

APPENDIX TWO

TECHNICAL SECTION OF THE PROBE

TEST 1 - TECHNICAL

PURPOSE OF THE TEST

The purpose of this test is to find out what you understand some of the special words used in your Mathematics textbook mean.

INSTRUCTIONS

1. You are required to answer all 20 questions given.
2. Each question consists of a statement in which one term is underlined.
3. Please explain what you understand the meaning of the underlined term to be.
4. You are required to present your answers in the space provided under each question.
5. You can present your understanding in one of the following ways:
   (a) Give an explanation of the term.
   (b) Give a synonym (another word with identical meaning).
   (c) Give a diagram illustrating the meaning of the term.
   (d) Give a combination of any of the above to best illustrate your understanding of the term.

EXAMPLE

Example of Question:

The surface area of a One Rand coin can be calculated by using its diameter. What do you understand by the term diameter?

____

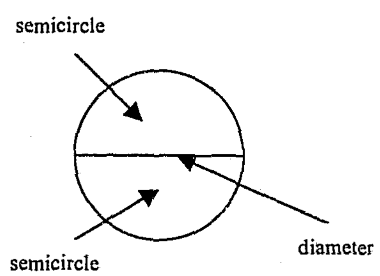
____

Example of Answers:

(a) By giving an explanation
"A straight through the centre of the circle, and connecting two points on either side of the centre."

(b) By giving a synonym
"Circle bisector".

(c) By illustrating with a diagram



(d) By giving a combination of any of the above
"A straight line through the centre of the circle, and connecting two points on either side of the centre."
And
"Circle bisector".

1. Quadrilaterals are some of the figures studied in geometry. What do you understand by the word quadrilaterals?

____

____

____

2. Binomials are studied extensively in algebraic mathematics. What do you understand by the word binomials?

____

____

____

3. We usually use percentages when we talk about examination marks, at school or about money involving discounts, profits etc. What do you understand by the word percentages?

____

____

____

4. A straight can be drawn by using an equation. What do you understand by the word equation?

___

___

___

5. The perimeter of a tennis court is significantly smaller than that of a soccer field. What do you understand by the word perimeter?

___

___

___

6. When one integer is divided by another, the answer is not always an integer. What do you understand by the word integer?

___

___

___

7. The word hypotenuse used mainly in mathematics originates from the Greek language. What do you understand by the word hypotenuse?

____

____

____

8. A straight line can have negative ordinates. What do you understand by the word ordinate?

____

____

____

9. Prisms have been used widely in the study of light. What do you understand by the word prisms?

____

____

____

10. In the olden days, most swimming pools had the shape of a rectangle. What do you understand by the word rectangle?

____

____

____

11. The theorem of Pythagoras is one of the most famous theorems in geometry. What do you understand by the word theorem?

___

___

___

12. All fractions have a numerator. What do you understand by the word numerator?

___

___

___

13. When sampling, the ratio of the data found in the sample is assumed to be equal to that of the data found in the entire population. What do you understand by the word ratio?

___

___

___

14. The study of trinomials is not new in mathematics. What do you understand by the word trinomials?

___

___

___

15. Some solutions of quadratic equations can be represented graphically. What do you understand by the phrase quadratic equation?

____

____

____

16. Most of the trigonometric graphs have no asymptotes. What do you understand by the word asymptote?

____

____

____

17. Some points on the straight line have the same abscissa. What do you understand by the word abscissa?

____

____

____

18. It is well known that the word isosceles has Greek origins. What do you understand by the word isosceles?

____

____

____

19. Square roots are widely used by engineers. What do you understand by the word squ..re roots?

20. Most buildings have walls that are perpendicular to each other. What do you understand by the word perpendicular?

APPENDIX THREE

PARADOXICAL JARGON SECTION OF THE PROBE

TEST 2 - PARADOXICAL

PURPOSE OF THE TEST

The purpose of this test is to find out what you understand some of the special words used in your Mathematics textbook mean.

INSTRUCTIONS

1. You are required to answer all 20 questions given.
2. Each question consists of a statement in which one term is underlined.
3. Please explain what you understand the meaning of the underlined term to be.
4. You are required to present your answers in the space provided under each question.
5. You can present your understanding in one of the following ways:
   (a) Give an explanation of the term.
   (b) Give a synonym (another word with identical meaning).
   (c) Give a diagram illustrating the meaning of the term.
   (d) Give a combination of any of the above to best illustrate your understanding of the term.

EXAMPLE

Example of Question:

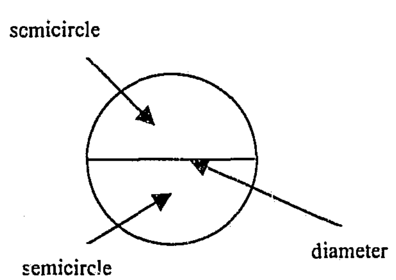
The surface area of a One Rand coin can be calculated by using its diameter. What do you understand by the term diameter?

Example of Answers:

(a) By giving an explanation
"A straight through the centre of the circle, and connecting two points on either side of the centre."

(b) By giving a synonym
"Circle bisector".

(c) By illustrating with a diagram



(d) By giving a combination of any of the above
"A straight line through the centre of the circle, and connecting two points on either side of the centre."
And
"Circle bisector".

1. The <u>product</u> of zero and zero is zero. What do you understand by the word <u>product</u>?

____

____

____

2. In algebra, the number "zero" has some special <u>properties</u>. What do you understand by the word <u>properties</u>?

____

____

____

3. The <u>difference</u> of two non-equal numbers is non-zero. What do you understand by the word <u>difference</u>?

____

____

____

4. <u>Fractional</u> numbers can be represented by parts of a unit circle. What do you understand by the word <u>fractional</u>?

____

____

____

5. In algebra, terms that are not the same can not be collected together. What do you understand by the word terms?

____
____
____

6. Some mathematicians have labelled odd numbers as masculine. What do you understand by the word odd?

____
____
____

7. It is well known that not all numbers are rational. What do you understand by the word rational?

____
____
____

8. The sum of zero and zero is zero. What do you understand by the word sum?

____
____
____

9. A set of proper fractions is a subset of the set of all fractions. What do you understand by the word proper?

____

____

____

10. On the number line, a solution set can be represented by a closed interval. What do you understand by the word closed?

____

____

____

11. Measuring the space occupied by a solid is best done using a cube as one's unit. What do you understand by the word cube?

____

____

____

12. Most different solids have different number of faces. What do you understand by the word faces?

____

____

____

13. The compliment of an angle can be found without using a diagram. What do you understand by the word compliment?

____
____
____

14. Lines of the form y = c are parallel to each other. What do you understand by the word parallel?

____
____
____

15. The roots of any equation can be found using algebraic methods. What do you understand by the word roots?

____
____
____

16. Right angles are some of the special angles in trigonometry. What do you understand by the word right angles?

____
____
____

17. The range of most graphs is determined by inspection. What do you understand by the word range?

____

____

____

18. Prime numbers form part of the number system. What do you understand by the word prime numbers?

____

____

____

19. Not all numbers have reciprocals. What do you understand by the word reciprocals?

____

____

____

20. Functions are widely studied in algebra. What do you understand by the word functions?

APPENDIX FOUR

THE FINALTEST QUESTIONNAIRE

TECHNICAL	:	QUESTIONS 1-20
PARADOXICAL JARGON	:	QUESTIONS 21-33

PURPOSE OF THE TEST

The purpose of this test is to find out what you understand some of the special words used in your Mathematics textbook mean.

INSTRUCTIONS

1. You are given 33 questions to answer.
2. Each question consists of a statement in which one term is underlined.
3. You are required to show your understanding of the precise meaning of the underlined terms.
4. Each of the questions has five possible answers.
5. Choose the answer you consider to be correct.
6. Then put a cross (X) on the letter corresponding to your chosen letter on the answer sheet provided.

EXAMPLE

The surface area of a One Rand coin can be calculated by using its diameter. What is a diameter?

a. A special line
b. A circle bisector
c. A group of circles
d. A straight line
e. A law of circles in mathematics

The correct answer is

a	~~b~~ (X)	c	d	e

HOW SURE ARE YOU OF YOUR ANSWER?

1. You are further required to indicate how sure you are that your chosen answer is correct.
2. Please indicate how sure you are by putting a cross (X) in the appropriate block on the answer sheet.
   - I am absolutely sure that my answer is correct.
   - I am not so sure that my answer is correct.
   - I do not really know, I am just guessing.

   For the example above, if you are absolutely sure that the answer is correct, you would show this as follows:

~~Sure~~ (X)	Not so sure	Guessing

1. Quadrilaterals are some of the figures studied in geometry. What is a quadrilateral?
   a. A figure with equal sides
   b. A figure with equal angles
   c. A figure with two equal sides
   d. A figure with four sides
   e. A figure with two equal angles

2. Binomials are studied extensively in algebraic mathematics. What is a binomial?
   a. A term that includes two numbers
   b. An expression of two terms
   c. Another word for "two"
   d. Two parts of a triangle
   e. A multiple of two

3. We usually use percentages when we talk about examination marks. What are percentages?
   a. Profits that one gets
   b. Fractions consisting of two whole numbers
   c. Parts per hundred
   d. Numbers not more that hundred
   e. Numbers that have been divided

4. A straight line can be expressed by an equation. What is an equation?
   a. Another word for "a problem"
   b. A statement of equality between two expressions
   c. Another word for "a formula"
   d. The arrangement of an expression according to order
   e. The addition or subtraction of numbers

5. The perimeter of a tennis court is significantly smaller than that of a soccer field. What is a perimeter?
   a. The distance between two points
   b. The size of a circle
   c. The size of a field
   d. The length of a closed curve
   e. The shape of a triangle

6. When one integer is divided by another, the answer is not always an integer. What are integers?
   a. They are whole numbers which, when divided by others, leave a remainder
   b. They are whole numbers and decimal numbers
   c. They are whole numbers that are even numbers
   d. They are positive whole numbers, negative whole numbers and zero
   e. They are whole numbers which, when divided by others, leave no remainder

7. The word hypotenuse, used mainly in mathematics, originates from the Greek language. What is a <u>hypotenuse?</u>
   a. Longest side of a triangle
   b. The side opposite the right angle in a right-angled triangle
   c. One of the sides of a triangle
   d. A side which is always positive when measured
   e. A side which is adjacent to the right angle in a right-angled triangle

8. A straight line can have negative ordinates. What is an <u>ordinate?</u>
   a. A number that is on a straight line
   b. A coordinate that has a negative sign
   c. The midpoint of a line
   d. A number that is different from other numbers
   e. A coordinate measured from the x-axis parallel to the y-axis

9. In the olden days, most swimming pools had the shape of a rectangle. What is a <u>rectangle?</u>
   a. A four-sided figure with two opposite sides equal
   b. A four-sided figure with two opposite sides and angles equal
   c. A four-sided figure whose angles are all equal to 90^0
   d. A four-sided figure with opposite angles equal
   e. A four-sided figure with all sides equal

10. The theorem of Pythagoras is one of the most famous theorems in geometry. What is a <u>theorem?</u>
   a. A general conclusion which has been proved
   b. A way of solving a problem
   c. A law or rule used in geometry
   d. An explanation of the angles in a geometric diagram
   e. A method of calculating angles in geometry

11. All fractions have a numerator. What is a <u>numerator?</u>
   a. The line that separates two expressions in a fraction
   b. An expression below the line in a fraction
   c. A number divisible by 2
   d. A number that is part of a fraction
   e. An expression above the line in a fraction

12. When sampling, the ratio of the data found in the sample is assumed to be equal to that of the data found in the entire population. What is a <u>ratio?</u>
   a. A number that is unknown
   b. A number that is a result of a calculation
   c. The relative sizes of two quantities
   d. The result of a division
   e. A solution to an equation

13. The study of trinomials is not new in mathematics. What is a trinomial?
   a. A three-sided figure
   b. An expression that is divisible by three
   c. Another word for "three"
   d. An expression of three terms
   e. A triangle with three equal angles

14. Some solutions of quadratic equations can be represented graphically. What is a quadratic equation?
   a. An expression in which one solves for two unknowns
   b. An equation of the second degree, containing the unknown raised at most to the second power
   c. An equation containing x as an unknown
   d. A four sided geometric figure with four equal angles and four equal sides
   e. A four sided figure with two opposite and equal sides

15. Most of the trigonometric graphs have no asymptotes. What is an asymptote?
   a. A line which is approached by a curve infinitely close, but never meet
   b. A straight line that moves away from a curve
   c. A straight line that touches a curve at only one point
   d. A straight line that lies next to the x-axis
   e. A never-ending line that moves away from the origin

16. Some points on the straight line have the same abscissa. What is an abscissa?
   a. A series of points that join together to form a circle around the origin
   b. A point that is on a straight line
   c. The co-ordinate measured from the y-axis parallel to the x-axis
   d. A group of co-ordinates that fall in the quadrant
   e. A set of lines that have the same length but different gradients and never meet

17. It is well known that the word isosceles has Greek origins. What is an isosceles triangle?
   a. A four sided diagram with two equal sides
   b. A triangle with all sides equal
   c. A triangle with sides that are all unequal
   d. A set of two adjacent circles
   e. A triangle with two equal sides

18. Square roots are widely used by engineers. What is a square root?
   a. A point where two diagonals of a square meet
   b. The result we get when we multiply a number by two
   c. The result we get when we multiply a number by itself
   d. The result we get when we divide a number by two
   e. A number which, when multiplied by itself, produces the given number

19. Most buildings have walls that are perpendicular to each other. What does word perpendicular mean?
   a. When two straight lines are parallel and equal to each other
   b. When two straight lines intersect so as to form an angle of 90 degrees
   c. When a line cuts another straight line at an obtuse angle
   d. When a line is opposite the right angle in a right-angled triangle
   e. When a line divides another line into two equal halves

20. Axioms are very useful in the teaching and learning of mathematics. What are axioms?
   a. Diagrams used when explaining concepts of algebra
   b. Statements accepted as true without further proof
   c. Instruments used to draw mathematical objects
   d. Special exercises used for testing beginners in mathematics.
   e. Calculations that involve only two variables.

21. The product of zero and another number is zero. What is a product?
   a. A quantity that is raised to the power of zero
   b. The result of dividing one quantity by another
   c. The result of factorizing
   d. The result of multiplying two or more quantities
   e. A quantity that multiplies another quantity

22. In algebra, exponents are widely used. What is an exponent?
   a. A special name for a number that has similar qualities as another number
   b. A characteristic of agreement between two sets of objects
   c. A figure showing the number of times a quantity must be multiplied by itself
   d. A symbol that denotes numbers that are usually too big
   e. An abbreviation of a long expression

23. The difference of two non-equal numbers is non-zero. What is a difference?
   a. The result of dividing one quantity by another
   b. A result that is not the same as others
   c. A quantity that has a negative sign
   d. The result of subtracting one quantity from another
   e. A quantity that is different from another quantity

24. Some mathematicians have labelled odd numbers as masculine. What are odd numbers?
   a. Numbers that are small
   b. Numbers that are not evenly divisible by 2
   c. Numbers that are non-real
   d. Numbers with remainders
   e. Numbers that are multiples of 3

25. The sum of zero and zero is zero. What is a <u>sum?</u>
    a. A result of subtracting more than one quantity
    b. A result of adding one or more quantities
    c. A set of numbers
    d. A mathematical equation normally given to students for solving
    e. A portion of a bigger quantity of objects

26. On the number line, a solution set can be represented by a closed interval. What does the phrase <u>closed</u> interval mean?
    a. A point where the number line stops
    b. Last number of an interval
    c. Interval that contains both of its end points
    d. Not being able to add further than one has done
    e. A number that is inside a bracket

27. Most solids have faces. What are <u>faces?</u>
    a. Front views of quantities
    b. the ways polyhedrons appear
    c. different types of quantities
    d. plane surfaces that bound a polyhedron
    e. Quantities that can be changed

28. The compliment of an angle A can be found without using a diagram. What is a <u>compliment</u> of an angle A?
    a. The size of angle A
    b. The angle 90^0-A
    c. The solution of angle A
    d. The angle A+90^0
    e. The angle A+180^0

29. Right angles are some of the special angles in trigonometry. What are <u>right angles</u>?
    a. Angles between 0^0 and 90^0
    b. Angles between 90^0 and 180^0
    c. Angles of 90^0
    d. Angles that are equal
    e. Angles that are not equal

30. The range of most graphs is determined by inspection. What is a <u>range?</u>
    a. The size of a graph
    b. The set of values that a function takes on
    c. The shape of a graph
    d. The arrangement of a graph
    e. The set of numbers which corresponds to another set

31. Prime numbers form part of the number system. What are prime numbers?
   a. Numbers that are small
   b. Numbers which start from 2 and which are divisible by 2
   c. Numbers, excluding 0 and 1, which are divisible by 1 and themselves only
   d. Numbers that are not evenly divisible by 2, like 1;3;5;7;9;
   e. Numbers that have no square roots

32. Not all numbers have reciprocals. What does the word reciprocal mean?
   a. Undefined
   b. Multiplicative inverse
   c. Opposite
   d. Exponent
   e. Number in front of a variable

33. Functions are widely studied in algebra. What is a function?
   a. The work performed by one or more objects
   b. The method that one applies when solving a problem that involves mathematical expressions
   c. Something that a problem is based on
   d. An association of exactly one object from one set with each object from another set
   e. A relation

ANSWER SHEET

Name: ______________________________

Gender: ______________________________

Question	Possible Answers				
1	a	b	c	d	e
2	a	b	c	d	e
3	a	b	c	d	e
4	a	b	c	d	e
5	a	b	c	d	e
6	a	b	c	d	e
7	a	b	c	d	e
8	a	b	c	d	e
9	a	b	c	d	e
10	a	b	c	d	e
11	a	b	c	d	e
12	a	b	c	d	e
13	a	b	c	d	e
14	a	b	c	d	e
15	a	b	c	d	e
16	a	b	c	d	e
17	a	b	c	d	e
18	a	b	c	d	e
19	a	b	c	d	e
20	a	b	c	d	e
21	a	b	c	d	e
22	a	b	c	d	e
23	a	b	c	d	e
24	a	b	c	d	e
25	a	b	c	d	e
26	a	b	c	d	e
27	a	b	c	d	e
28	a	b	c	d	e
29	a	b	c	d	e
30	a	b	c	d	e
31	a	b	c	d	e
32	a	b	c	d	e
33	a	b	c	d	e

How sure are you?

Sure	Not so Sure	Guessing

References

Adetula, L.O. (1990) Language Factor: Does it affect children's performance on word problems? *Educational Studies in Mathematics*. 21: 351-365.

Adler, J. (1998) Lights and limits: Recontextualising Lave and Wenger to theorise knowledge of teaching and learning school mathematics. (Forthcoming).

Aiken, L.R. (1972) Language factors in learning mathematics. *Review of Educational Research*. 42(3):359-386.

Anghileri, J. (1995) Language, Arithmetic and the negotiation of meaning. *For the Learning of Mathematics*. 15(3): 10-14.

Austin, J.L. and Howson, A.G. (1979) Language and mathematical education. *Educational Studies in Mathematics*. 10(1979):161-197.

Barrass, R.R. (1979) Vocabulary for introductory courses in biology : necessary, unnecessary and misleading terms. *Journal of Biological Education*. 13(3):179-191.

Brissenden, T. (1988) Talking about mathematics : *Mathematics discussion in primary classrooms*. Basil Blackwell Ltd: England.

Brodie, K. (1989) Learning Mathematics in a Second Language. *Educational Review*. 14(1): 39-53.

Cleghorn, A. and Dube, R. (1998) Code-swtching in mathematics lessons in Zimbabwe. In Ogude, N. A. and Bohlmann, C. (Eds). *Proccedings of the 6th Annual Meeting of SAARMSE*, University of South Africa, Pretoria, pp.121-125.

Chapman, A. (1997) Towards a model of language shifts in mathematics learning. *Mathematics Education Research Journal*. 9 (2): 152-173.

Clarkson, P.C. (1992) Language and Mathematics: A comparison of bilingual and monolingual students of mathematics. *Educational Studies in Mathematics*. 23: 417-429.

Dawe, L. (1983) Bilingualism and mathematical reasoning in English as a second language. *Educational Studies in Mathematics*. 14(1983):325-353.

Halliday, M.A.K. (1975a) 'Some aspects of sociolinguistics,' in *Interactions between linguistics and mathematical education*, UNESCO, Copenhagen, 64-73.

Hardcastle, L. and Orton, T. (1993) Do they know what we are talking about. *Mathematics in School*. 22(3):12-14.

Mercer, N. (1995) A theory of practice. Chapter 5 in *The guided construction of knowledge: talk between teachers and learners.* Clevedon: Multilingual matters.

Mercer, N. (1985) 'Communication in the classroom' in *Every Child's Language, An In-Service Pack for Primary Teachers, Book 1,* Clevedon, Multilingual matters in association with the Open University.

Mokuku, T.T. (1993) Biology and language : evaluating the validity of a multiple-choice test for use with Standard 8 English second language ecology students. Unpublished MSc(Science Education) Research Report. University of the Witwatersrand.

Nhlapho, M.V. (1993) Problems encountered by English first language and English second language pupils with technical and non-technical terms used in ecology. Unpublished MSc(Science Education) Research Report. University of the Witwatersrand.

Nicholson, A.R. (1977) Mathematics and language. *Mathematics in School.* 6(5):32-34.

Otterburn, M.K. and Nicholson, A.R. (1976) The language of (CSE) mathematics. *Mathematics in School.* 15(5):18-20.

Pimm, D. (1987) Speaking mathematically. Routledge and Kegan Paul, London.

Setati, M. (1998) Code-switching in a senior primary class of second language mathematics learners. *For the Learning of Mathematics.* 18 (1): 34-40.

Shuard, H. and Rothery, A. (1984) Children reading mathematics. John Murray, London.

Vygotsky, L.S. (1971) Thought and Language. M.I.T. Press, Cambridge, Mass.

Vygotsky, L.S. (1978) Tool and symbol in child development. Chapter 1 in *Mind in Society*, Cambridge: Harvard University Press.

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