A STUDY OF THE RESPONSES OF CULTURALLY DIFFERENT PUPILS TO MATHEMATICS VOCABULARY

by

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DECLARATION

I, the undersigned, hereby declare that this dissertation is my own original work and that it has never been presented in part or in its entirety at this or any other university in order to obtain a degree.

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SUMMARY

This study examined the effects of second language in the learning of mathematics by the black pupils. The first aim was to investigate pupils' understanding of the meaning of words found in their text books. The second aim was to determine the level of difficulty experienced by pupils in learning the meaning of mathematical terms. The third aim was to find out whether mathematics performance is influenced by any particular respondents' characteristics. To this end, an achievement test with three subtests was administered to a representative sample of black pupils doing mathematics at standard nine and ten.

The first subtest (TEST A) consisted of questions that require pupils to define concept found in their textbooks. The second subtest (TEST B) was designed to elicit dual conceptualisation from a pupil, i.e. a pupil responded by defining a concept or by means of a diagram. The third subtest (TEST C) consists of descriptions of concepts. The pupil had to respond by a word to each description.

A large percentage of black pupils did not perform very well in all mathematics tasks. They made best responses by means of diagrams, but did poorly in language expression. This is an indication that culturally different pupils' poor performance in mathematics tasks, is due to language limitations. Further on there is no relationship between language and spatial tasks.

The present study revealed that standard nine and ten pupils have problems in defining concepts that are found in their mathematics text books. They also fail to associate a concept with a description. The causes for these problems are varied. It may be due to language that it is restricted to the classroom situation or the methods used in teaching new concepts are to culturally different pupils.

Results also indicated that performance of pupils is less influenced by variables like sex and age than by class, stream and mathematics grade. It has been found that age has no influence on the performance of mathematics tasks. The performance of all age groups is the same. It was found that the performance of boys and girls does not differ. On the other hand, standard ten pupils' achievement was better than that of standard nine pupils. In the same vein, the science group pupils did better than the general and commerce pupils. Pupils doing higher grade mathematics also showed better performance than pupils taking standard grade mathematics.

OPSOMMING

Hierdie studie het die invloed van 'n tweede taal by die onderrig van wiskunde onder swart leerlinge ondersoek. Die eerste doel was om leerlinge se begrip van die betekenis van woorde wat in hulle handboeke voorkom, te ondersoek. Die tweede doel was om te bepaal hoe moeilik leerlinge dit ondervind om die betekenis van wiskundige begrippe te leer. Die derde doel was om te bepaal of wiskundeprestasie beïnvloed word deur enige spesifieke respondente se karaktereienskappe. Sodoende is 'n prestasietoets met drie subtoetse op 'n verteen= woordigende monster van swart standerd nege en tien wiskunde leerlinge toegepas.

Die eerste subtoets (TOETS A) het bestaan uit vrae wat verlang dat leerlinge begrippe wat in hulle handboeke voorkom met definieer. Die tweede subtoets (TOETS B) is ontwerp om tweeledige begripsvorming by 'n leerling te ontlok, d.w.s. 'n leerling het beantwoord deur 'n begrip te definieer of deur middel van 'n diagram. Die derde subtoest (TOETS C) het uit begripsbeskrywings bestaan. Die leerling moes antwoord deur 'n gepaste word vir elke beskrywing te kies.

'n Groot persentasie van swart leerlinge het nie baie goed gevaar in alle wiskundige opdragte nie. Hulle het die beste gevaar deur middle van diagramme maar het swak gevaar met taaluitdrukking. Hierdie is 'n aanduiding dat kultureelverskillende leerlinge se swak prestasie in wiskundeopdragte aan taalbeperkings toegeskryf kan word. Verdermeer is daar geen verwantskap tussen taal en ruimtelike opdragte nie.

Die huidige studie het getoon dat standard nege en tien leerlinge probleme ondervind om begrippe te definieer wat in hulle wiskunde handboeke voorkom. Hulle sukkel ook om 'n begrip met 'n beskrywing te verbind. Die oorsake van hierdie probleme is allerlei. Dit mag as gevolg van 'n taal wees wat tot die klaskamer beperk is of dat die metodes wat gebruik word om nuwe begrippe te onderrig vir leerlinge kultureel vreemd is.

Bevindinge het ook aangedui dat leerlinge se prestasie minder beïnvloed word deur veranderlikes soos geslag en ouderdom as deur klas, stroom en wiskundepunt. Daar is bevind dat ouderdom geen invloed op die uitvoering van wiskundeopdragte het nie. Die prestasie van alle ouderdomsgroepe was dieselfde. Dit is bevind dat die prestasie van seuns en dogters nie verskil nie. Andersyds, was die prestasie van standerd tien leerlinge beter as die van standerd nege leerlinge. Soortgelyks, het leerlinge in die wetenskapsgroepering beter presteer as die in die algemeen- en handelsgroepering. Leerlinge wat wiskunde op die hoërgraad geneem het, het ook beter gevaar as die standaardgraad wiskunde leerlinge.

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CHAPTER ONE

1. INTRODUCTION

1.1 MOTIVATION FOR THE STUDY

Before 27 April 1994, South African schools were racially differentiated into White, Black, Indian and Coloured. White schools were further divided into English medium and Afrikaans medium schools. With the exception of Afrikaans medium schools, the medium of instruction in all these schools is English. Black schools offer three languages, while the rest of the other schools have two languages. Two official languages are offered in black schools. These are English and Afrikaans. The third language offered in black schools is the mother tongue. Afrikaans and mother tongue are taught as subjects while English is a subject as well as the medium of instruction (Matabane, 1990; Hartshorne, 1991).

The black child learns the two official languages for the first time at school. English affects the black child in two ways, as a new subject and as a medium of instruction. Schmied (1991) contends that English is the language of a European nation and Western culture, it cannot, therefore, carry the association and connotations of an African identity. Education in English deracinate the black child who is compelled to learn the new culture. He is now alienated from his own culture.

Thus, in this dissertation, a black child is referred to as a *culturally different* child.

A culturally different pupil finds himself in a school environment which contains more than one language. Such languages could be, e.g. English, Afrikaans and Zulu. One language which is important and a subject of this research is the mathematical language. The circumstances of learning mathematical language are different from those of learning mother tongue or any other language. For a culturally different pupil, mathematical language is heard, read and learnt only in the classroom. In support of this argument, Pimm (1987) asserts that mathematical language involves unfamiliar symbols, rather than words. These symbols are often seen on paper. Rarely do people make use of oral communications, in mathematical language.

Researchers do not perceive mathematical language in the same way. Papert (Pimm, 1987) regards mathematics as an everyday language and maintains that the computer language Logo, is one of the means of gaining entry into the environment of mathematical language.

Wheeler and Wheeler (1961) maintain that mathematics is a language of those who wish to express ideas of shape, quantity, size or order. It is the language that is used to describe our physical world, like facilitating transactions in the market place and analyzing complexities of modern society. Wheeler and Wheeler (1961) further argue that to communicate effectively, it is essential to have a knowledge of this language.

According to Beilin (1975) mathematics is characterized as the language of science. The superiority of mathematics as a language system and also as a language of science derives from its ability to present abstract ideas with greater precision and clarity than other forms of representation. Beilin (1975) also asserts that mathematical language makes communication of certain complex abstract ideas possible with greater clarity, precision and economy than other languages.

If we consider language in general and not mathematical language, the principles of humanistic sociology, define language as a cultural object or value in the life of a particular speech community or group. Communication therefore amongst members of a group can be thought of as a tendency to activate certain values in a cultural group (Smolicz, 1979).

There are as many languages as there are people speaking them. These languages are very different from one another. Anderson and Stageberg (1979) advocate that the differences are the kinds of sounds used and the ways of putting them together.

Although languages are different, several researchers (Anderson & Stageberg, 1979; Bolinger, 1975) mention the following homogeneity among languages :

a) **Language is peculiar to human beings**

All people in the world have language. It is the language that enables people to communicate with each other. Communication conveys emotion through smile, tears and music. Through the use of language communication, there is also understanding and reacting to what someone says. The response or reaction may be to make a statement, to ask a question, to agree or disagree, to carry out directions and to answer questions in a negative or affirmative way. Finocchiaro (1967) also concurs that every language in the world is rich enough and sufficiently complete for its speakers to carry out their daily activities.

b) **The medium of language is sound**

All languages are based on speech sounds. According to Anderson and Stageberg (1979) speech sounds are sound waves created in a moving stream of air within the cavity of speech organs, and resulting in vibrations. Vibrations go to the same direction due to the activity of the speech organs. This vibration is combined into small units of design. The sounds made, produce words which have meaning to any person who knows the language.

c) **Language is embedded in gesture**

Gesture is a mode of communication that human beings have. It is also called the body language, as a person uses his body to articulate his speech. Gesture may occur alone, for example when the teacher tells the pupils to be quiet she puts her index finger on her mouth. Gesture may also accompany the speech.

d) **Language is arbitrary**

Every language has its own arbitrary symbols or words to express an object or idea. There is no connection between the name of an object and its nature. If a child is asked why a certain object is called a clock, for example, the answer will probably be "because it is a clock". This is confirmed by Finocchiaro (1967) that no one knows why words convey certain meanings. But all speakers of the language do know and can use general terms associated with objects or concepts in their environment.

e) **Language is conventional**

The effectiveness of a language rests upon a kind of unspoken public agreement that certain things will be done in certain ways. This is one consequence of its arbitrariness. For example speakers of English agreed upon calling a certain animal a horse. This is an arbitrary agreement. The principal function of language, communication, would break down if everybody insisted on using his own private arbitrary names or words for things. Anderson and Stageberg (1979) advocate that the agreement is often not complete. For example people may argue over whether or not whales are fishes or spiders are insects. Such arguments, however, are wholly within the conventional field of language.

f) **Language is culturally transmitted**

Language is passed on from one generation to the other as a form of learned rather than physically inherited behaviour. Children learn language from their parents and older brothers, sisters and other members of the community, who in turn have learned language at an earlier time. This learning begins at infancy and continues in varying intensity throughout life.

g) **Language is learned behaviour**

The change that is more dramatic for a child is the acquisition of a language. As Morris (1982) puts it, that language depends on physical maturation and control of muscles that move in the mouth and tongue. According to Finocchiaro (1967), children are born with the ability to make sounds. Sounds take shape and become meaningful only through the constant hearing and repetition of those sounds made by adults.

Kaplan (1986) also affirms that the only way children learn vocabulary is through imitation. He further alleges that children also learn words when they have need for them. For example a child learns to say "cookie" if he sees it, because he hears the word "cookie" used, and he wants it.

1.2 MATHEMATICS AS A LANGUAGE

Mathematics is a language on the basis that it is composed of meanings appropriate to the communication of mathematical ideas. The names of symbols of mathematics are arbitrary, i.e. there is no connection between the name of the symbol and the nature of the symbol. Like all languages, mathematics is acquired through learning. This means that mathematics satisfies all the characteristics of a language (Crandall, 1987).

Although mathematics is a language, certain words carry a mathematical meaning which is different from the usual everyday meaning. For example in the mathematical context, the word "relation" means a set of ordered pairs. In everyday language it means a relative (Orton, 1987). This however, causes confusion in mathematics classes. This confusion occurs at the level of interpretation of particular words. Should, for instance, everyday meaning be carried over to mathematical setting and this variant usage be unfamiliar to a child, a number of difficulties may ensue in the learner.

When children start formal schooling, they have already absorbed and processed huge amounts of information about language and customs of their society (Berry, 1985). At school the culturally different pupil comes across mathematics which is taught in a second language. The performance of such pupils in mathematics is likely to be adversely affected.

Berry (1985) maintains that learner's mother tongue has a string of influences on his cognitive processes, like classification and recognition. These processes are important in the learning of mathematics. The mother tongue of a culturally different student lacks mathematical, scientific and technical vocabulary necessary for use as medium of instruction and learning right through school (Wilkinson, 1981). For example :

An egg has an **oval** shape.

A wedding ring has a **circular** shape.

A coin has a **round** shape.

A tennis ball has a **spherical** shape.

The Zulu language has one name for all the above examples or shapes, which is round. This means that all these shapes will evoke one concept to a culturally different pupil.

Classification according to degree or intensity, builds up into a hierarchy. The Zulu language falls short of this classification. In Zulu language, classification is limited to independent, nominal or discreet groupings. Hierarchical classification such as the following example does not exist in Zulu language :

A is smaller than B but C is bigger than B.

This shows that in Zulu language, the concepts "bigger" and "smaller" do not exist. Research evidence (Austin & Howson, 1979; Peters, 1966) confirms that black languages have a limited vocabulary. This is due to the cultural demands that have not led to the development of a terminology, adequate for modern international view of Mathematics. Peters (1966) further points out that there are no Zulu words for theorem, equation, function, quadratic and parallelogram.

The lack of some mathematical terms in the black language indicates that there are gaps in the language of black students. This also means that a black student is not only incapacitated but as Strevens (Austin & Howson, 1979:172) points out "there is a major difference in mental preparation for mathematics learning between a learner whose language makes use, in some recognisable form, of the international Greek-Roman terminology, its prefixes (pre-, post-, anti-, etc.) suffixes (-action, -or, -ant, -ize, etc.) and roots (equ, arithm, etc.), and a learner whose language contains neither these items ... nor any translation equivalent to them".

A culturally different student who is caught between his unavailing mother tongue and the language which dictates the design of his curriculum, develops the survival strategy. The strategy is generally speaking, to stifle his natural impulse to questions and simply memorize what the teacher wants. At the secondary school and tertiary levels, emphasis is on solving a problem, or proving a theorem. The rote learning fails to produce the required performance levels. The student's lack of understanding suddenly appears, for the first time. At this stage the habit of memorization has become entrenched, that is, it is not possible to do away with this habit. This therefore is one of many factors that lead to failure in mathematics (Crandall, 1987; Berry, 1985).

According to Crandall (1987) mathematics language, like all other languages, has special syntactic structures i.e. the grammatical arrangement of words, showing their connection and relation. The characteristic of these structures is the frequent use of logical connectors, which indicate the nature of relationship between parts of a text. Culturally different students usually experience difficulty in putting mentally the logical connectors in their perspective. For example, Wendy is as old as Michael. The connectors being : *as ..... as*. Munro (Crandall, 1987) further mentions other syntactic structures which are also frequently used in mathematics. These structures are also confusing to culturally different students. For example, numbers may be used as nouns rather than adjectives, like : *Forty is five times a certain number. What is this number?* Here the problem is compounded by the problem of structures and the problem of ratio scale.

When the culturally different student learns in the medium of English, he is not yet able to handle the language efficiently. Consequently he is unable to communicate with understanding and is at the same time learning new concepts which are specifically for mathematics (Wilkinson, 1981).

Culturally different students use English as a second language in mathematics classes. This is one of the factors which contribute to minimal communication in the classroom. In addition, cultural limitations have a bearing on the mode of classroom communication. One of the rules of traditional culture for Blacks in the Republic of South Africa (RSA) is slavish obedience on the part of the child. This dampens his initiative, originality and creativeness to a great extent (Wilkinson 1981). In black society, children are seen and told, not heard. The suppressed characteristics are needed in the learning of mathematics. Pupils lacking these characteristics cannot be expected to do well in mathematics. Chimuka (Wilkinson, 1981) contends that passivity in mathematics class room is to a great extent due to communication difficulties. Pupils would like to ask and answer questions, but are unable to express themselves in the second language. Even if the child is keen to participate in mathematics, the adverse conditions under which the black pupils learn, like large class sizes, hinders the individual the interaction between the teacher and the pupil.

A culturally different child is brought up in a traditional society, i.e. a society which has a social organization, educational and general culture of black people before being altered and destroyed by Western contact and culture (Dreyer, 1980). This society is also characterized by what Wilkinson (1981) calls the absence of numeration. Zaslavsky (Wilkinson, 1981) asserts that the majority of African numeration system has *five* as the primary base, because counting is practised as a one-to-one correspondence with parts of the body like fingers. Large numbers which cannot be represented by fingers are unwieldy description. A pupil from such background is bound to encounter problems in mathematics. Mathematics deals even with abstract concepts in calculation and is not tied to the concrete level of counting in units of five.

In addition to the effects of words and language on memory, they also affect the way we think about things. As Bishop (1979) advocates differences in languages imply differences in thought. That is to say, people with different linguistic backgrounds think differently, relative to the object of thought. According to the *linguistic relativity hypothesis* (Whorf, 1956) the language one speaks determines one's mode of thinking and one's view of the world. This implies that if a language lacks a particular expression, the thought that the expression corresponds to, will probably not occur to people who speak that language.

The linguistic relativity hypothesis cannot be accepted without modification. One dimension for modification is indicated by the fact that a need to think about things differently, may change a language and not vice versa. This is a source of neologism. While different languages encode experiences differently, any thought can be expressed in any language. In this view, language affects interpretation but not perception. Culture accounts for different views of reality. Language merely expresses a type of knowledge that is native to a culture.

1.3 STATEMENT OF THE PROBLEM

Effective instruction in mathematics is at present, more than ever before, of greatest importance. There is also additional demand of mathematics knowledge made by technology and sciences. The teaching of mathematics should make pupils actively involved in developing mathematical knowledge. This knowledge can be acquired by exploring, discussing describing and demonstrating. The teaching of mathematics can also effectively be done through developing the mathematics language, because integral to these methods of learning is the language. Linguistic abilities affect performance in mathematics, no wonder mathematics is regarded as specialised language. (National Council of Teachers of Mathematics, 1989; Wilkinson, 1981 and Aiken, 1972).

There are many aspects of the issue of language which might affect learning. Anecdotes about children experiencing mathematics difficulties are found in abundance. The most common mathematics difficulty is understanding of subject terminology, i.e. mathematical vocabulary.

Learning mathematics in a second language is another problem. The ability to solve a mathematical problem depends on the language and its culture. According to Austin and Howson (1979) the traditional cultural demands have not led to the development of terminology adequate for modern international view of mathematics. Michau (1978) has confirmed that studies conducted amongst black people of the Republic of South Africa, show that, there are differences and inadequacies as far as mathematical conceptualization is concerned. She further points out that Zulu language does not have the word or symbol for a naught or zero.

For black children the problem of mathematics becomes compounded since some of the basic mathematics concepts are not encoded in their language. Such concepts will not be easily accessible to them, or at least will prove very difficult. This implies that a child should attain a certain level of concept formation in English to be able to solve mathematical problems. While English poses its own problems this becomes compounded in mathematics.

Formal mathematics is highly specialised and is difficult to assimilate when compared to everyday language. Apart from mathematics being specialised, there are words which occur in mathematics and ordinary English but have different meanings, for example the term "figure" means body shape in ordinary language and means numerical symbol in mathematical language. Other words have same meanings for both ordinary and mathematical language, like to word "similar". These different categories of mathematical words are a source of confusion and difficulty to pupils who are not speakers of the English language.

1.4 AIMS OF THE STUDY

1.4.1 To find out whether pupils understand the meaning of words found in their textbooks.

1.4.2 To determine the level of difficulty experienced by pupils in learning the meaning of mathematical terms, i.e. to determine how much students know about mathematical vocabulary.

1.4.3 To find out whether pupils can discover mathematical concepts on the basis of information given, i.e. concept identification.

1.4.4 To determine the influence of respondents' characteristics on mathematics test performance.

These characteristics are :

1.4.4.1 Variable of sex

1.4.4.2 Variable of age

1.4.4.3 Variable of class

1.4.4.4 Variable of stream

1.4.4.5 Variable of mathematics grade

1.5 ASSUMPTIONS

The following hypotheses are formulated to fulfil the aims of the study :

1.5.1 The culturally different pupils understand the meaning of words found in their textbooks.

1.5.2 There will be no differences among culturally different pupils regarding the level of difficulty in learning the meaning of mathematical terms.

1.5.3 There will be no differences among pupils with regard to concept identification in mathematical tasks.

1.5.4 No differences exist in mathematics test performance among pupils grouped according to the following characteristics :

1.5.4.1 Variable of sex

1.5.4.2 Variable of age

1.5.4.3 Variable of class

1.5.4.4 Variable of stream

1.5.4.5 Variable of mathematics grade

1.6 DEFINITION OF TERMS

The following are operational definitions of terms which appear in the title of this research.

1.6.1 Culturally different pupil :

The term culturally different pupil means a pupil who comes from traditional black cultural milieu. The traditional black society has little or no numeration activities. The culturally different pupil comes from this traditional black society. This culturally different pupil has to cope with new frame of meanings of a second language, which is a medium of instruction in mathematics.

1.6.2 Mathematics vocabulary :

In this context, mathematics vocabulary means mathematical terminology composed of ordinary English words commingled with various brands of highly stylized formal symbols. The mixture of this language varies from elementary mathematics to mathematics at a tertiary level.

1.6.3 Response

In this study response shall mean a student's definition of a mathematical stimulus word or concept.

1.7 PLAN OF STUDY

Chapter 1

This chapter consists of : motivation for investigation in this field, statement of the problem, aims of the study and a plan for the organization of the whole scientific report.

Chapter 2

Chapter two provides a theoretical background to the study. This background focuses on the role of language in the development of mathematical concepts. The cultural and philosophical background of a black child is also reviewed. The pragmatic reasons to teach mathematics in a second language and the place of mathematics in a multilingual society are also discussed.

The relationship between mathematics as a language and English will be looked into.

Chapter 3

Chapter three consists of the empirical research design and the results of the pilot study.

Chapter 4

This chapter details analysis and interpretation of the data. The hypothesis formulated in chapter one are tested in this chapter.

Chapter 5

Chapter five gives a synthesis of different findings. Summary and recommendations are also discussed in this chapter.

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CHAPTER TWO

2. REVIEW OF STUDIES ON THE EFFECT OF SECOND LANGUAGE IN THE LEARNING OF MATHEMATICS.

2.1 INTRODUCTION

English and Afrikaans have been the only official languages in South Africa. This situation will be curtailed by the advent of new government in 1994. It has already been indicated that there will be eleven languages in the new South Africa.

In the past the two official languages were enforced media of instruction in schools. For whites, there are Afrikaans speaking schools and English speaking schools. The black counterparts did not enjoy this privilege. The black schools could either use English or Afrikaans as a medium of instruction. These official languages are regarded as second languages for a black child. The mother tongue is used as a medium of instruction in junior primary phase of education. From higher primary to senior secondary school the medium of instruction is English or Afrikaans.

Being exposed to English or Afrikaans as medium of instruction has many attendant problems. Black students could not attain proficiency in these languages. As a result poor scholastic performance characterize black students. Their receptive and expressive skills in official languages are poor. This problem tends to be magnified in certain subjects, mathematics in particular.

Gray and Tall (1993) allege that "Mathematics is an enigmatic subject in which a few succeed with discarning ease, while others seem doomed failure". This shows that a black child is also faced with the challenge of learning this difficult subject in a foreign language.

English as a medium of instruction in the teaching of mathematics creates a classroom culture that is different from the culture reflected in black children's homes. The cultural background of the culturally different child will be examined to find out how it affects his learning of mathematics.

Long before children can talk, they form schemata about things. Children start to form real concepts the moment they learn to talk. In this way they surmount a lot of vocabulary from their environment. The early language of big, small might seem not mathematical when in actual fact it is a basis of mathematical language. It is therefore imperative to look into the concept formation of a child.

Various psychologists have come up with different views about the relationship between language and thought. Some psychologists believe that language is dependent on thought while others believe the opposite. There are also those who believe that language and thought are independent. The learning of mathematics is also viewed by different theorists in different ways.

Living together of different races, thus forming multilingual societies is one of the characteristics of the South African situation. Children of such societies use same schools. A need to use a common language arises. English and Afrikaans serve as official languages used in schools. These languages are called second languages for such pupils as they have their mother tongue.

2.2 THE CULTURAL BACKGROUND OF A BLACK CHILD

Many black people lead a traditional way of life, particularly in certain rural areas. It is, however generally true to say that the tribal life-style is rapidly disappearing due to the growth of western influence (Morris & Levitas, 1984). In view of the aim of this study, it is imperative to give a brief outline of the backgrounds from which the culturally different pupils are brought up.

A large proportion of black parents seem traditional in their orientation, while others have taken over the western way of life. Even the parents who have taken over much from western culture, still attach values to established customs. For example, the dressing up in a western way, can be regarded as norms and values that represent the outward form. The internalised form of values like discipline and the way of bringing up children is still traditional. The manifestation of traditional forms sometimes continues to exist parallel with western culture, like belief in ancestors and Christian faith. Albeit the two extremes there are parents who according to Groenewald (1976) remain faithful to their tradition and tribal culture, but who, to some extent take part in western customs at the same time.

Many culturally different students come from impoverished traditional domestic environments. A large percentage of these students come from rural areas, where huts are made up of mud. The rest of the students are from urban areas. Most of the houses in the urban areas are four-roomed houses, i.e. comprising of a kitchen, dining room and two bedrooms. This house has a floor space of ± 66 m^2. This four-roomed house can accommodate a family of up to fifteen. Besides being over-crowded, this house from the author's point of view is more habitable than the other types of houses called shacks. These shacks are ubiquitous but the material used to build them vary from place to place. These are the types of houses which serve as temporal accommodation for people working in cities, whereas in urban areas they tend to be permanent. It would appear that shanks have come to stay. People prefer to live in urban shanks than to live in rural areas, particularly for the younger generation, city life is praiseworthy.

The impoverished environment is characterized by lack, of magazines, furniture and educational toys. Recreation facilities are non-existent in such areas. Town planners in black areas do not include parks, libraries, fields and similar facilities. Black children play in streets. It is amazing that Groenewald (1976) views this as a peasant life and further maintains that poverty is the rule rather than the exception.

A family from which a culturally different child is brought up, is influenced by industrial development, the economic attitude of whites and the impact of school education. Black families are also divided into the following categories :

a) The family which still lives in rural areas with husband, wife and children undisturbed by distant employment. In this type of family, the man is the head of the kraal. "The only economy is practised on a subsistence level comprising a few head of cattle of poor stock." (Luthuli, 1981 : 30.)

b) The families which also live in rural areas, but the husband works in urban area. The husband has a temporal residence at the compound, hostel or puts up a shack next to the work place. It is not unusual for this kind of migratory labour to breed polygamy. As a breadwinner, the man supports two families in this set-up.

c) The families which live in townships can also be divided into two groups :

   i) The families that live in houses provided by local authorities, called four-roomed houses. Husband, wife, children and relatives are crammed in this two-bedroom-house sometimes called a match-box house.

   ii) There are also economically "well-off families" (Luthuli, 1981:46) who are capable of building their own sophisticated and westernized houses. This is a middle class of black society. Both the husband and wife are employed among township dwellers. Township dwellers appear to be in contact with the Western influence (Luthuli 1981).

The environment of a culturally different child is described as simple, because among other factors it lacks facilities. Groenewald (1976) points out that the task of herding cattle for the boys in the rural areas or the loitering of township boys is not challenging. The situations in which these two groups of boys find themselves require no particular intellectual challenge, de Lemos (1974) conducted studies on the development of spatial concepts among white and Zulu groups and confirmed that poor performance among Zulu children was due to poor home environment.

The conduct of the traditionally oriented black man is governed by traditionally established rules and codes of behaviour. Badenhorst (Groenewald, 1976:54) has this to say "All spiritual and material matters are established in unchangeable patterns of behaviour, taboos and customs are continued unchallenged". There is thus less chance of personal interpretation and adaptation to a situation. Abiola (1971) refer to this as an "assimilative rigidity of behaviour".

After the young child has been weaned at approximately three years of age, the emphasis in the parent-child relationship is laid on respect and obedience. Overt demonstration of love decreases and inculcation of certain personality qualities are emphasized. Children must slavishly obey older persons. Conformity and submission to authority are the dominant values (Groenewald, 1976). Hellman (Groenewald, 1976) describes the parent-child relationship as follows : "The parents' attitude towards the child is strict, stern and unbending. Only rarely did I encounter families in which the mother made any attempt to level the differences between the child and herself, by encouraging discussion with them and attempting to enter into their interests and to understand their problems." On the other hand the father has a position of authority and expects absolute obedience from the members of the family. Little is done to let children reason why they had to act in a certain way. The child is instructed how to behave in everyday situations, and such behaviour is enforced by punishment or threat (Groenewald, 1976). Authoritarian measure of discipline are partly good for the sole reason of training individuals to be responsible and to respect. These measures are also partly bad in as much as they degenerate creativity

(Sibaya, 1992). This creativity is needed in the learning of mathematics.

A culturally different student is therefore characterized by respect, loyalty, submissiveness and unconditional acceptance of authority. Unconditional obedience is thus a matter of course to such students. From childhood to adulthood people are subjected to the slavish submissiveness to authority of old people in the society. An expression not uncommon with many black cultures is that children are seen not heard. This expression has stood the test of time, to date among the Zulus (Sibaya, 1992). Its implication is recognition of adults as authority figures. This makes the black children to obey and not to think.

According to Groenewald (1976) the maternal love for the child decreases with the increase in age of the child. The reason being that the mother has other young children to look after, or there are other obligations towards a large family. Fathers on the other hand, do not pay much attention to the baby, since traditionally that is the responsibility of the mother. The other reason of fathers not responsible for the upbringing of their children, is that they are seldom at home, due to employment far away from their families.

"The traditional Zulu society was a relatively stable and static one" (Dreyer, 1980:34). Nowadays traditional setting has changed due to the contact between black people and white people. This transformation has led to the change of culture. Singleton (1974) defines culture as "patterns of meaning, reality, values, actions and decision-making that are shared by and within social activities". These patterns among the black people have changed, as a result of acculturation i.e. the process of individual and group change, caused by contact with various cultural systems. Acculturation is thus the cause of confusion to the black society, since the old generation is not well versed with some aspects of western culture, which are passed to the new generation. "So what we have now is not Zulu culture but transitional culture in a state of flux and even confusion" (Dreyer, Thembela, Badenhorst, Dlomo, Vos, Luthuli & Olivier, 1977:12).

According to Bishop (1985) cultural transmission entails transmission of new knowledge and cultural patterns from "anyone who knows to any one who does not". There are ideas and values from other cultures which are new to both the one who is supposed to 'know', the adult and the one who does not 'know', the culturally different student. Uncertainty and fear of the new, unknown future in such condition is inevitable. The new values have shattered the clearly outlined image of adulthood of traditional society. This could be one of the reasons, why children are denied verbal exploration, like asking the question "why" (Dasen, 1974).

One of the rules of any culture, is that the adult intervenes in the life of a young person and guides him according to norms and values of the society. The new values which the child acquires from school are unknown to the parents. The reason is that the schools is one example of a new world in the black culture, unknown to most of the older generation.

The task of guidance towards adulthood is therefore, left solely to the teacher. Due to "cultural dislocation" between the home and the school, confusion reigns between parents and children (Presmeg, 1988). Adolescents, no longer willingly conform without questions. They go to the extent of rejecting parental control. According to Zaslavsky (1970) further disruption came with the missionaries, who demanded that Africans renounce their traditional beliefs, and who introduced European-oriented education. As a result, there was little continuity between the school and the African child's social environment. Since the subject matter had little relevance to the child's life, he was not motivated to learn. This accounted for the emphasis on rote memory which characterized the education of African children.

The cultural change and loss of tradition among the Blacks, brought about change and a new value system. Even the fixed religious practices and beliefs made way for new or changed practices. These and other factors cause a new society for Blacks to emerge (Dreyer, 1980).

A culturally different child comes from this mingled situation. A society that partly knows its culture and partly knows a foreign culture.

2.3 THE ROLE OF LANGUAGE IN THE DEVELOPMENT OF MATHEMATICAL CONCEPTS.

Concept formation and perception are interrelated. Perception occurs when the stimuli from the outside world in the form of sight, sound, touch, taste and smell enter the nervous system via the appropriate sense organs (Lovell, 1971; Austin & Howson, 1979). In the nervous system the stimuli turns into signals which are being selected in the nervous system. The factors which determine selection depend on the expectancy and needs of the individual. After selection the signals are sent to the brain for interpretation thus we experience sensations. The interpretation given to incoming signals in the brain, is our perception of the external world. Perception is therefore, the reinforcement of sensation in the brain by past experience, ideas, expectancy and attitude.

Concepts on the other hand, are formed as the resultant of perception of the world. Concept formation will thus occur if a child can discriminate between the objects or events before him. According to Lovell (1971) discrimination demands that the individual should recognize and appreciate common relationships, and differentiate between these and other unlike properties. For example, the common feature among a number of circles with different sizes and made of different colours is roundness. Concepts therefore can be defined as perceptual invariants of objects, sensations, sound and feelings. These are internal representations of classes or categories of experience (Behr, 1980; Carroll, 1964; Carroll, 1967; Yelon & Weinstein, 1977).

According to Carroll (1967) concepts would not exist if the world was totally inorganic. The existence of organisms capable of complex perceptual responses make concepts become possible. There is evidence that animals other than human beings behave with regard to concepts, (Carroll, 1967). In this case our attention will be focused on human organisms. Cromer (1991) alleges that concepts precede encoding in language. However, there are three views that contrast this notion. The first view indicates that the child begins to use new forms or lexical items, perhaps by mere imitation, and thereby slowly comes to understand what they encode through their repetitive use in particular situations. A second view sees the child as attaining primitive concepts during development which then affect and are affected by language, i.e. are encoded. A third view credits the child with already possessing a variety of primitive concepts. Those that are specifically encoded in the language, are retained and developed and others are not reinforced. These views are similar to or extensions of Whorfian views in which concepts are determined or at least influenced by language (Cromer, 1991). All these views indicate the relationship between language and concepts.

Research on deaf children (Durkin, 1991) indicates that language is basic in the formation of concepts. Furth (Durkin, 1991) reports that deaf children have more difficulty with the concept of opposition than with the concept of similarity. Bishop (1985) believes that this situation is caused by the fact that, once it has been recognized that two objects are the same, little more remains to be said, but in comparing different objects more language-based concepts need to be drawn in. Jeffrey and Bishop also mention research findings in which deaf children were found to have difficulty with sequencing, i.e. putting things in order. They also argue that sequencing need verbal concepts like greater than or less than, to find the relationship between numbers.

Yelon, *et al.* (1977) maintain that concept attainment takes place in a gradual and continuous way, under the influence of environmental factors. Klausmeier and Hooper (1974) describe the Wisconsin model, which includes four levels of concept attainment. These are briefly discussed below.

1. **The concrete level** in which the individual recognizes an object and represents it internally; a child learns the word dog when he/she sees it.

2. **The identity level**, in which the individual can recognize the same object in different times. "The new critical operation is generalizing" (Yelon *et al.*, 1977:131). For example a child who sees another dog will generalize that it is a dog.

3. **The classificatory level**, is inferred when the individual treats two instances of the same set

as equivalent, although he cannot name common characteristics of both object. For example, a child sees other dogs and generalizes that they are equivalent, although he may not be able to say, why they are, and applies "dog" to the entire class of animals.

4. **The formal level**, the individual can name the concept, define it, discriminate and name its attributes.

These levels also indicate that when a child learns a concept, he cannot start from the fourth level but the sequence is strictly ordinal.

Successful methods of instructing a school child depends on understanding the development of concepts in the child's mind. According to Behr (1980) concept learning makes it possible for the individual to respond to things or events or words as a class. Behr further maintains that language plays an important part in the learning of concepts.

According to Cruikshank and Sheffield (1989) children's early experiences of number-related language start before their school activities. Children start to classify things as follows : belonging together or not belonging together; family members are seen as a unit against neighbours, things are judged as small or big, tall or short, fast or slow. This is the way children quantify their world. Children use the quantitative words when talking to each other and when communicating with adults. This type of communication will develop the child's quantitative experiences and language. Although this emerging language may not sound mathematical, it does represent a foundation on which mathematics language should be built (Cruikshank & Sheffield, 1988). Many quantitative words are based on a ratio level of measurement. Such concepts have no equivalents in African languages. This makes black children to be at a disadvantage when these concepts are applied in mathematics at school.

Lovell (1971) further mentions that language and mathematical symbols play a part in the concept formation in mathematics. Mathematical concepts are one class of concepts that generalize relationships between certain kinds of data. For example when a child is learning about natural numbers (1; 2; 3; 4; 5; ....) the child has to move from perceptions of the environment, like teaching aids. If the learning of mathematical concepts is based on practical work, then the problem of mathematical concepts will be evaded. Macnab and Cummins (1986) refer to the problem on mathematical concepts as belonging to a realm of thought which resembles a shadowy land, where through the mist one occasionally glimpses one feature, and afterwards another. They further comment that mathematical concepts are like a land of mystery, where clear outlines of the everyday world experience are replaced by cloud - like structures whose boundaries are uncertain and whose forms change. Thus at one moment there seems to be fixed and clear-cut forms of change and another appears to have altered beyond recognition.

Research findings reveal that children develop language in concert with their experiences (Cruikshank & Sheffield, 1988). The experiences are crucial to make sense. Cruikshank and Sheffield (1988) further emphasize that in the initial stages of mathematics learning, the quantitative experience must be closely connected to the language that describes those experiences. One of the main problems facing black teachers is to establish mathematical concepts. Difficulties are experienced not only in introducing concepts, but also in establishing them. The establishment of concepts means that in any given cognitive structure, a person consciously acts and applies an abstract concept from a preceding situation to a new one.

To help the child develop his mathematical concept, he must be taught the language and symbols of mathematics, and language does more than simply provide vocabulary. It is also basic to the formation of concepts and mental processes (Barham & Bishop, 1991). It is the language that will enable an individual to communicate mathematical concepts. Lovell (1971) confirms this and highlights the importance of language by saying that the grasping of mathematical concepts is not the beginning and end of mathematical ability. Such ability demands besides the understanding of concepts, knowledge of mathematical language.

According to Sapir-Whorf hypothesis, language and habits of a community predispose certain choices of interpretation (Durkin, 1991). In line with this hypothesis is the argument that people think and perceive in ways made possible by the vocabulary and phraseology of their language, and that concepts not encoded in their language will not be accessible to them (Durkin, 1991). This indicates that the problem of conceptualization of the culturally different child is caused by lack of continuity of the language used at home and at school.

Dickson, Brown and Gibson (1988) reveal that the acquisition of language and concepts is a dynamic process. The child's understanding and use of language and concepts varies with the involvement of the child in the situation in which they are used and the relevance they hold for him. Such relevance is minimal to the black child who learns the mathematical concepts in a foreign language. Macnab and Cummins (1986) concur with Dickson *et al* 1988. and give further explanation that mathematical concept appears in a particular context and thus carries with it certain features connected with specific context. For example multiplication is interpreted as repeated addition, thus multiplication as an operation on whole numbers by its very nature makes things bigger. On the other hand multiplication of a fraction and whole number like ½ of 12 now involves reduction in size, i.e. it makes things smaller. Multiplication is multifaceted.

Marjoram (1974) advocates that the part played by language in the child's intellectual development in general and no less in mathematical concept development in particular is not fully appreciated. "It is, undeniably, a mark of the good class teacher that he educes ideas by question and discussion" (Marjoram, 1974). This is just as necessary when children are doing practical work individually or in small groups. The idea of discovering concepts by using relationship or pattern becomes consolidated and operational for the child, when he has verbalized it. It is in this development of concepts using language that a mathematics teacher of a culturally different student plays his most critical role. The mathematics teacher has to coax, impel the reluctant culturally different student to communicate his findings. Moreover, the mathematics teacher must gradually bring the culturally different student to use language with more precision than elsewhere, for in mathematics, concepts are less ambiguously used and more strictly defined than in any other discipline.

2.3.1 LANGUAGE AND THOUGHT

Human beings have greater intellectual capacities than members of other species. To a large extent this superiority results from humans' capacity for thinking. Human beings also have a unique system for communication, i.e. language, that serves as a primary vehicle for expressing thought (Price, Glickstein, Horton and Bailey, 1982).

From an early age, human beings develop internal processes that represent sensations and perceptions in such a way that they can be stored in memory. These processes can later be brought into consciousness and be manipulated in the absence of stimuli that originally evoked them. Human beings can be aware of and respond to these internal processes, and when they learn language they are likely to call them by such terms as "thinking", "imagination", "ideas" or "concepts" (Carroll, 1964).

The relationship between language and development of thinking has been studied by many psychologists. Often, however, their work has been with young children and has not been mathematically oriented. As a result there are few findings that can be applied immediately to mathematical education at secondary and tertiary level (Austin & Howson; 1979).

In the early stages of language learning, the child's own preverbal internal processes which are stimulated by thinking are conditioned to the symbols used by others in his environment. As the child assimilates the structure of his language, his internal processes become more like those of the speech of the members of community as a whole (Carroll, 1964). The mathematics language learned by culturally different students does not belong to any community. Mathematics language is confined to the classroom situation and is not found anywhere else. The only person conversant with this language, is the teacher. Such restricted conditions of learning mathematics vocabulary result in problems to the culturally different student.

The relationship between language and thought is often cast in a chicken and egg legend. The question is what comes first? Does language develop independently of thought, or is thinking impossible without language? (Yelon, Weinstein & Weener, 1977).

The first group of theorists believe that **language and thought develop independently.** Numerous studies reveal that language does not depend on thought. Piaget (Kaplan, 1986) argued that language is independent of thought and action. This is supported by his experiment where he asked preschool children to crawl and explain what they have done. It was not until five or six years of age that children could explain what they had done. Initially they could comply with the instruction or command but did not have the linguistic ability to express themselves.

Piaget (Austin & Howson, 1979) also presented an alternative description of language development. He divided the talk of children into two groups, the ego-centric and the socialized speech. The ego-centric speech is a non commutative speech whereby children talk out aloud only to themselves and are unable to differentiate thought from action. They do not bother to whom they are speaking not whether they are being listened to. In socialized speech however, there is clear intention to communicate in order to cause or persuade the listener to adopt some cause of action. According to Piaget, ego-centric speech is simply an accompaniment to the child's action and serves no other purpose. He wrote : "Language is not enough to explain thought, because the structures that characterize thought have their roots in action ..." (Behr, 1980:56).

Further to the pursuance of the theory of independence of language and thought, Flavell (Kaplan, 1986) found that two or four year-olds could group objects on the basis of 'physical relationships', yet 'they were not able to name these categories or relationships'. Sinclair-deZwart (Kaplan, 1986) found that even if young children were taught the meanings of such relationship (i.e. words such as "more" or "less") they did not show the ability to use these concepts when tested. In other words, teaching meanings of these words in a linguistic context had no effect on the child's cognitive growth and performance. This view is also supported by research Furth and Yonniss (Yelon *et al.*, 1977) in which deaf children were found to do as well on nonverbal logical tasks as children with normal hearing. As a result they made the following conclusion :

> It seems to follow that the development of logical thinking cannot be critically dependent on the presence of language since

> deaf subjects who were severely deficient in language succeeded on nonverbal logical tasks as well did hearing subjects who had had the benefit of constant exposure to language from early childhood (Furth & Yonniss as cited by Yelon *et al.*, 1977:59).

The research findings mentioned above support the idea of independence of language and thought. It is my contention that black children face language problems in the learning of mathematics through the second language. Consequently, these children recite a theorem but cannot apply it in a rider. In this instance, black children can verbally describe a rule or principle but its application is beyond the realm of their comprehension.

The second group of theorists believe that **thinking depends on language.** Bruner (Yelon *et al.*, 1977) argues that language is essential to thought and that, in fact, the highest form of thought is language. He further maintains that, without language, children can refer to concrete objects by pointing. Also according to Bruner (Price *et al.*, 1982) human language permits the sharing of information about things that may not have physical reality, i.e. things that may not be present at a time of discourse.

Another prevailing idea in this doctrine is expressed by Whorf (1967). He argues that talking or the use of languages restrict the way people view the world and the way they are able to think. There is a hypothesis which states that language determines or strongly influences the way one thinks or perceives the world. Whorf's hypothesis in this context called **linguistic relativity or linguistic determinism.** Whorf came up with the idea that different languages structure thinking processes and perception of different aspects of the world. He believed that these structured processes and perceptions have a great influence on the way language speakers think about the world. For example most African languages do not distinguish between the same range of colours like blue, violet and green as do Western European languages (Michau, 1978). Thus African languages have one word for the three colours. According to Whorf the variety of terms would make the speakers of the English language, perceive the world differently from a person who has a single word for a particular category (Anderson, 1980). This is also emphasized by Brown (1956) who alleges that languages do not determine thinking but predispose people to think in a particular way.

Behaviourist tradition in psychology has been shown to influence the view that language precedes thought.

This view is based on the empiricist theory of mind and its beliefs concerning the mechanism by which knowledge, including language is acquired. The behaviourist viewpoint also does not exclude the possibility of cognition prior to language. Their emphasis however is on the application of behaviourist principles to the study of acquisition of language. Adherents to this position conceptualize language acquisition in a vacuum, with the child passively being exposed to the language around him. The child is also reinforced for his imitations of language spoken in his community (Cromer, 1991). The behaviourist point of view indicates that language-learning is a protracted process. It is therefore difficult for the culturally different student to acquire mathematics concepts in English language immediately when he starts school.

In contrast to the behaviourist viewpoint, is Chomsky's approach that the child is not a "blank slate", but has a number of formal and substantive liquistic mechanisms which are part of his 'language acquisition device'. Children require only exposure to the language prevailing in their own culture. This means that children can acquire the grammar of any particular language because their brains are innately patterned to understand the structure of languages (Kaplan, 1986).

This does not explain the range of difficulty for a child to learn a second language.

The third group of theorists argue that **language and thought are equal.** There seems to be a variety of proposals about language and thought. One of the proposals which seemed to be strong was advanced by Watson. Watson (Anderson, 1980) alleged that thought processes are really motor habits which would be observable as movements in larynx during so-called 'silent' thought. It was however, discovered that in some situations people engage in various silent thinking tasks without detactable vocal activity. This finding did not upset Watson. He raised a counter argument that thinking involves the whole body. He cited fascinating evidence that deaf mutes actually make signs while asleep. Furthermore he asserts that speaking people who have done a lot of sign language also use sign language while asleep.

Price *et al.* (1982) argues that contradictory evidence exists to take Watson's proposition seriously. This evidence derives from the complex thought processes displayed by animals, non-speaking human beings and people who lose speech as a result of injury. This shows that thoughts and their acquisition are difficult to observe, but speech units and the acquisition of productive language are scientifically observable and quantitatively measurable (Cromer, 1991).

In turn, languages have grammar which are assumed to be merely norms of conventional and social correctness. Hence, when anyone talks about reason, logic and laws of correct thinking, is referring to grammatical facts that have a background character of his own language, but by no means universal in all languages. Whorf (Cromer, 1991) shows that the Hopi Indian language of North America, gets along without tenses for its verbs, and has no words in grammatical forms, constructions or expressions that refer directly to what we call time. On the other hand European languages "treat time as an objective entity" - (Cromer, 1991:43). The importance of time in English language is reflected by the past, present and future tenses in their grammar.

Importance of language and thought has been contended by Bernstein (Cromer, 1991) who alleges that children from working-class background have restricted language codes, while children from middle-class homes possess an elaborate code. He further asserts that potential and developed intelligence is mediated through language system. The lack of elaborated code by the working-class children prevents them from developing their intellectual faculties to their fullest capacity.

Language restriction also applies to the culturally different student. Allport and Pettigrew (Michau; 1978:24) confirmed that Zulu culture is "... probably the most spherical or circular of all Bantu cultures, possibly the most spherical of all the African cultures". They pointed out that this bias to circularity is reflected in the linguistic system, where no words exist for square and rectangle, whilst round and circular are well-represented. This causes concern, if the language of the black child lacks these concepts so common in mathematics.

According to Carroll (1964) thinking aided by language is called reasoning. The ability to reason depends on the ability to formulate steps in an inferential process in terms of language. It is however difficult to measure the reasoning of an individual, because reasoning is an internal process. Attempts have been made (Carroll, 1964) to observe these internal processes by asking the individual to 'talk aloud' in his reasoning processes. There is no guarantee, of course, that the subject can give full verbalization (introspection) of his reasoning processes, even with every intention of doing so. It is also possible that this process of producing an overt verbalization can affect the course of reasoning process. The culturally different student has a problem of verbalizing mathematics concepts, as he is learning mathematics in a second language. It is known that "students with high verbalization abilities could transfer learned mathematical generalization" (Aiken, 1972).

2.3.2 LEARNING THE LANGUAGE OF MATHEMATICS

Children in all parts of the world learn the number-word sequence used in their own culture (Fuson, 1991). This is an essential foundation for learning mathematics of quantity (Travers, 1982) or grammar of counting (Ginsburg, 1983). The number-word sequence is originally learned as rote sequence much as the alphabet is learned, since number words at this stage have no meaning. Piaget (Langford, 1987) alleges that children can only know the meaning of word-sequence, when they know about the properties of ordinal series and cardination. The child's early development of this number concept has implications in the learning of mathematics at school. This means there will be a smooth transfer of knowledge from what has been learnt at home to what is being learned at school. Such transfer of knowledge does not exist for the culturally different student since "the vehicle of instruction" (Strevens, 1980) at school is not his mother tongue.

Several theorists have come up with different ways of learning mathematics. This has resulted in several theories of learning. Learning the language of mathematics also falls under these theories because mathematics is a language (Pimm, 1987). The theories about the nature of learning mathematics are represented as follows :

Jean Piaget (Bell, 1978) studied various stages through which human beings progress in their intellectual growth. He emphasizes the intellectual development as a process of assimilation and accommodation of information into mental structure. Assimilation is defined as the process whereby objects or their attributes are incorporated into the individual's existing cognitive structures. Accommodation occurs when the individual modifies those internal cognitive structures to conform to new information. These two words go together because an individual can only assimilate those elements of his environment to which he is able to accommodate himself (Fontana, 1981). This means that learning is not merely adding new material to a stack of old material, but new information causes the stack of old information to be modified to accommodate the assimilation of new information. Piaget's work also reveals that pupils solve mathematical problems in accordance with their level of maturation.

According to Behr (1980) Guilford developed a "Model of intellect" - in which he drew attention to several cognitive operations amongst which he included convergent and divergent thinking. Convergent thinking is characterized by predetermined conclusion, where there is a recognized 'right' or 'best' answer. Divergent thinking on the other hand is characterized by originality and flexibility in solving problems (Yelon *et al.*, 1977). Guilford contends that the importance of divergent thinking has not yet been sufficiently appreciated by educationists. Guilford's model shows us that a pupil's intellect is comprised of many different factors and are present in varying degrees. This means that a pupil must do various mathematical activities to strengthen each cognitive factor.

According to Bell (1978) the two theorists in learning, Gagne' and Ausubel, developed techniques and strategies for classroom teaching. They both formulated models for structuring the content of a discipline such as mathematics. Gagne' developed the bottom-to-top approach to structuring content into learning hierarchies which build upon simpler, prerequisite facts, skills and concepts to learn more complex skills, concepts and principles. Ausubel has developed a theory of meaningful verbal learning which can be used when presenting material in a lecture or expository mode to pupils. Ausubel's approach can be very useful in secondary schools.

Bruner and Kenney (Bell, 1978) formulated four theorems about learning mathematics, which they have named construction theorem, notation theorem, theorem of contrast and variation and the theorem of connectivity.

Construct theorem postulates that the best way for a student to begin to learn a mathematical concept, or rule is to construct their own representations of ideas about the concept or rule. Bruner and Kenney emphasized that in the early stages of concept learning, understanding appears to depend upon the concrete activities which students carry out as they construct representations of concept.

Notation theorem states that early constructions or representations can be made cognitively simpler and can be better understood by students if they contain notation which is appropriate for student's level of mental development. For example a concept of mathematical function can first be represented as = 4 + 1 ; where and denote natural numbers. When students begin algebra they then represent the same concept as $y = 2x + 3$ and in advanced algebra courses students use $y = f(x)$ to represent functions. Bell (1978) calls this sequential approach of building a notational system in mathematics as **spiral teaching and learning.**

Contrast and variation theorem advocates that most mathematical concepts have little meaning for students until the mathematical concepts are contrasted with other concepts. For example, irrational numbers are defined as numbers that are not rational. New concepts in mathematics are learnt if they are presented by a variety of examples of that concept. Usually elements enclosed in braces form a set, but a set can also be formed by elements not enclosed in braces.

Connectivity theorem stipulates that each concept, principle and skill in mathematics are connected to other concepts. The important activities in mathematics learning is searching for connections or relations among mathematical structures (Bell, 1978).

Munro (1979) reveals the following causes of problems when children learn the language of mathematics :

1. **Differences in meaning of words used to code mathematics concepts** : There are three types of words that are used in mathematics communication. These are :

   i) Words that are defined in normal usage, and that preserve this meaning in mathematics.

ii) Words that occur exclusively in mathematics usage, and are defined in terms of these contexts only.

iii) Words that occur in both normal and mathe= matical usage, but which have different meaning in both situations, e.g. sum, product, root.

To derive the intended meaning from a verbal mathematics statement, it is necessary that the child's understanding of meaning of each word in the context be adequate. Words in group (iii) above for example, change with context, i.e. such words can be used in a mathematical context or in an everyday usage. Many children may understand the word in its everyday usage, but may not understand its mathematical connotations, and may have difficulty to distinguish between the two senses in which a particular word is used. "Some children may simply be unaware that the word is being used in a different sense" (Munro, 1979), which is the case with the culturally different child.

The acquisition of intended meaning for the words in (ii) above needs an appropriate learning experience. In this context, Munro (1979) has this to say : "Obviously the type of learning experience provided may affect adequate acquisition". For example a mathematics term may be defined in terms of :

a) A formal definition, e.g. a triangle is a plane figure bounded by three sides.

b) A list of attributes or characteristics which will make one triangle different from the other triangles, e.g. an obtuse angled triangle is defined in terms of angles, while an equilateral triangle is defined in terms of sides.

c) A series of illustrative drawings on the basis of which a child should make triangles by cutting papers.

d) A reference to real life examples, i.e. a child is exposed to many instances of triangles occurring in his environment.

2. The use of prepositions to convey a particular operation.

Children experience difficulties with problems on division. The concept of division is often found to be difficult to master. Munro (1979) justifies this position by referring to associated language usage. For example let us consider two statements on division :

i) 6 is divided by 3

ii) 6 is divided into 3

Many children cannot see that these are inverse statements since 'by' and 'into' are opposite or inverse meanings. When the two statements are converted into mathematical symbolism, they are :

i) $6 \div 3$

ii) $3 \div 6$

This shows that many mathematical relations and concepts are difficult to understand and cause confusion to children because both the grammatical and semantic meanings of words change. This is further confirmed by Adda (1982) that the confusion between meaning and sign is the root of great number of mistakes in mathematics.

3. **Mathematical statements involve mathematical operations**

There are mathematical statements in which two or more elements are related temporally, spatially or comparatively. The following examples illustrate such statement :

simplify : 2(10+3)

add 10 and 3 then multiply by 2.

The above examples illustrate that children must be able to use spatial cues to interpret the mathematical processes expressed in symbolic form. In this case of $\frac{7 + 4}{2}$, children must first add seven and four and then divide by two. Instead, most pupils will start by dividing a term by a factor, i.e. dividing four by two (Munro, 1979).

4. **Mathematics problem coded in normal language.**
Some mathematical tasks are presented to children as word problems. Children experience difficulty in translating word problems, which are in ordinary language into corresponding mathematical form. These problems involve an interplay of syntactic, semantic, inferential, temporal and contextual knowledge (Kintsch & Greeno, 1985). "Even very common, everyday words such as, each and altogether can be quite confusing in these contexts" (Shire & Kevin, 1991). This trans=lation is difficult to children. According to Munro (1979) many children lack some cognitive and linguistic abilities demanded to solve verbal mathematical problems. They need to be trained to abstract various pieces of numerical information in order to be able to solve problems in Mathematics.

"It must be a handicap to have to learn in a language which is alien, and which is not reinforced outside the school, by what one hears and uses at home and in the market place" - (Morris, 1978:74). This means that for the child who has to begin to learn in a second language, must be taught linguistic concepts and structures. These must be presented in a concrete and dynamic form, for the child to assimilate the new knowledge. This also applies to mathematics. Mathematics must not be taught by writing symbols on the chalkboard, rearranging them and getting the 'answer' and thus tell pupils to learn the process by heart. Pupils must be involved in activities and discussions which will ensure understanding.

Relational terms like **'more' and 'less'** usually take a variety of mathematical meanings, depending on the context in which they are used. Jones (1982) alleges that the meanings of these words are not understood by the majority of children before entering school, but gradually acquired with further language development and presumably formalised instruction in mathematics. Jones further argues that a delay in acquisition of these meanings can lead to a mismatch between the language demands of the curriculum and the language competence of the learner. This has shown to be particularly severe with children learning mathematics in a second language. Jones (1982) conducted a research amongst the Papua New Guinean children. English to these children is a second language and their medium of instruction at school. The findings of the research was that the Papua New Guinean children misinterpreted mathematical statements involving 'more' and 'less'. The understanding of elementary mathematics depends on the understanding of these semantically related terms. If this is not acquired the result is that the child's ability to solve a wide variety of word problems in mathematics will be limited.

2.4 MULTILINGUAL SOCIETY AND PRAGMATIC REASONS FOR TEACHING MATHEMATICS IN A SECOND LANGUAGE

Multilingualism is a pervasive modern reality. In this regard, Oller (1979:74) has this to say : "Ever since that cursed Tower was erected the people of the world have had this problem". Difficulties in communication between social groups of different language backgrounds are apt to rise in two ways mentioned by Oller (1979) as: the failure to communicate on factual level, i.e. information that is usually the focus of classroom activities or failure to communicate on emotive or attitudinal level, which is the communication that relates to self-concept of the child. Not only verbal cues but social cues are difficult to understand across population groups.

According to Cummins (1979) there are two bilingual situations. One of the situations is called a submersion programme where a child belongs to a minority and learns the language of the majority. The child then goes to school where the language of the majority is used, the child is thus submersed in a culture that speaks a different language. This situation is to be contrasted with the situation in which a child speaks the majority language in the home and then is sent to school where another language is used as a medium of instruction, sometimes with the major part of school programmes. This situation is referred to as immersion programmes. The immersion programmes are similar to conditions of a black school child in South Africa.

Research findings (Cummins, 1979 & Hornby, 1977) indicate that the immersion programmes seem to be beneficial in terms of general cognitive development. The language skills of children have been enhanced through bilingualism. This means that sometimes the effect of bilingualism is enhancement of skills in the native language (Travers, 1977). Oller (1979) confirms that multilingual society display a rich diversity of language varieties.

It has been argued that children in school be compared only against themselves and never against group norms. Oller (1979) asserts that this argument implicitly denies the nature of normal human communication.

Evaluating the language ability of an individual by comparing him only against himself is a little like clapping with one hand. Something is missing. It only makes sense to say that a person knows a language in relation to the way that other persons who also know that language perform when they use it. Becoming a speaker of a particular language is a distinctively socializing process. It is a process of identifying with and to some degree functioning as a member of a social group.

The educational system of Blacks in Africa is an unfortunate break from the process of cultural development at home. This means that a child comes to school from a cultural and linguistic different background. He brings to the communication context of the school, many sorts of expectations that will be inappropriate to many aspects of changes at school (Abiola, 1977; Dawe, 1983; Brown, 1987). Considerations will therefore be focused to specific difficulties faced by pupils learning mathematics in a multilingual society.

Research (Levin, 1992; Cocking & Chipman, 1988) reveals that a student's command of English plays a role in his/her performance in mathematics. Souviney (Clarkson, 1991) used various languages and mathematical instruments to measure cognitive development among students in grades 2, 4 and 6. The more successful students in higher grades were those who were able to utilise their language abilities effectively.

This shows that a pupil who is learning mathematics in a second language faces a big challenge. This is also revealed by Brodie (1989) that language spoken in the classroom is not only important for communication and understanding, but needed for mathematical thinking and problem solving, and the construction of mathematical meaning.

Research on cross-cultural studies of various population groups on cultural, memory, spatial and mathematical variables yielded the following results : There was no significant difference between the second language English speaking students and the mother-tongue English speaking students on memory tasks. The only differences were on mathematical language tests. In particular, it was noted that the second language English speaking students handled word-free computational problems quite well, but had difficulty with verbal arithmetic problems (Clements & Lean, 1980; Morris 1978; Dawe, 1983). The contrast between the performance in the two types of arithmetic is almost certainly a reflection of the difference in their dependence upon language. Morris (1978) mentions a study in Zambia which produced similar results. Here the performance of English medium learners was compared with learners in schools where vernacular teaching was employed in the early years of schooling. In mechanical arithmetic there were no significant differences in performance. In problem arithmetic, the vernacular learners were more successful than were children who began their schooling in the medium of English.

Dawe (1983) gives the following research findings for bilingual children learning mathematics in English as a second language in British schools.

1) Among immigrant children from the West Indies show the poorest performance in mathematics, even when children considered by their teachers to be fluent in English. This appears to be true after a full primary and a full secondary education in English schools. In the same vein, Michau (1978) analysed black students' matric mathematics results in South Africa. The findings were similar to Dawe's findings. She found that the standard of achievements in mathematics was abnormally low when compared with students of other races. Michau further comments that it is not at high school level, that the grounds for poor achievements are established. The roots of

the problem seem to lie in the child's early school years.

2) The problem of language as a barrier to learning increases in magnitude as immigrant children progress through school. This has been shown for Indians, Pakistanis and West Indian children alike. Berry (1985) also confirms this by saying that the poor performance of a child may go unnoticed. This is due to the fact that the child could learn the elementary arithmetic by rote. Problems only surface during secondary school, when emphasis is now on solving problems or proving theorems of which rote method does not apply.

3) Increase in the length of time learning English result in marked improvements in arithmetic and verbal abilities. However spatial and perceptual abilities appear to develop less well. de Lemos (1974) also found a marked difference between white and Zulu children in spatial and perceptual skills.

Statements on the comparison of performance and common tasks of people from the two totally different cultures are familiar in cross-cultural literature. Biesheuvel and Cryns (Omari, 1976) contended that "Africans both literate and illiterate, experience difficulties in interpreting pictorial materials and that they failed to transcend the synthetic form of a perceptual gestalt, to form concepts and to see parts of the whole". Omari (1976:370) argues that the problem is not with child but "the imported materials carry values and skills foreign to African children". Abiola (1971) also supports Omari by arguing that the low level of achievement is due to "European-imported skill patterns". Omari and Abiola's argument reflects the conditions under which a culturally different student learns mathematics in a second language. Bishop (1988) supports Omari and Abiola's argument by maintaining that mathematics is conceived of as a cultural product and more inclined to the Western culture. The argument is further carried out that "If the tables were turned, if the majority were suddenly the minority, their scores of educational tests might be expected to plummet to the same levels as are typical minorities in today's U.S. schools (Baratz, 1969).

Mestre, Gerace and Lochhead (1982) conducted a study that involved mathematical traditional skills amongst the monolingual and bilingual Hispanic engineering students. The findings revealed that language proficiency is related to performance. These findings are supported by another study that was carried out by

Clement, Lochhead and Monk (1981). This study revealed that students always wrote the reverse of what they intended. For example in a problem where students were required to write an equation :

> There are six times as many students as professors at this university. Use S for number of students and P for the number of Professors. (Clement *et al.*, 1981).

The majority of students responded by writing $6S = P$ in which case the variables are reversed. From the author's experience such responses would not be uncommon to black students as well.

The above studies indicate a problem in language acquisition. This language questions arises from the current view of contemporary industrial societies as pluralist. As a consequence, declarations are made that we live in societies that are 'multicultural' and 'multilingual' (Kalantzis, Cope & Slade, 1989). The multilingual or multicultural situation make people learn one or more language other than their mother tongue. Such languages are called second languages. According to Travers (1977) a second language may be acquired under many different circumstances. A child may live in a society where more than one language is spoken. Then, there is a child raised in a foreign country by his English-speaking parents, and sent to

English-speaking school. This child still has to learn the language of the foreign country in order to play with children in the neighbourhood. There is also a child who learns her first language at home, where the parents belong to a minority language group. This child has to learn a second language to profit from instruction in school, like the so-called culturally different child. In addition, there is a child who learns his first language as a member of the majority, and is then taught a second language at school.

According to Pimm (Durkin & Shire, 1991) mathematics is not a natural language in the sense that French and Arabic are. For example there are no groups of people for whom mathematics is their first language. The relationship between mathematics and language is that the language expresses ideas and meanings of mathematical concepts.

Mathematics can therefore be expressed in any language. The expression of mathematics in natural languages lead to the development of what Pimm (1987) calls the mathematics register. The development of the mathematics register results in certain meanings being available in the language. There is also a coining of new terms which do not have meanings in the ordinary language (Pimm, 1987).

The mathematics register in the South African situation is in English, which is a second language to the Black child. The idea of teaching mathematics in a second language is supported by Pimm (Durkin & Shire, 1991). Pimm alleges that the development of mathematical register in English took place about the sixteenth century. He also mentions the fact that mathematical textbooks were among the very first to be printed rather than Latin or Greek.

The requirements of expressing mathematical meanings can place strains on a language. One of the most challenging aspects of language study is giving an account of how registers grow. At one level, this can be done by looking for principles behind the ways new words and expressions are coined. One important tool in this creative aspect of language is that of metaphor as a means of providing old names for new names (Pimm, 1987). Metaphor and analogy are figures of speech which make natural language powerful. This process has also been used in countries that switch from English to national language like Tanzania. For instance, the name used for diagonal does not fit all the criteria of a diagonal (Pimm, 1987). This is the problem faced by other languages if they switch from English to vernacular. For example, a triangle in Zulu is "unxantathu". This word does not fit the characteristics of a triangle.

Zaslavaysk (1970) encountered difficulties in African numeration. First of all there is no organized body of knowledge on the subject. The large number of African tribes also have their own language. In addition to the language barrier, is the problem of variation of names and spelling. In this case there is a need for a language that will provide means of communication in mathematics which are concise and unambiguous (Cockcroft, 1991). English serves this purpose, and is a second language to a black child.

According to Cockcroft (1991) mathematics can be used to present information in many ways, not only by means of figures and letters but also through the use of tables, charts and diagrams as well as of graphs and geometrical technical drawings. Furthermore, the figures and other symbols which are used in mathematics can be manipulated and combined in systematic ways so that it is often possible to deduce further information about the situation to which mathematics relates. A language that can be used in all these circumstances is English.

Language is the key to belonging. Even though we use language to quarrel, Governments want us to belong, and perceive the power of language. They thus formulate a policy for language development for the country as a whole. The medium of learning is therefore laid down by the ministry in conformity with the government policy (Morris, 1978). In the South African situation English and Afrikaans are the two official languages that are used in schools.

Besides government policy, there are also pragmatic reasons for pupils to learn mathematics in English. The diversity of cultural and linguistic groups sharing the same classroom makes it imperative to use a common language. This language is English. Instruction in English will also help students who want to further their studies in mathematics at tertiary level. Brodie (1989) points out that there is a belief that African languages are not suitable for mathematical or scientific education, as they lack technological vocabulary and do not easily allow the expression of mathematical and scientific ideas. Clement (1984) confirms this statement. This is in opposition to Wilson's assertion (1981), who opposes the statement that any language has the capacity for development to the point where it can bear the weight of whatever demands made upon it. Clements argues that "a certain language has deficiencies so far as the teaching and learning of mathematics and science are concerned. I would maintain that all are not equally useful for the teaching and learning of mathematics".

In a multilingual society there are contrasting competencies of different languages that convey ideas of varying complexity. This does not bother any one. But the concepts of mathematics and science do matter. Morris (1978) advocates that we are members of one world, and of a world in which we all wish to be modern. It is therefore necessary for all nations to generate their own stock of scientists, engineers, technologists and technicians. Mathematics provides the intellectual tools for all these trades. There is no chance of any country becoming scientifically self-sufficient if its schools cannot teach mathematics. Thus the language medium used in schools must be developed to the point where it can clearly convey concepts of mathematics without ambiguity. In the South African context, English appears to be the language for the teaching of mathematics and other subjects. It is lingua franca for the several countries in the world. It has propelled the development of scientific thinking for centuries. To study mathematics in Zulu would be tantamount to reverse history to the 14th century.

2.5 CONCLUSION

A child from a black society is brought up in traditional ways irrespective of whether parents are educated or not. This upbringing is characterized by imposition by the parents and no questions on the part of the child. The enquiring mind which is a prerequisite for problem-solving in mathematics is suppressed. Lack of environmental stimulation or impoverished environment also add to the scholastic retardation of the black child particularly in mathematics.

The discussion in this chapter shows that language enables the child to communicate his experiences acquired from the environment. Language can therefore, be referred to as the basis of concept formation. The learning of concepts in mathematics also takes the same form. The rate of dynamic acquisition of mathematical concepts through foreign language will tend to be slower in a black child. Such a situation places a big demand on mathematics teachers of a culturally different child.

Psychologists seem not to agree on whether language depend on thought or vice versa. Besides this disagreement, psychologists agree with each other that there is a relationship between language and thought.

The learning of mathematics has taken a top priority in the teaching and learning situation. This has resulted in the development of different models, techniques, strategies and theories of learning mathematics.

Although English and Afrikaans are the official languages of the country, black languages seems to be the "language of the minority". These languages are designated as such because they are not suitable to be used in mathematics, due to their lack of technological vocabulary.

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CHAPTER THREE

3. METHODOLOGY : RESEARCH DESIGN AND PROCEDURES

3.1 INTRODUCTION

The procedure followed in this study was as follows :

a) Administration of an achievement test to standard nine and standard ten pupils doing mathematics for a pilot run.

b) Standardizing the achievement test.

c) Applying the standardized version of an achievement test to final study sample of standard nine and standard ten pupils doing mathematics.

3.2 THE STUDY SAMPLE

This study purports to investigate the responses of black matric pupils to mathematics vocabulary. The study sample consisted of standard nine and standard ten pupils doing mathematics. The schools were chosen from Mahlabathini, Vryheid and Madadeni circuits. The two schools chosen at Mahlabathini and Madadeni circuits are at the location, which can be regarded as the urban area. The school at Vryheid is in the rural area. The sample was representative because schools were chosen from different inspection circuits. A total of 200 pupils was obtained for a pilot run. A cluster sampling design was used in this study. The inspection circuits selected form a cluster. This is an acceptable sampling design if a researcher deals with elements scattered over a province or country (Eckhard & Ermann, 1977).

TABLE 3.1 DISTRIBUTION OF SUBJECTS - PILOT STUDY

Sex	Male				Female				Total
	104				96				200
Class	Standard 9				Standard 10				
	128				72				200
Grade	Standard Grade				Higher Grade				
	79				121				200
Stream	Science		General			Commerce			
	115		0			85			200
Age	14	15	16	17	18	19	20	21+	
(in years)	2	3	16	50	34	55	25	15	200

3.3 THE RESEARCH INSTRUMENT AND ITS ADMINISTRATION

Since no instrument could be found for investigation, the researcher designed an achievement test based on the syllabi for standards six to nine inclusive. The instrument consists of forty items. Questions were designed to cover indepth standards six to nine syllabi. The questions are divided into three groups. The first group of questions requires the subjects to define certain concepts in mathematics. The second group requires explanation of a concept by means of a diagram and definition. The last set of questions requires the subject to give a name to a symbol or information given (concept identification). The researcher was meticulous not to ask the same question differently in the three groups or categories.

The questionnaire was first given to the mathematics teachers of local schools, to establish content validity. The researcher found out that by mid-September teachers had completed the standard nine syllabus. The pilot study was then conducted during the first week of October. This was done during free periods and after lunch.

The first set of questions (Test A) has a total score of fourteen marks, since each question has a score of two marks. Each question in the second set of questions (Test B1 and B2) elicits two answers from the pupil, to the same question; a pupil is expected to respond by means of a diagram and also by means of a definition. The total mark for each question is four marks, i.e. two marks for a diagram (B1) and two marks for a definition (B2). A separate total score is obtained for the column on diagrams and a separate total score for definitions. The total score for the whole test is forty-four. The last set of questions (Test C) has a total score of twenty-six marks.

The administration of the instrument was conducted under the supervision of a subject teacher and a researcher. They played a role of invigilators. The researcher explained to the pupils that it was a way of finding out how much they knew about mathematics. They were also told that there were no calculations, so as to reduce anxiety. Pupils had to write the answers on the spaces provided next to each and every question.

3.4 ITEM SELECTION

In item selection, there are procedures designed to give a researcher the reliability of a measuring instrument (Nachmias & Nachmias, 1976; Goode & Hatt, 1952; Black & Champion, 1976; Ten Brink, 1974; Wiersma & Jurs, 1990). Item selection can be done in two ways, by using : (1) **Internal consistency method**, which is one way of estimating reliability. The total score of each subject is divided by the number of items in a scale. The average item score of each individual is then correlated with each of the actual item scores. The items are then arranged in order from high to low in accordance with the value of coefficient correlation. The items with low coefficients are discarded and the selection made from the remainder (Goode & Hatt, 1952; Black & Champion, 1976; Nachmias & Nachmias, 1976; Ten Brink, 1974).

Item analysis is another method of selecting items which yield an internally consistent scale. This method enables the researcher to determine which items are not consistent with the test in measuring the phenomenon under investigation. This method is appropriate for both norm-referenced and criterion-referenced tests. Norm-referenced test is a form of evaluating performance of pupils in terms of relative position held in a particular group. In the criterion-referenced test, an attempt is made to determine whether the examinee has reached a certain specific criterion performance or mastered a specific task (Gronlund & Linn, 1990; Ebel & Frisbie, 1991; Chase 1978; Rosenthal & Rosnow, 1991; Payne, 1992).

The second method was used in the pilot study since the achievement test follows norm-referenced test procedures. Item analysis embraces two aspects in particular, namely : the discrimination index of an item and the difficulty index of an item (Mulder, 1982).

The **discriminative index** (Annexure D) was used in the following way : The total scores of two hundred subjects were ranked from the highest score of sixty-one, to the lowest score of ten. Fifty subjects with the highest score were selected for the upper quartile while the other fifty subjects with the lowest scores were selected for the lower quartile. The selection was done in accordance with what Black and Champion (1976) say, that the upper quartile should contain the upper 25% of the largest scores in the distribution and the lower quartile should contain 25% of the smallest scores. Subjects with scores in the centre of the distribution are excluded from further consideration.

The second step was to determine the number of testees who answered each item correctly for each of the two groups that fall under upper and lower quartile (Annexures B & C). Further, for each item, the total number of correct responses in each group was divided by fifty which is the total number of testees in each quartile. The result is called the proportion. The difference of proportions for upper and lower quartiles was found. The result is called the discriminative index. In other words the discriminative index, d_i for the item i is calculated by the formula :

$$d_i = \frac{U_i}{n_{iU}} - \frac{L_i}{n_{iL}},$$

where :

U_i : is the number of examinees in the upper quartile who answered the item, i correctly.

L_i : is the number of examinees in the lower quartile who answered the item, i correctly.

n_{iU} : is the number of testees in the upper quartile.

n_{iL} : is the number of testees in the lower quartile

(Allen & Yen, 1979; Chase 1978).

According to Black and Champion (1976) and Allen and Yen (1979) items with low d_i, i.e. 0,1 ; 0 or negative d_i are improved or eliminated. Items number 6, 10, 12 and 15 had d_i equal to 0,1. Items number 2, 8 and 9 had d_i=0 and item number 4 had a d_i of -0,1. All these items were discarded.

The second procedure was to calculate an **item difficulty** (Annexure E) for each item. According to Garrett & Woodworth (1977), there are three ways of determining item difficulty : (1) by the judgment of competent people who rank the items in order of difficulty (2) by how quickly the item can be solved (3) by the number of examinees in the group who get the item right. In this case an item difficulty called p_i is defined as the proportion of examinees who get the item correct, i.e. the number of subjects who get the item correct divided by the total number of subjects. The third alternative was used in the pilot study since Garrett & Woodworth (1958 : 363) also regard it as "the standard method for determining difficulty in objective examinations". If p_i is close to 0 or 1, the item should be discarded, since no one got the answer correct or everyone got the answer correct respectively. In both cases, the item does not discriminate among examinees with different trait level (Allen & Yen, 1979). There were three items (items No. 8; 10 & 12) in the pilot study whose p_i was 0 and one item (item No. 2) the p_i was 1. When discriminative power was calculated these items were amongst the items that were discarded.

3.5 RESULTS OF THE PILOT STUDY

As a result of item analysis (item difficulty and discriminative power methods) nine items were discarded from the original scale which consisted of 40 items. The scale or instrument, i.e. achievement test used in the final study therefore consists of 31 questions. These questions are subdivided into :

TEST A consisting of seven items

TESTS B1 AND B2 consisting of eleven items

TEST C consisting of thirteen items

The final study was conducted in inspection circuits (cluster samples) different from those that were used for the pilot study. These inspection circuits are Mehlesinwe and Nqutu. The former circuit combines both rural and urban schools while the latter is predominantly rural.

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CHAPTER FOUR

4. PRESENTATION AND DISCUSSION OF RESULTS

The presentation consists of tables and their interpretation. The discussion of findings is reserved for a separate section. This arrangement facilitates the integration of findings and theory.

4.1 ADMINISTRATION OF THE SCALE

The scale was administered to four hundred and fifty pupils. The composition of the final study sample is indicated in table 4.1.

The sample is divided according to sex, class, grade, stream and age. Each of these criteria for division, has levels. The criterion of sex has obvious two levels of 221 males and 229 females. The variable of class consists of two levels namely 106 pupils in standard nine and 344 pupils in standard ten. The school subjects are usually taken at two levels in standard ten, namely higher grade (218 pupils) and standard grade (132 pupils). The grades have implications for a pass percentage cut-off point. For example, a 50% pass mark is required for the Mathematics standard grade whereas for the same subject at higher grade a 40% pass mark is a criterion.

The variable of stream indicates the subjects combination students follow. There are three curricula namely the science stream (233 pupils), the general stream (16 pupils) and the commercial stream (211 pupils). The variable of age ranges from 14 years to 21 years and above. Each age group has its corresponding frequency of pupils. For example, the age group of 14 years has a frequency of zero.

TABLE 4.1 DISTRIBUTION OF SUBJECTS - FINAL STUDY SAMPLE

CRITERIA	LEVELS								TOTAL
Sex	Male				Female				
	221				229				450
Class	Standard Nine				Standard Ten				
	106				344				450
Grade	Standard Grade				Higher Grade				
	132				318				450
Stream	Science			General		Commerce			
	223			16		211			450
Age in years	14	15	16	17	18	19	20	21 and above	
	0	5	41	87	79	94	55	89	450

TABLE 4.2 DISTRIBUTION OF PUPILS IN THE THREE CATEGORIES OF UNDERSTANDING OF THE MEANING OF WORDS IN THEIR MATHEMATICS TEXTBOOKS (N = 449)

TEST A MARKS	CATEGORY	NUMBER OF STUDENTS	PERCENTAGE	MEAN
10+	High Achievers	10	2.23	10.8
5-9	Average Achievers	49	10.91	6.6
0-4	Under Achievers	390	86.86	1.3

Table 4.2 reveals that very few pupils (13.14%) understand the meaning of words found in their mathematics textbooks. The majority of pupils (86.86%) do not understand the meaning of words found in their mathematics textbooks. The underachieving group constitutes about 86.80%. This point will be discussed at length in the section on discussion of findings. It is enough to report on data analysis at this juncture. It is striking to note that the mean score of 390 pupils is far below of only ten high achievers. This is a pointer to reduced number of students who enrol and pass mathematics.

TABLE 4.3 LEVEL OF DIFFICULTY OF THE MEANING OF MATHEMATICS TERMS (N = 450)

	TREATMENT A	CONDITIONS B	t-VALUE	SIGNIFICANCE LEVEL
Average Score	11.90	3.22		
Standard deviation	4.01	3.70	33.78*	.05

*p ≤ .05

Table 4.3 shows significant difference between the two treatment conditions. This indicates that the combined group of standard nine and ten pupils, experience problems with definition of concepts found in the syllabus (condition B). The same group of students however, are able to represent these concepts diagrammatically (condition A). The problem of second language speakers accounts for differences in performance under these two conditions.

The hypothesis of no difference in performance under two treatment conditions is rejected. Pupils perform differently when asked to define or to represent mathematics concepts by means of a diagram. Pupils' level of difficulty is associated with definitions rather than diagrams in expressing mathematics concepts.

TABLE 4.4 CONCEPT IDENTIFICATION IN MATHEMATICS (N = 448)

	BELOW AVERAGE SCORE (12 & below)	AVERAGE SCORE (13-19)	ABOVE AVERAGE SCORE (20-26)
Frequency	296	115	37
Percentage	66.07	25.67	8.26

Chi square = 245.98; $*p \leq .05$; df = 2

Table 4.4 shows the frequency distribution of pupils on achievement test C. This test measures concept identification in mathematics. Of the 448 pupils who wrote this test only 33.93% of the pupils passed. The failure rate of 66.07% is remarkable. It indicates that pupils do not know mathematics concepts. The three groups of students namely below average, average and above average groups, differ significantly among themselves ($p < .05$). The knowledge of mathematics concepts varies greatly in the population of pupils. There are very few pupils capable of concept identification. The majority of students are incapable of concept identification in mathematics tasks.

TABLE 4.5 THE RELATIONSHIP BETWEEN THE VARIABLES OF SEX AND PERFORMANCE IN MATHEMATICS

SEX	NUMBER OF PUPILS	MEAN SCORE	STANDARD DEVIATION	t-VALUE	PROBABILITY LEVEL
Male	219	27.99	13.63	0.8975	.3699
Female	229	26.89			

p > .05 : not significant

Table 4.5 reveals that boys and girls do not differ in their performance in mathematics. The mean scores for these groups of pupils do not differ significantly.

TABLE 4.6 THE RELATIONSHIP BETWEEN THE VARIABLE OF AGE AND MATHEMATICS TEST PERFORMANCE (N = 347)

AGE LEVEL IN YEARS	FREQUENCY	MEAN SCORE	HOMOGENEOUS GROUPS	CONTRAST AGE-GROUP	DIFFERENCE
15	4	23.00	X	-	-
16	27	29.74	X	15-16	-6.74
17	69	26.71	X	15-17	-3.71
18	60	28.73	X	15-18	-5.73
19	71	25.32	X	15-19	-2.32
20	41	23.98	X	15-20	-0.98
21	75	24.85	X	15-21	-1.85

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SUM OF SQUARES	D.F.	MEAN SQUARE	F-RATIO	SIGN. LEVEL
Between groups	1175.146	6	195.85761	1.287	.2623
Within groups	51729.033	340	152.14421		
Total (corrected)	52904.179	103 missing value(s) have been excluded.			

Table 4.6 reveals that there are no statistically significant differences among the mean scores for different age groups (F=1.29). The means are homogeneous i.e. the same. The means scores for the age-groups do not differ significantly. The greatest difference between two means is equal to -0.98.

It is amazing to note that there is no difference in mathematics performance between the fifteen-year-olds and successive older age-groups. The fifteen-year-olds perform as good as the 21-year-olds.

TABLE 4.7 THE RELATIONSHIP BETWEEN CLASS/STANDARD AND PERFORMANCE IN MATHEMATICS KNOWLEDGE

CLASS/ STANDARD	NUMBER OF PUPILS	MEAN	STANDARD DEVIATION	t-VALUE	PROBABILITY
9	104	25.42	10.47		
10	344	28.03	13.61	-2.0672	0.0399

$*P \leq .05$

Table 4.7 reveals statistically significant differences between means of standard nine and ten pupils. A test of equal variances is rejected i.e. the null hypothesis of equality is rejected and that of unequal variances is a more plausible hypothesis.

Pupils from standard nine and ten groups, performed differently in this mathematics knowledge test. The table indicates that standard ten pupils out-perform their standard nine counterparts.

Although there are statistically significant differences between the two groups, their mean scores are apparently close.

TABLE 4.8 THE RELATIONSHIP BETWEEN MATHEMATICS PERFORMANCE AND STREAM

STREAM	NUMBER OF PUPILS	MEAN	STANDARD DEVIATION	t-VALUE	PROBABILITY
Science	220	29.17	12.88		
Commerce & General*	228	25.74	12.90	2.82	0.0051

* General = 16 and Commerce = 212

Table 4.8 shows very high statistically significant differences. The evidence suggests that the science stream, i.e. group of students studying mathematics and science out-perform the group of students studying commerce and general streams.

The hypothesis that no differences exist in mathematics test performance among pupils grouped according to the variable of stream, is rejected. This means that students following science stream do better in mathematics than those in general and commerce streams.

TABLE 4.9 THE RELATIONSHIP BETWEEN GRADES AND PERFORMANCE IN MATHEMATICS

GRADE	NUMBER OF PUPILS	MEAN	STANDARD DEVIATION	t-VALUE	PROBABILITY
Standard Grade	132	23.77	11.42		
Higher Grade	316	28.96	13.31	-4.17	0.0001

*$p \leq .05$

Table 4.9 reveals statistically significant differences between groups of pupils, doing standard and higher grade mathematics. Pupils taking mathematics higher grade out-perform those doing mathematics standard grade.

The hypotheses of equal variance is rejected. The hypothesis that no differences exist in mathematics test performance among pupils grouped according to the variable of grade is rejected. Pupils doing mathematics at different grades perform differently. The difference in performance is statistically significant.

4.2 DISCUSSION

This study was intended to find answers to the following questions :

4.2.1 DO PUPILS UNDERSTAND THE MEANING OF WORDS FOUND IN THEIR MATHEMATICS TEXTBOOKS?

This study reveals that there is a low percentage of pupils (13.14%) who understand the meaning of words found in their textbooks. The underachieving group constitutes (86.86%). The culturally different pupils were unable to give definition of words like equation. These words are contained in the syllabus for standard six. This is an indication that, although they might know what "an equation" is, they seem to fail to express themselves in English. It shows that expression in English language is a problem. In support of this argument, studies show that language is independent of thought and action, especially in younger children. Piaget (Kaplan, 1986) conducted an experiment, where he asked preschool children to crawl and explain what they have done. It was not until five or six years of age that children could explain what they have done. Children could comply with the instruction or command but did not have linguistic ability to express themselves. The theory of independence of language and thought is also supported by Flavell (1977) and Sinclair-de Zwart (Kaplan, 1986), who found that two or four year olds could group objects on the bases of physical relationships like "more" or "less", but did not use these concepts when tested. This could be the case with culturally different pupils.

The other reasons for pupils' underachievement in **TEST A**, which requires them to give definition of words could be the restricted conditions of learning mathematics. Mathematics is confined to classroom situation. This is the only place where pupils can learn mathematics. The only person conversant with the language of mathematics is the teacher. The language of mathematics learned by a culturally different pupil is foreign to his culture. It does not belong to his community. Carrol (1964) also shows that the child's own preverbal internal processes are stimulated by thinking are conditioned to symbols used by others in his environment. As the child assimilates the structure of his language, his internal processes become more like those of the speech of the community as a whole.

Poor performance which is the result of language restriction in TEST A, could be due to the background of the culturally different pupils. Black parents have little input in the study of their children. The reason could be lack of knowledge of the subject or that parents are a working class. They therefore have no time to teach their children. Beinstein (Cromer, 1991) also supports this argument. He argues that children from the low working class group have restricted language codes, because they do not have time to spend with their parents. On the other hand, children from middle class homes possess an elaborated language code due to their interaction with parents. The lack of elaborated code by the working class children prevents them from developing their intellectual faculties to their fullest capacity. Berger (Le Roux, 1994) concurs with this statement. He maintains that members from disadvantaged environments, like culturally different pupils, are subjected to poverty. Members of a culture of poverty experience language deprivation. This is due to the fact that all the available time and energy should be converted into money. Le Roux (1994) further asserts that special programmes must be instituted in academic institutions to assist in poverty stricken culture. Pupils with their problems and handicaps in mathematics skills should also be helped.

Furthermore, pupils' responses to **TEST A**, reveals that they have a problem in distinguishing between language used in daily communication and the language of mathematics. Pupils were asked to define the terms : **FUNCTION** and **VOLUME**. The term function was defined as

a social activity and the term volume was defined as **a sound.** This finding is in line with Maree's study (1992) in which pupils of 11-12 years age-range defined **volume** as **knob of a television set.** Some of these words have a mathematical meaning which is unrelated to everyday usage (Cooney & Hirsch, 1990; Backhouse, Haggarty, Pirie & Stratton, 1992; Brodie, 1991).

This study also reveals that mathematical terms or concepts are not only confused with everyday language. A similar problem is encountered across curricula. The same word can be defined differently in different subjects. Pupils were asked to define **A RAY** in the present study. Among other responses, a ray was defined as **wave of high frequency.** This definition is derived from physical science and not mathematics. Bishop (1991) views this problem as an overlap of words in mathematics and other school subjects.

The problem of defining words in mathematics context and science context should not be overemphasized. Mathematics is instrumental in understanding other science subjects. Peat (1990) further confirms this argument by saying that mathematical languages influence peoples' thought in science. This is due to the fact that science uses mathematical language to define some of its concepts, like using the language of co-ordinates, which is a mathematical language to discuss movement of objects in space and time.

In addition, mathematics plays a crucial role in elucidating and formalizing ideas in natural sciences, (Mickens, 1990; Steen, 1979). Mickens (1990) further asserts that mathematics also plays an important role in the discovery process by helping to reveal the limits of a paradigm through quantitative predictions. The involvement of mathematics in other subjects, especially natural science, makes it share its vocabulary with sciences.

For pupils to know the meaning of the words found in their text means that they should know the language used in mathematics. Studies conducted by Morris (1978) in Ireland and Zambia, among the monolinguals and bilinguals, confirm the problem of language among bilinguals. It was discovered that bilinguals did better in mechanical arithmetic than problem arithmetic. This is because mechanical arithmetic needs the skill of computing, which is based on tables and rules of computing. On the other hand, problem arithmetic requires a pupil to perceive the nature of a problem. This involves being able to read and comprehend the written word.

The problem of bilingual pupils can only be solved if these pupils become competent speakers, readers and writers of the second language. This means that pupils should use and think in one's first language, which is a very difficult process. Pupils therefore, who learn mathematics in a second language are educationally handicapped (Morris, 1978).

In the present study, culturally different pupils performed poorly in **TEST A** which measured understanding of mathematics language. This finding supports studies conducted by Morris in 1978. The culturally different pupils in the present study manifest a problem in defining mathematical terms, like equation and factorization. This problem can be attributed to language restrictions.

The impact of bilingualism on mathematics performance is well-documented. Dawe's study (1983) is worth mentioning at this juncture. In his study he used second language speakers who attended schools in Britain. In the present study the culturally different pupil uses English as a second language. Dawe's findings can be summarized as follows :

The following points show findings of research conducted by Dawe (1983) to bilingual children learning mathematics as a second language in British schools.

i) Immigrant children of West Indians showed poorest performance in mathematics, even though these were children considered by their teachers to be fluent in English. This has been shown to be true after a full primary and secondary education in English schools.

ii) There is evidence of dialect interference in West Indian Children at two crucial stages in their development. This starts in early learning of English in the infant years. The dialect interference also occurs during formal operational stages, in the early adolescence.

iii) The problem of language as a barrier to learning, especially in mathematics, increases in magnitude as immigrant children progress through school. This has been the same for Indian, Pakistani and West Indian children.

The under-achievement of culturally different pupils in all tests that require the use of language in the present study, is the evidence of effects of bilingualism discussed above. The culturally different pupils are also bilinguals and they are learning mathematics in a second language. The poor performance in the tests of the present study shows that bilingualism is a potential handicap to a child. It results in a poor cognitive development and school achievement (Brodie, 1989; Earp & Tanner, 1980; Morris, 1978).

Dialect interference has also been found in the present study where pupils refer to function as a social activity and also to volume as the sound of the radio. The two words are commonly used in this sense in the language of culturally different pupils. It would be expected that standard nine and ten pupils are now in a position to express themselves in English. This is contrary to what is found in the present study.

4.2.2 HOW MUCH DO PUPILS KNOW ABOUT MATHEMATICAL VOCABULARY FOUND IN THEIR STANDARDS SIX TO NINE SYLLABI?

This study has found that pupils have greater difficulty in defining a concept verbally than representing the same concept diagrammatically. The level of difficulty of the meaning of mathematical terms is restricted to definitions. Pupils do conceptualize mathematical terms but fail to express them verbally.

The achievement test that measured the level of difficulty of mathematical terms, elicited two responses to a single question. A pupil was required to represent a concept diagrammatically in condition A and to define the same concept in condition B. The average score for condition A was greater than the average score for condition B. This finding reveals that pupils do better in concretizing concepts than in abstracting them.

The poor performance in this study where concepts are defined by means of phrases or words than by diagram can be accounted by what Munro (1979) refers to as inadequate language processing abilities. To derive the meaning of a concept, the child should process the statement syntactically, i.e. to use grammatical information to arrange elements relative to each other, and semantically, i.e. to understand what is meant by a word (Dale & Cuevas, 1987). The semantic and syntactic meanings of words or phrases do not change with context in mathematics.

The method of teaching is also a contributory factor in the problem of defining concepts. A teacher uses a formal definition of term as a starting point. This process involves enlisting attributes and characteristics of a term. For example, a quadrilateral may be defined as a plane figure bounded by four segments. The teacher presents a set of different quadrilaterals to the child. To this point, the child is a passive recipient of knowledge. As a third step, the teacher uses a series of concept-attainment tasks to assess whether a child can distinguish between quadrilateral and non quadrilateral figures. This indicates the first participation of the child in this learning process. There is however, up to this point, not much language used by the pupil or child to learn and define the concept "quadrilateral". For a culturally different pupil, this problem of defining a concept becomes compounded.

In this study, it was observed that pupils do better when representing a concept diagrammatically than when defining it. What accounts for this better performance? The explanation can be found partly on Van Hiele's theory and partly on spatial experiences.

A better performance in defining concepts by diagrams indicates that diagrams do not depend on language.

Dickson, Brown and Gibson (1988) confirms this argument by saying that a young child's first interaction with his environment, before the development of language, depends totally on spatial experiences. A good performance of pupils in this study also shows that they have successfully completed Van Hiele's levels of spatial development. Van Hiele's theory focuses mainly on school geometry, fifty five percent of the questions in this study are based on school geometry. Van Hiele's theory of spatial development (Williams, 1992; Dickson, Brown & Gibson, 1988) has the following levels, which coincide with stages of development of the individual :

Level one - From birth to end of primary school : Recognition

Pupils learn some vocabulary in geometry. They learn to distinguish figures in terms of their shapes as a whole. They do not necessarily recognize the properties of the figures. For example a six year old can reproduce a square, rectangle on a geoboard using rubber bands, but does not see a square as a special type of a rectangle. For him the two diagrams are distinct with separate shapes.

Level two - Standard 6 : Analysis

The pupil can now recognize the properties of the given figure. These properties become realized through observations during practical work, when drawing and measuring. A pupil sees that a rectangle has four right angles, that the diagonals are of the same length. Opposite pairs of the sides of a parallelogram are also recognised as being of the same length, but pupils still cannot see a rectangle as a particular parallelogram.

Level three - Standard 7 : Ordering

Pupils are now able to recognize the relationship between figures. The square is now seen as a special case of a rectangle.

Level four - (Standard 8) and Five (Standard 9 & 10) : Deduction and Rigour

At this stage, pupils can now use theorems and axioms to draw conclusions. This means that at this stage the deductive reasoning has developed. Pupils also recognize the need for precision in dealing with the relationships between structures. It is also expected that the standard nine and ten pupils have reached this level (William, 1992).

According to the medical research (Orton, 1992) spatial ability is controlled by the right hemisphere of the brain. The right hemisphere processes stimuli as a whole structure and processes images rather than words. The left hemisphere on the other hand controls language and speech and excels in performing sequential tasks, logical reasoning and analysis. There has been a suggestion that school education tends to concentrate on developing abilities controlled by the left hemisphere whilst the right hemisphere is comparatively neglected (Orton, 1992). It is not surprising therefore, that the culturally different pupils did better in a section with diagrams. The discussion above also brings to light that diagrams or figures do not depend on language as they are controlled by the right hemisphere of the brain. The discussion also emphasizes that poor performance on definitions of concepts in this study is related to those faculties that are controlled by the left hemisphere of the brain.

To account for the failure of culturally different pupils to define concepts while doing better to represent the same concept by means of a diagram, Backhouse, Haggarty, Piere and Straton (1992) use the following diagram, to show the discrepancy.

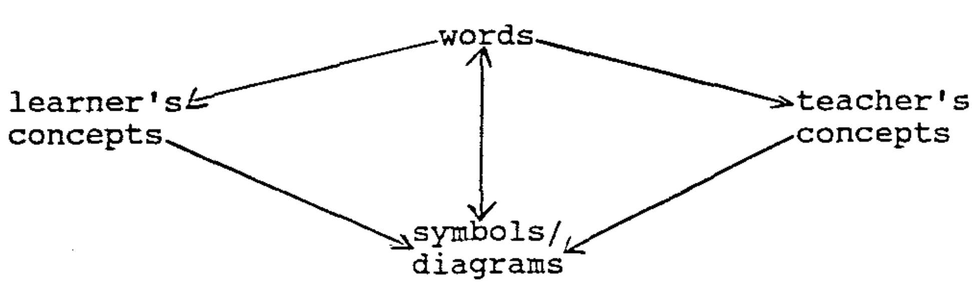

Figure 4.2 Pupil - Teacher conception

The diagram shows that the meaning of the teacher's concept is different from that of the learner, i.e. there is no common understanding of the same word. On the other hand, the teacher and the learner have the same understanding when using symbols. From this study, pupils are able to draw a parallelogram, a circle and write natural numbers but cannot define these concepts.

A study on classroom interaction carried out by Bauersfeld (1980) showed that, although teachers and children use language to interact, they behave according to their own actual subjective realities. Thus, teachers and pupils are frequently at cross-purposes even though they both believe that they understand each other. This shows that communication from a sender reaches the receiver with distortion. The distortion of meaning between the teacher and pupil is inevitable in mathematics.

Like other forms of writing, mathematics is expressed in a coded form. The reader has to decode the information in order to extract the meaning. According to Shaurd and Rothery (1984) there are two coding systems that are used in mathematics. There is a coding system for words as well as for signs and symbols. The code used in representing words is sound, and this involves language. The code used in representing a symbol, is pictorial/diagrammatic. For pupils to learn a symbol, they should link it with the idea of some spoken words which correspond with that idea and the symbol. Shaurd and Rother (1984) use the following diagram to illustrate the relationship between symbols and words.

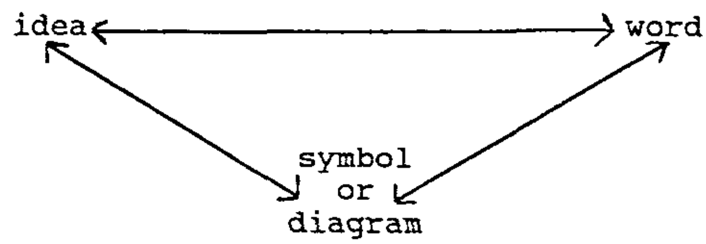

Figure 4.3 Relationship between a symbol and a word

unlike a word that occurs alone, symbols or diagrams have words and ideas that convey their meaning. This makes the meaning of a diagram or symbol clear. Pupils have no problem in learning diagrams or symbols. In addition, symbols provide efficient means of storing and conveying information, because they allow the compression of a lot of information into a small space, for example a formula. Symbolic mathematical expressions do not have the problem of redundancy like the every day speech, which results in a dense reading. (Pimm, 1987).

The requirements of expressing mathematical ideas in natural languages lead to the development of mathematics register. This consists of words, phrases and diagrams. Words found in mathematics register are specific to mathematics like quadrilateral, parallelogram, hypotenuse (Pimm, 1987). A child can only learn these words and their meaning in a mathematics class.

4.2.3 CAN STUDENTS DISCOVER MATHEMATICAL CONCEPTS ON THE BASIS OF INFORMATION GIVEN?

The study reveals that pupils cannot identify mathematics concepts. About 33.93% of the sample of pupils passed the test of concept identification. This means that 66.07% of the pupils were unable to do this task. In this task a description is given and a pupil is required to respond in one word to fit the description. The pupils were unable to form an association between a description and a concept. According to Skemp (1979) there is a difference between a concept and its name. A concept is an idea, but the name of a concept is a sound or mark associated with it. Skemp (1979) further advocates that the association between the name and the concept is formed after concept has been formed, or in the process of forming the concept. If the same name is heard or seen each time an example of a concept is encountered, the concept will be formed. Pupil's failure in concept identification indicates a lack of association between a concept and its name. It also shows that pupils do not always use the mathematical terms in varied situations so as to remember their names.

Associating a name with a concept helps to classify the concepts by means of its perceptual properties (Skemp 1979, Orton, 1992). Most of the pupils in this study refer to a trapezium as parallel lines. This shows that pupils can recognize properties of the concept but cannot classify the concept because they are failing to associate the name with the concept.

The problem of identifying concepts could also be related to the way of retrieving the learned material from the memory. Skemp (Byers & Erlwanger, 1985) distinguishes between relational and instrumental understanding in mathematics. The two types of understanding affect teaching, learning and thinking in mathematics. Relational teaching stresses mathematical relationships, whilst instrumental teaching relies on remembering rules. Skemp (Byers & Erlwanger, 1985:261) further says "It is certainly easier to learn that area of a triangle = base X height than to learn why it is so". Instrumental learning is a short cut in learning mathematics since pupils memorize some rules. This method, however, is not always helpful to the pupil, when he cannot differentiate between an expression and an equation. Most of the responses given, when pupils were asked to give the name of $3x^2+5x+7$, was that this is an equation of finding roots, or it is factorization. This shows that pupils at standard nine and ten level cannot make a distinction between an expression and an equation, which is the standard six work.

The other source of mathematical errors is due to memory transformation and subjective organization. Memory transformation and subjective organization occurs when pupils construct meaning from their memory by simplifying the mathematical material he is learning. The pupil tries to introduce his own unit, coherence and consistency into material he has learnt at different times (Byers & Erlwanger 1985). While pupils construct meaning of old and new concepts, strategies and algorithms tend to be confused and substituted for each other. The resulting errors are what Radatz (1979) calls an interference. In this study, this is reflected by the responses of saying that a trapezium is a parallelogram. Usually properties of a parallelogram are taught first before the properties of a trapezium. It is an indication of interference in the pupils' minds of the two quadrilaterals.

According to Child (1981) concepts are generalizations built up by abstracting particular sensory events and critical attributes. They are not actual sensory events, but representations of some aspects of the events. With most concepts there are wide margins of attribute acceptability, e.g. a quadrilateral can be a square, a parallelogram or a kite. There were responses in this study that a trapezium is a parallelogram. This could be an indication that these pupils do not know all the attributes of a parallelogram or of a trapezium.

Concepts are also dependent upon previous experience. Home background and educational opportunities are possible variables in the formation of concepts (Child, 1981; Harris, 1991). Child (1981) further argues that concepts function in two ways, i.e. extensionally and intentionally.

The *extensional* use of concepts applies where meaning given is widely acknowledged. It is defined in terms which are patent to anyone observing the object or event. Concept usage arises from common agreement and acceptance of the objective attributes of the object. For example, a triangle has meaning which we all accept. The *intentional* use of concepts can vary considerably from one person to another. In this case the concept is defined as a result of personal, subjective experiences accompanying the formation of concepts. A symbol of computation like a multiplication sign or division sign might arouse anxiety to a pupil because he does not know his tables of multiplication very well.

Concepts also form horizontal and vertical organizations. Example of horizontal classification is square, rectangle, rhombus and kite belonging to a subset of quadrilaterals. Vertical classification on the other hand results from the presence of hierarchies. For example, a rhombus is a special type of parallelogram which is subordinate to a bigger order of quadrilaterals (Child 1981). If culturally different pupils are able to make these classifications when forming concepts about quadrilaterals they would, for example, not make an error of saying a trapezium is a parallelogram, although they belong to the same group of quadrilaterals, they belong to different categories due to different attributes.

Vergnaud (Harris 1991) has developed a theoretical model of concepts based upon the idea that concepts always involve three aspects, which are invariants, representations and situations. *Invariants* which Child (1981) calls attributes, refer to properties or relations associated with a concept, e.g. equivalence, distributivity, proportionality and symmetry. On the other hand, invariants are linked to symbolic *representations*. Invariants are therefore expressed in a number of ways, for example through natural language, through written language, diagrams and tables, which are called symbolic representations. Finally, concepts are tied to *situations* which imbue them with meaning (Harris, 1991). Usually a concept is tied to multiple representations and situations. In such cases a concept is related to another concept. This may be the reason that culturally different pupils call a trapezium a parallelogram or a third degree expression as a factorization.

Michau (1978) alleges that the low achievement of mathematics at high school level, as compared to other subjects is attributed to different cultural background in the development of mathematics concepts. Michau further argues that studies conducted among various black people within the Republic of South Africa indicate differences and inadequacies as far as mathematical conceptualization is concerned. This argument is confirmed by a pass rate of 33,93% in a test in the present study where pupils were required to give the name of a given symbol or phrase, i.e. concept identification. Poor performance in mathematics therefore, does not reflect the potentiality of the pupils (Michau, 1978; Dawe, 1983). One of the causes of underachievement is conceptualization. Studies conducted by Raum (Michau, 1983) revealed that number symbols of various tribes in Natal are cumbersome and that number concepts are rarely formed in the abstract, but refer to suitable objects. Peters (1966) also confirms this argument by saying that no terms exist in the Zulu language for theorem, equation and a vast number of other mathematics concepts. The study also shows that pupils could not define the word equation which is a common mathematics terminology in a mathematics class.

4.2.4.1 TO WHAT EXTENT IS PERFORMANCE ON MATHEMATICS TESTS INFLUENCED BY THE VARIABLE OF SEX?

This study reveals that performance on mathematics tests is independent of the sex of the pupil.

Evidence around the world that there are sex-related differences in mathematical ability is not consistent (Orton, 1992; Kruteskii, 1976; Suydam & Weaver, 1977). The results of the present study confirms this argument. There was no difference in performance between boys and girls taking mathematics.

In many countries, however, the pattern of attainment in mathematics tends to be uniform. More boys than girls succeed in mathematics examinations. What accounts for this observation?

Research findings show that girls and boys in the same class are not treated in the same way. It was found that it was largely boys who were involved in different types of interactions. Boys were asked a greater percentage of higher order questions while girls received a greater percentage of lower-cognitive-level questions. Boys also created more response opportunities for themselves by initiating more contact with the teacher by calling out answer and guessing more frequently. Boys also volunteered more. It was found that teachers do not have preferential treatment of the same sex (Koehler, 1990; Good, Sikes & Brophy, 1973; Seinhardt, Seewald & Engel, 1979).

A range of techniques, both qualitative and quantitative, were used to monitor classroom behaviour and teachers' beliefs. These explain gender differences on educational performance in mathematics. The research also indicated teacher practices, i.e. Delamont (1983) explored the extent to which gender reinforced teachers' perception and expectations of students (Delamont, 1983; Seder, 1990). Seder (1990) found consistent differences in the way teachers judged and valued contributions of boys and girls in their mathematics classes. This was in favour of boys. His findings also reflected differences in the way boys and girls described themselves as learners. Girls usually underrate themselves while boys do the opposite.

The research conducted by Joffe and Foxman (1986) showed some important aspects of both attitudes and performance, which appeared to be difference for boys and girls respectively. Their survey showed the following :

i) When boys and girls were asked to rate statements that indicated perceived difficulties in mathematics, girls tended to make moderate assessments, by using the extremely positive and extremely negative positions on the rating scales than boys do.

ii) Girls expressed greater uncertainty about their mathematical performance. Boys on the other hand expressed a greater expectation of success.

iii) Boys overrated their performance in mathematics in relation to written test results, but did not do as well as they expected. Girls underrated their performance and did better than they expected.

Joffe and Foxman's findings (1986) indicate that boys perceived mathematics as a subject for them rather than girls. Boys will work hard in order to succeed, on the other hand, girls will not be motivated to work hard as they believe that mathematics is not their subject.

The findings of the present study and also of the other researchers indicate that the variable of gender is coupled with other factors. These are among others:

differential treatment of boys and girls in the mathematics class, teachers' beliefs and stereotypes as well as the effects of attitudes.

4.2.4.2 TO WHAT EXTENT IS PERFORMANCE ON MATHEMATICS TESTS INFLUENCED BY THE VARIABLE OF AGE?

The present study reveals that the variable of age has no influence on mathematics achievement. Different age groups perform similarly in all mathematics tasks. The average scores for the age ranges, 15-21, are homogeneous.

This study focuses on pupils who have reached Piaget's stage of formal operations. This is the stage at which Farrell and Farmer (1980) say that the adolescent can deal with the "form" of the situation and need not resort entirely to concrete aspects of the problem. Statistics show that by the age of twelve, ten to fifteen percent of the pupils appear to have reached this stage (Backhouse *et al*, 1992). The sample of the present study consists of pupils whose age range is between 14 and 21 years of age. That is why one of the hypothesis of this study is that there will be no difference in the performance of pupils grouped according to age. This is the stage where standard nine and ten pupils can reason abstractly. The syllabus for mathematics at standard nine and ten requires abstract thinking.

There are four stages of cognitive development according to Piaget. Furthermore, Piaget (Farrell and Farmer, 1980) has identified four characteristics of formal operational stage. The characteristics depend upon one another. The four characteristics of formal operational stage outline the way in which an intellectually mature adolescent thinks. These characteristics are :

i) Treatment of the real as a subset of the possible : At the formal level reality is considered as a subset of the possible with the result that hypothesis may proceed from non observed and non experienced phenomena. This means to have the ability to imagine the possible as containing the real. The formal thinker is therefore freed from the restrictions of his or her senses (Biehler & Snowman, 1993; Farrell & Farmer, 1980; Kaplan, 1986).

ii) Combinatorial analysis : At the formal stage an adolescent is capable of considering all possible combinations of variables in a systematic manner. This ability is a necessary condition for generating all possibilities and thus determine the shift in the orientation towards the real and the possible condition. For example, Inhelder and Piaget (Farrell & Farmer, 1990) describe responses to the experiments on the law of floating bodies. The experiment involves the classification of objects as floating and non floating. Children who have not reached the formal operational stage incorrectly predict that a coin will float because it is 'little', or that a wood plank will sink because it is 'heavy'. The solution involves understanding of density, which presupposes an understanding of weight and volume. The latter, therefore, is not being fully realized before the early formal stage (Farrell & Farmer, 1980).

iii) Hypothetical-deductive reasoning : This is the ability to form hypothesis, which leads to certain logical deductions. The real-possible relation and the use of combinatorial analysis, are apparent in the actualization of these characteristics (Farrell & Farmer, 1980; Kaplan, 1986).

iv) Propositional thinking : The elements manipulated by the formal thinker are logical

> propositions, statements containing raw data rather than the raw data itself. The formal thinker is using abstractions and not tied to concrete objects. The adolescent is operating on propositions via conjunction, disjunction, implication, negation and equivalence (Farrell & Farmer, 1980).

High school pupils are more likely than younger pupils, to grasp relationships. They can mentally plan a course before proceeding and test hypotheses systematically (Biehler & Snowman, 1993).

The limitation of language can be one of the causes that makes the culturally different pupils incapable of using these characteristics consistently.

4.2.4.3 TO WHAT EXTENT IS PERFORMANCE ON MATHEMATICS TEST INFLUENCED BY THE VARIABLES OF CLASS, STREAM AND MATHEMATICS GRADE

The findings of the present study reveal that the variables of class, stream and mathematics grade have an influence on mathematics performance. Pupils grouped according to these variables perform differently.

With regard to the variable of class, the standard ten pupils outperformed their standard nine counterparts.

Pupils grouped according to the three streams, namely Science, Commerce and General combined perform differently. The Science stream seems to have an urge over the two. This confirms the generally held belief that only bright students follow Science courses. Closely related to the variable of stream, is the variable of grade. The variable of grade indicates the level at which the course is taken. The higher grade is superior to the standard grade. In this study, the two grades were found to differ significantly. In the same vein, only brighter pupils enrol for higher grade.

In standard eight, pupils choose their subjects in accordance with their individual needs, abilities, aptitudes and interests. Their choice of subjects determines the nature of their courses which lead to the attainment of Senior Certificate (Standard Ten) (Harmse, du Toit & Broeksma, 1984; Sibaya, Hlongwane, Maphumulo & Zwane, 1994). The subjects chosen should fall under three streams. Science, General and Commerce.

The *Science stream* : In addition to the official languages, the remaining subjects are natural science subjects like physical science and biology. Mathematics is an essential subject in this course.

The *General stream* : Consists of official languages. In the remaining subjects one of the subjects must be a science subject, either mathematics or biology.

The *Commercial stream* : Comprises of the official languages and commercial subjects like Economics, Business Economics and Accounting. Mathematics is not compulsory but is a necessity for accounting.

This shows that mathematics runs through all the streams. This study includes pupils doing mathematics in all the three streams. Although no research has been conducted, there is a general comment by mathematics teachers that commerce students have a negative attitude towards mathematics. This leads to high failure rate of mathematics by commerce students. On the other hand students pursuing general stream, i.e. studying history, geography or biblical studies, feel that there is little or no relationship between their subject package and mathematics. There is therefore, no need to study "this difficult subject". The strong feeling from this group is that they should do away with mathematics. The results of this study confirm this argument. The pupils in the science stream out-performed pupils in the commercial and general streams combined.

Matric results show that black pupils do worse in mathematics than in any other subject (Michau, 1977). The percentage pass quoted by Michau (1978) is that in 1977 only 46,10% of pupils passed mathematics at higher grade as compared with 41,6% for the standard grade. This is parallel to the findings of the present study where there is a significant difference between groups of pupils taking mathematics at higher grade and standard grade. The mean scores of these groups were 28.96 and 23.77 respectively.

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CHAPTER FIVE

5. SUMMARY, RECOMMENDATIONS AND LIMITATIONS

5.1 SUMMARY

5.1.1 THE PROBLEM

This study was designed to investigate the responses of culturally different pupils to mathematics vocabulary, i.e. whether culturally different pupils are in a position to define, represent mathematics concepts by means of diagrams, and to do concept identification.

5.1.2 THE AIMS OF THE STUDY WERE

a) To find out whether pupils understand the meaning of mathematics concepts found in their textbooks.

b) To determine the level of difficulty experienced by pupils in learning the meaning of mathematical terms.

c) To find out whether pupils can discover mathematical concepts on the basis of information given, i.e. concept identification.

d) To determine the influence of respondents' characteristics on mathematics test performance.

These characteristics are :

(1) variable of sex

(2) variable of age

(3) variable of class

(4) variable of stream

(5) variable of mathematics grade

5.1.3 THE FOLLOWING HYPOTHESIS WERE FORMULATED

a) The culturally different pupils understand the meaning of words found in their textbooks.

b) There will be no differences among culturally different pupils regarding the level of difficulty in learning the meaning of mathematical terms.

c) There will be no differences among pupils with regard to concept identification in mathematical tasks.

d) No differences exist in mathematics test performance among pupils grouped according to the following characteristics :

(1) variable of sex

(2) variable of age

(3) variable of class

(4) variable of stream

(5) variable of mathematics grade

5.1.4 METHODOLOGY

Chapter one consists of motivation for investigation in this field, statement of the problem, aims of study, hypotheses and a plan for the organisation of the whole scientific report. Chapter two comprises a review of previous work done in this area. Chapter three details the method of study used in this research. The measuring instrument is in an achievement test. The measuring instrument was constructed and standardised by the researcher. Chapter four contains the analysis of data and discussion. Chapter five consists of a summary, findings and recommendation.

5.1.5 FINDINGS

Very few pupils (13.14%) understand the meaning of words found in their mathematics textbooks. The majority of pupils (86.86%) do not understand the meaning of words found in their textbooks. A large percentage of pupils could not define terms, like function and gradient. These terms are not new to standards nine and ten pupils. These terms appear as early as standard eight level. These pupils even fail to define a word like equation. Their first contact with this word is at standard six. The problem of the culturally different pupil in these mathematical tasks is English expression.

It means that, language is a barrier to know these mathematical terms. Flavell (1977) and Sinclair-de Zwart (Kaplan 1986) also found that two and four year olds could group the objects on the bases of physical relationships like "more" or "less", but could not use these concept when tested.

The other reasons for failing to understand the meaning of words in the present study is that, the language of mathematics is restricted to the classroom. Pupils cannot converse in the language of mathematics outside the classroom. The language of instruction in mathematics is English. This is a second language to the culturally different pupil. The pupil also encounters this mathematics language at school. On the other hand, the English of mathematics is more complex than ordinary English. The reason being that mathematics has words which have the same meaning in English and in mathematics. There are also words which occur in mathematics and in English but have different meanings. Mathematics has also technical vocabulary. It also shares its words with other science subjects but with different connotations. This brings confusion to the culturally different pupil, at a time when he is still battling with the second language.

The present study also reveals that standards nine and ten pupils experience problems when defining concepts found in their text books (Condition B). The same group of pupils show a better performance when representing the same concepts by means of diagrams (Condition A). Language is still a contributory factor to poor performance in defining the concepts. The language deficiency in this case may be due to the method of teaching definition of concepts. For example a teacher defines the concept and give different examples. The learner only listens to this presentation. Although the pupil has been a passive participant, at the end he will be expected to define the concept. This becomes difficult, because the pupil did not practice the definition in the presence of the teacher, and also get help when necessary.

A good performance in defining a concept by means of a diagram than by words of phrases is supported by Van Hiele's theory of spatial development. It mentions that standards nine and ten pupils have completed the spatial development and should thus be in a position to deal with any symbol or diagram given. Medical research (Orton 1992) also supports this finding in the present study. It maintains that language and symbols or diagrams are controlled in different parts of the brain. This indicates that there is no relationship between language and diagrams or symbols. It has also been found (Backhouse *et al*, 1992) there is a lack of common understanding of the meaning of words. For example, concepts that are in this study were regarded, by mathematics teachers of standards nine and ten of the local schools, as familiar but proved to be difficult to pupils.

In this study, 448 pupils wrote a test on concept identification. About 33.93% passed the test and 66.07% failed. In this test, pupils had to respond by giving a word to a description or by a diagram. The large percentage of failure indicates that pupils cannot form associations between a description and a concept.

There were responses in the present study that an expression is an equation of finding roots or it is a factorization. Such responses raises many questions. Are these pupils failing to retrieve information from the memory?; or is there any interference occurring in the learned material or do these pupils know all the attributes of a concept in question?; or are these pupils lacking previous experience on which concepts depend on studies?

The variable of sex does not affect performance in this study. There are two views about gender and performance. One view maintains that boys perform better than girls. The other view holds that the performance between boys and girls does not differ. The findings of the present study are therefore, in line with the latter view.

In the present study, age has no influence on the performance of mathematics. The performance of the fourteen year olds does not differ from their successive older age group. This finding supports Piaget stage of cognitive development, that is the formal stage. The age range of the pupils in the study belongs to the formal stage of development. That is why there is no difference in the mathematics performance between age groups.

This study reveals that the variables of class, stream and mathematics grade influence the performance in mathematics. With regard to the variable of class, standard ten pupils out-performed the standard nine pupils in all tests. Pupils grouped according to the three stream, science, commerce and general, performed differently. The science group performed better than the other two groups. The variable of mathematics grade also influenced pupils differently. The pupils taking higher grade mathematics out-performed the pupils taking standard grade mathematics.

5.2 RECOMMENDATIONS

This study has opened the following avenues for future research :

a) This study investigated the responses of culturally different pupils to mathematics vocabulary. There is however, a need to investigate the relationship between reading ability and performance in mathematics.

b) There is a need to study ways of encouraging pupils with limited English proficiency to participate in a mathematics class.

c) The findings in this study that culturally different pupils can define a concept diagrammatically need to investigate whether it is true for pupils of other cultures other than black culture.

d) Mathematics is a specialized language. There is therefore, a need to investigate classroom communication and its effect on the learning of mathematics.

e) The extent to which cultural factors, language in particular, either promote or retard the accessibility to the concepts framed in the language of mathematics need to be examined.

f) There is also a need to look into the readability of mathematics text. It could happen that the wording of mathematical problems and the instructions provided, may exceed the still limited grammatical vocabulary equipment of the pupils in the second language.

g) There is a need for development of research instrument of language and performance in mathematics.

h) A study of comprehension and performance in mathematics is needed.

5.3 LIMITATIONS OF THE STUDY

Although this study has achieved its objectives, several limitations exist with regard to sampling, instrument used and research design.

a) In stating the purpose of this study, the writer has used lucid terms. These terms however, do not encapsulate the whole field of investigation. The researcher mentions the purpose of the study as to find out whether culturally different pupils can respond to mathematics vocabulary.

b) There are also definitional limitations : The operational definition of the term "response" embraces several attributes. Response is used to mean a pupil's definition of a mathematical word or stimulus.

c) The testing for the study was conducted during the afternoon sections. Poor performance could partly be attributed to pupils being exhausted at that time of the day.

d) The validity and reliability of the scale were established. The scale has a moderate reliability. The values of validity and reliability were computed. These values are subject to change as a result of pupils' level of knowledge. Different subsamples could therefore yield different validity and reliability coefficients.

e) There is a need to supplement this statistical approach by clinical interviews, i.e. to use the verbal protocol techniques in order to analyse further the individuals' comprehension level and the global picture.

f) The research design could also be improved by using stratification in sample selection. This means that for all purposes of analyses, pupils with varying level of knowledge be treated separately. The sample could be divided into high achievers, average achievers and under-achievers.

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ANNEXURE A

The scale used in the pilot study.

This is an enquiry on how much you know about mathematics vocabulary. DO NOT WRITE YOUR NAME, but just give particulars (by means of a tick √) regarding your :

Sex	Male	Female						
Age	14	15	16	17	18	19	20	21 and above
Class	Std 9	Std 10						
Stream	Science	General	Commerce					
Mathematics grade	Standard grade	Higher grade						

Turn the page and start

SECTION A

Give any definition you might know of the following words :

1. Ray

----

2. Axiom

----

3. Volume

----

4. Factorisation

----

5. Equation

----

6. Function

7. Gradient

8. Subject of the formula

9. Concurrent lines

10. Collinear

SECTION B

Fill in the following two columns of information.

e.g. :

Word		**Symbol or diagram**	**Description of the word**
number line			Graph represen= ting the correct order of numbers according to their cardinal value
1) Natural numbers			
2) Triangle			
3) Angle of depression			
4) Rational number			
5) Power			

Word	Symbol or diagram	Description of the word
6) Trapezium		
7) Angle		
8) Parallelogram		
9) Cardinal number		
10) Circle		
11) Hexagon		
12) Discriminant		
13) Co-ordinates of a point		

SECTION C

Give names that are represented by the following :

1) $\left(\frac{-b}{2a} \; ; \; \frac{-}{4a}\right)$

____

____

____

2) The graph of $y = -2x^2 + 3x - 6$

____

____

____

3) $|x| = \begin{cases} x & \text{if } x \geq 0 \\ x & \text{if } x < 0 \end{cases}$

____

____

____

4) $2^x = 2^3$

____

____

____

5) $3x^2 + 5x + 7$

____

____

____

6) (x ; y)

7)

8) $\sqrt{-2}$

9) ax _ by + c = 0

10) tangent

11) $\dfrac{\text{hypotenuse}}{\text{adjacent side}}$

12) $25(43+9) = (43+9)25$

----

13) ____horizontal____

----

14) $\text{cosec } x = \dfrac{1}{\sin x}$

----

15) The perpendicular bisectors of the sides of a triangle intersect at one point

----

----

16) A ______________ D

B ______________________________ C

----

17) $\frac{\sin A}{a} = \frac{\sin B}{a} = \frac{\sin C}{a}$

ANNEXURE B

Examinees on the Upper Quartile

EAMINEES ON THE UPPER QUARTILE

RESPONDENT NUMBER	TOTAL SCORE
13	59
1	57
20	57
41	57
47	57
143	57
78	56
32	56
33	55
42	55
80	55
62	55
137	54
34	53
31	52
95	52
183	52
102	52
187	51
10	51
12	50
77	50
94	50
108	50
144	50
59	50
17	49
85	49
98	49
157	49
35	48
40	48
97	48
182	48
24	47
26	47

RESPONDENT NUMBER	TOTAL SCORE
189	47
53	47
67	47
73	47
76	46
110	46
142	46
152	46
165	46
61	46
44	45
96	45
103	45

ANNEXURE C

Examinees on the Lower Quartile

EXAMINEES ON THE LOWER QUARTILE

RESPONDENT NUMBER	TOTAL SCORE
128	28
92	27
135	27
160	27
170	27
134	27
138	27
158	27
170	27
196	26
135	26
148	26
107	25
118	25
162	25
171	25
3	24
114	24
116	24
9	23
123	23
172	23
130	21
141	21
188	21
86	21
122	20
193	20
46	19
14	18
119	18

RESPONDENT NUMBER	TOTAL SCORE
163	18
186	18
173	18
168	17
174	17
15	16
176	16
178	16
22	15
180	14
36	14
169	14
115	12
195	10
167	10
127	8

ANNEXURE D

Item Analysis

ITEM ANALYSIS : TEST A

ITEMS	EXAMINEES IN UPPER QUARTILE (UQ)	EXAMINEES IN LOWER QUARTILE (LQ)	PROPORTIONS UQ	PROPORTIONS LQ	DISCRIMINATIVE INDEX
1	19	1	0.4	0	0.4
2	25	10	0.5	0.2	0.3
3	40	0	0.8	0	0.8
4	37	22	0.7	0.4	0.3
5	18	1	0.4	0	0.4
* 6	4	0	0.1	0	0.1
7	27	14	0.5	0.3	0.2
* 8	4	0	0.1	0	0.1
* 9	8	3	0.2	0.1	0.1
*10	2	1	0.0	0	0

* Items eliminated

ITEM ANALYSIS : TEST B

ITEMS	EXAMINEES IN UPPER QUARTILE (UQ)	EXAMINEES IN LOWER QUARTILE (LQ)	PROPORTIONS UQ	PROPORTIONS LQ	DISCRIMINATIVE INDEX
1	35	20	0.7	0.4	0.3
* 2	49	48	1.0	1	0
3	25	4	0.5	0.1	0.4
4	15	7	0.3	0.1	0.2
5	43	26	0.9	0.5	0.4
6	35	8	0.7	0.2	0.6
7	44	27	0.9	0.5	0.4
8	31	6	0.6	0.1	0.5
* 9	3	5	0.1	0.1	0
10	48	32	1.0	0.6	0.4
11	36	6	0.7	0.1	0.6
12	47	22	0.9	0.4	0.5
13	48	28	1.0	0.6	0.4

* Items eliminated.

ITEM ANALYSIS : TEST C

ITEMS	EXAMINEES IN UPPER QUARTILE (UQ)	EXAMINEES IN LOWER QUARTILE (LQ)	PROPORTIONS UQ	PROPORTIONS LQ	DISCRIMINATIVE INDEX
1	33	18	0.7	0.4	0.3
2	50	26	1	0.5	0.5
3	46	32	0.9	0.6	0.3
* 4	0	3	0	0.1	-0.1
5	13	4	0.3	0.1	0.2
6	47	23	0.9	0.5	0.4
7	39	14	0.8	0.3	0.5
8	14	4	0.3	0.1	0.2
* 9	7	4	0.1	0.1	0
10	34	5	0.7	0.1	0.6
11	42	8	0.8	0.2	0.6
*12	3	0	0.1	0	0.1
13	24	8	0.5	0.2	0.3
14	14	6	0.3	0.1	0.2
*15	10	5	0.2	0.1	0.1
16	36	12	0.7	0.2	0.5
17	44	13	0.9	0.3	0.6

* Items eliminated.

ANNEXURE E

Item difficulty

ITEM DIFFICULTY : TEST A

ITEMS	EXAMINEES	PROPORTIONS
1	49	0.2
2	61	0.3
3	75	0.4
4	122	0.6
5	40	0.2
6	7	0.4
7	79	0.4
8	7	0.1
9	25	0.1
10	5	0.1

ITEM DIFFICULTY : TEST B

ITEMS	EXAMINEES	PROPORTIONS
1	122	0.6
* 2	196	1
3	60	0.3
4	45	0.2
5	146	0.7
6	85	0.4
7	156	0.8
8	72	0.4
9	15	0.1
10	162	0.8
11	86	0.4
12	142	0.7
13	157	0.8

* Item eliminated

ITEM DIFFICULTY : TEST C

ITEMS	EXAMINEES	PROPORTIONS
1	85	0.1
2	152	0.1
3	170	0.3
* 4	45	0
5	34	0.2
6	157	0.4
7	107	0.5
8	43	0.2
* 9	15	0
10	75	0.6
11	103	0.6
*12	5	0
13	83	0.3
14	46	0.2
15	23	0.1
16	96	0.5
17	117	0.6

* Items eliminated

ANNEXURE F

The Final Scale

This is an enquiry on how much you know about mathematics vocabulary. DO NOT WRITE YOUR NAME, but just give particulars (by means of a tick √) regarding your :

Sex	Male	Female						
Age	14	15	16	17	18	19	20	21 and above
Class	Std 9	Std 10						
Stream	Science	General	Commerce					
Mathematics grade	Standard grade	Higher grade						

Turn the page and start

SECTION A

Give the mathematics definition you might know of the following words :

1. Ray

----

2. Axiom

----

3. Volume

----

4. Factorisation

----

5. Equation

----

6. Function

----

7. Gradient

SECTION B

Fill in the following two columns of information.

e.g. :

Word	Symbol or diagram	Description of the word
number line		Graph represen= ting the correct order of numbers according to their cardinal value
8) Natural numbers		
9) Angle of depression		
10) Rational number		
11) Power		
12) Trapezium		

Word	Symbol or diagram	Description of the word
13) Angle		
14) Parallelogram		
15) Circle		
16) Hexagon		
17) Discriminant		
18) Co-ordinates of a point		

SECTION C

Give names that are represented by the following :

19) $\left(\frac{-b}{2a} \;;\; \frac{-}{4a}\right)$

20) The graph of $y = -2x^2 + 3x - 6$

21) $|x| = \begin{cases} x \text{ if } x \geq 0 \\ x \text{ if } x < 0 \end{cases}$

22) $3x^2 + 5x + 7$

23) $(x \;;\; y)$

24)

25) $\sqrt{-2}$

26) tangent of a circle

27) $\frac{\text{hypotenuse}}{\text{adjacent side}}$

28) ______ horizontal ______

29) $\text{cosec } x = \frac{1}{\sin x}$

30) A ______________ D

B ______________________________ C

31) $\frac{\sin A}{a} = \frac{\sin B}{a} = \frac{\sin C}{a}$

ANNEXURE G

Respondents' Particulars – Pilot Study

Column 1	=	Pupil's number
Column 2	=	Sex : M = Male ; F = Female
Column 3	=	Pupil's age
Column 4	=	Class : Standards nine and ten
Column 5	=	Streams : S = Science
		G = General
		C = Commerce
Column 6	=	Grade : SG = Standard Grade
		HG = Higher Grade
Column 7	=	Total Scores = Tests A + B + C

1 PUPILS	2 SEX	3 AGE	4 CLASS	5 STREAMS	6 GRADE	7 TOTAL SCORES
1	F	17	9	S	SG	57
2	F	19	9	C	HG	41
3	F	19	10	C	HG	24
4	F	21	10	C	SG	22
5	M	17	9	S	HG	26
6	M	19	9	S	SG	36
7	F	20	9	S	HG	44
8	M	19	9	S	SG	44
9	F	19	10	C	SG	23
10	F	19	9	C	HG	50
11	M	17	10	C	SG	35
12	M	17	9	S	HG	50
13	F	17	9	S	HG	59
14	M	18	10	C	SG	18
15	M	19	10	C	SG	16
16	M	20	9	C	SG	30
17	M	17	10	S	HG	49
18	M	19	10	S	HG	42
19	F	19	10	S	HG	61
20	F	18	10	S	HG	57
21	F	21	9	S	HG	34
22	M	21	9	S	HG	15
23	F	17	9	S	HG	30
24	M	18	10	S	HG	47
25	M	18	10	S	HG	44

1 PUPILS	2 SEX	3 AGE	4 CLASS	5 STREAMS	6 GRADE	7 TOTAL SCORES
26	M	17	10	S	HG	47
27	M	19	10	S	SG	31
28	M	18	10	S	SG	32
29	F	18	10	S	SG	42
30	M	20	10	S	SG	40
31	F	20	10	S	SG	52
32	M	20	10	S	SG	56
33	M	19	10	S	SG	55
34	M	19	10	S	HG	53
35	M	17	9	S	HG	48
36	M	19	9	S	HG	14
37	F	19	10	S	SG	40
38	F	19	10	S	SG	43
39	M	19	10	S	SG	36
40	M	21	10	S	SG	48
41	M	17	10	S	SG	576
42	F	16	10	S	HG	55
43	F	17	9	S	HG	39
44	M	18	9	S	SG	45
45	M	16	9	S	HG	38
46	M	19	9	S	SG	19
47	M	17	9	S	SG	57
48	F	20	10	S	SG	40
49	F	21	10	S	HG	41
50	M	21	10	S	SG	35

1 PUPILS	2 SEX	3 AGE	4 CLASS	5 STREAMS	6 GRADE	7 TOTAL SCORES
51	M	18	10	S	SG	44
52	M	18	10	S	SG	44
53	M	19	10	S	SG	47
54	F	21	9	S	SG	39
55	F	19	10	S	SG	40
56	M	19	10	S	SG	43
57	F	21	10	S	SG	39
58	F	21	9	S	SG	41
59	F	17	10	S	SG	50
60	F	17	10	S	SG	35
61	M	19	9	C	SG	46
62	F	17	10	S	SG	55
63	F	19	10	S	SG	39
64	M	16	9	S	HG	46
65	M	18	9	S	HG	32
66	F	20	10	S	SG	34
67	M	17	10	S	SG	47
68	F	18	10	S	SG	32
69	F	19	9	S	SG	45
70	M	20	9	S	HG	36
71	M	17	9	S	SG	33
72	M	18	9	S	HG	33
73	M	19	10	S	SG	47
74	M	17	10	S	HG	37
75	M	18	10	S	SG	43

1 PUPILS	2 SEX	3 AGE	4 CLASS	5 STREAMS	6 GRADE	7 TOTAL SCORES
76	F	19	10	S	SG	46
77	M	17	9	S	HG	50
78	F	21	9	S	SG	56
79	F	17	9	S	HG	31
70	M	18	10	S	HG	55
81	F	17	10	S	SG	47
82	F	20	9	S	SG	30
83	M	16	9	S	HG	35
84	M	20	9	S	HG	38
85	F	17	9	S	HG	49
86	M	17	9	S	HG	21
87	M	16	9	S	HG	30
88	F	16	9	S	HG	36
89	F	16	9	S	SG	42
90	F	19	9	S	HG	41
91	M	17	9	S	HG	36
92	M	17	9	S	SG	27
93	M	17	9	S	HG	37
94	F	20	9	S	HG	50
95	F	17	10	S	HG	52
96	F	18	10	S	SG	45
97	M	21	10	S	SG	48
98	M	19	10	S	HG	49
99	M	17	9	S	HG	40
100	M	19	9	S	HG	35

1 PUPILS	2 SEX	3 AGE	4 CLASS	5 STREAMS	6 GRADE	7 TOTAL SCORES
101	M	19	9	S	HG	37
102	M	18	9	S	HG	52
103	F	18	9	S	HG	45
104	F	17	9	S	HG	33
105	M	19	9	S	HG	29
106	F	15	9	S	SG	34
107	F	16	9	S	HG	25
108	F	19	10	S	SG	50
109	M	17	9	S	HG	32
110	M	19	9	S	HG	46
111	F	19	9	S	HG	31
112	M	19	9	C	HG	30
113	M	14	9	C	SG	38
114	M	20	9	C	SG	24
115	M	19	9	C	SG	12
116	M	19	9	C	SG	24
117	F	20	9	C	SG	33
118	M	16	9	C	HG	25
119	M	20	9	C	HG	18
120	M	20	9	C	HG	33
121	M	20	9	C	SG	16
122	F	20	10	C	SG	20
123	F	17	10	C	SG	23
124	F	19	9	C	SG	42
125	F	14	9	C	SG	34

1 PUPILS	2 SEX	3 AGE	4 CLASS	5 STREAMS	6 GRADE	7 TOTAL SCORES
126	F	18	9	S	SG	34
127	F	20	9	S	SG	8
128	M	19	9	S	SG	28
129	F	17	9	S	SG	31
130	M	19	9	S	SG	30
131	M	19	9	S	SG	40
132	F	17	9	S	HG	38
133	F	19	9	S	HG	35
134	M	16	9	S	SG	27
135	M	17	9	C	HG	26
136	M	19	9	S	HG	32
137	M	19	9	S	HG	54
138	M	18	9	C	HG	27
139	M	17	9	C	HG	26
140	M	20	9	C	HG	23
141	F	16	9	C	HG	43
142	F	16	9	C	HG	46
143	F	18	9	C	HG	57
144	F	18	9	C	HG	50
145	F	18	9	S	SG	31
146	F	18	9	C	HG	32
147	F	16	9	C	HG	34
148	F	18	9	C	HG	26
149	M	21	9	C	HG	31
150	M	20	9	C	HG	41

1 PUPILS	2 SEX	3 AGE	4 CLASS	5 STREAMS	6 GRADE	7 TOTAL SCORES
151	M	18	9	S	HG	36
152	M	18	9	S	SG	46
153	M	21	9	S	HG	44
154	M	17	9	S	HG	43
155	M	17	9	C	HG	37
156	M	17	10	C	HG	32
157	M	18	10	C	SG	49
158	M	18	10	C	SG	27
159	M	17	9	C	HG	30
160	M	16	9	C	HG	27
161	M	19	9	C	HG	34
162	M	18	9	C	HG	25
163	M	19	9	C	HG	18
164	M	21	9	C	HG	30
165	M	17	9	C	SG	46
166	F	19	10	C	SG	18
167	M	19	10	C	SG	10
168	M	19	10	C	SG	17
169	M	18	10	C	SG	14
170	F	15	10	C	SG	27
171	M	20	10	C	SG	25
172	M	20	9	C	HG	41
173	M	20	9	C	HG	18
174	M	19	9	C	HG	17
175	M	18	9	C	HG	28

1 PUPILS	2 SEX	3 AGE	4 CLASS	5 STREAMS	6 GRADE	7 TOTAL SCORES
176	F	17	9	C	HG	16
177	M	20	9	C	HG	36
178	M	17	10	C	SG	16
179	F	19	9	S	HG	29
180	M	19	10	C	HG	14
181	F	19	9	S	HG	44
182	F	18	9	S	HG	48
183	F	17	9	S	HG	52
184	M	21	9	S	SG	31
185	M	18	9	S	HG	35
186	M	17	9	S	SG	36
187	F	19	9	S	SG	51
188	F	15	9	C	SG	21
189	F	16	9	C	SG	38
190	M	17	9	C	HG	32
191	M	17	9	C	HG	27
192	F	17	10	C	HG	31
193	M	17	10	C	SG	20
194	F	16	9	C	SG	39
195	M	20	10	C	SG	26
196	M	18	10	C	SG	36
197	M	19	10	C	SG	32
198	M	17	9	C	HG	40
199	M	17	9	C	HG	28
200	F	19	9	C	HG	30

ANNUXURE H

Respondents' Particulars – Final Study

Column 1	=	Pupil's number
Column 2	=	Sex : M = Male ; F = Female
Column 3	=	Pupil's age
Column 4	=	Class : Standards nine and ten
Column 5	=	Streams : S = Science G = General C = Commerce
Column 6	=	Grade : SG = Standard Grade HG = Higher Grade
Column 7	=	Total Score = Tests A + B + C

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
1	M	19	10	S	HG	40
2	M	20	10	S	HG	56
3	M	21	10	S	HG	48
4	M	18	10	S	HG	26
5	M	21	10	S	HG	28
6	M	19	10	S	HG	40
7	F	17	10	S	HG	38
8	M	21	10	S	HG	34
9	M	19	10	S	HG	36
10	F	19	10	S	HG	26
11	F	19	10	S	HG	30
12	M	19	10	S	HG	32
13	M	17	10	S	HG	72
14	F	21	10	C	HG	22
15	F	19	10	C	HG	20
16	F	21	10	C	HG	24
17	F	21	10	C	HG	30
18	M	21	10	C	HG	18
19	F	17	10	C	HG	24
20	F	21	10	C	HG	26
21	F	19	10	C	HG	32
22	F	21	10	C	HG	30
23	F	21	10	C	HG	28
24	F	20	9	C	HG	16
25	F	19	9	C	HG	14

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
26	F	17	9	S	HG	34
27	F	17	9	C	HG	10
28	M	19	9	C	HG	36
29	M	19	9	C	HG	20
30	F	17	9	C	HG	20
31	F	17	9	S	HG	16
32	F	19	9	C	HG	22
33	M	21	9	S	HG	20
34	F	21	9	S	HG	20
35	F	18	9	S	HG	14
36	F	15	9	S	HG	20
37	M	19	9	C	HG	38
38	M	21	9	C	HG	38
39	M	18	9	S	HG	34
40	F	20	9	C	HG	13
41	M	20	9	C	HG	30
42	F	17	9	S	HG	28
43	M	20	9	C	HG	12
44	F	16	9	S	HG	30
45	F	21	9	C	HG	24
46	F	21	9	C	HG	22
47	F	16	9	S	HG	20
48	F	18	9	C	HG	22
49	M	20	9	C	HG	42
50	F	18	9	S	HG	14

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
51	F	16	9	S	HG	42
52	F	17	9	S	HG	26
53	F	17	9	C	HG	20
54	F	18	9	C	HG	34
55	M	20	9	S	HG	22
56	F	18	9	C	HG	14
57	M	17	9	S	HG	18
58	F	19	9	C	HG	17
59	F	21	9	C	HG	18
60	M	20	9	S	HG	28
61	M	17	9	S	HG	32
62	M	19	9	S	HG	27
63	M	17	9	S	HG	39
64	M	21	9	S	HG	35
65	M	21	9	S	HG	22
66	M	19	9	S	HG	13
67	F	17	9	C	HG	31
68	M	19	9	S	HG	35
69	M	20	9	S	HG	12
70	M	21	9	S	HG	29
71	M	17	9	S	HG	35
72	M	20	9	S	HG	41
73	F	21	9	S	HG	22
74	F	19	9	S	HG	16
75	F	19	9	S	HG	6

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
76	F	16	9	S	HG	20
77	M	20	9	C	SG	6
78	M	17	9	S	HG	22
79	F	17	9	S	HG	18
80	M	19	9	C	HG	40
81	F	18	9	C	HG	33
82	M	16	9	C	HG	47
83	M	20	9	S	HG	18
84	M	19	10	C	HG	32
85	M	20	10	S	SG	48
86	F	19	10	C	SG	36
87	M	18	10	S	HG	44
88	M	18	10	C	SG	54
89	M	21	10	C	HG	26
90	M	21	10	C	SG	24
91	M	18	10	S	SG	50
92	M	19	10	C	SG	28
93	M	17	10	C	SG	34
94	M	21	10	C	SG	62
95	M	20	10	S	SG	48
96	M	21	10	C	SG	16
97	F	21	10	S	SG	24
98	M	21	10	C	SG	20
99	F	17	10	C	HG	28
100	M	16	10	C	HG	56

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
101	M	21	10	S	SG	46
102	M	21	10	S	HG	44
103	F	21	10	G	HG	21
104	F	21	9	C	HG	22
105	F	20	9	G	HG	20
106	F	16	9	S	HG	18
107	F	21	10	G	HG	20
108	F	18	10	G	HG	28
109	F	19	10	G	HG	26
110	F	20	9	S	SG	20
111	F	20	9	S	SG	34
112	F	19	9	S	SG	25
113	F	18	9	S	HG	31
114	F	18	9	G	HG	30
115	M	17	9	C	HG	54
116	F	17	9	S	HG	46
117	M	20	9	S	SG	34
118	F	16	9	S	HG	22
119	F	17	9	G	HG	10
120	F	17	9	S	HG	14
121	F	18	9	S	HG	22
122	F	17	9	G	HG	6
123	F	21	9	G	HG	24
124	F	19	9	S	HG	20
125	F	19	9	S	HG	22

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
126	M	18	9	S	HG	10
127	M	17	9	S	HG	28
128	F	17	9	G	HG	28
129	M	18	9	S	HG	32
130	M	19	9	S	SG	29
131	M	19	9	S	HG	29
132	M	18	9	S	SG	25
133	M	19	9	S	HG	55
134	F	20	9	S	HG	12
135	F	16	9	S	SG	24
136	F	17	9	S	SG	18
137	M	19	9	S	SG	31
138	F	17	9	S	SG	12
139	F	16	9	C	SG	43
140	M	17	9	G	HG	32
141	F	19	9	S	HG	21
142	M	19	9	S	HG	14
143	M	16	9	G	HG	33
144	F	19	10	G	SG	18
145	M	19	9	S	HG	54
146	M	19	9	G	HG	14
147	M	17	9	G	HG	14
148	F	19	10	C	SG	9
149	F	17	10	C	HG	18
150	F	19	10	C	SG	17

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
151	M	17	10	S	SG	24
152	M	18	10	S	HG	43
153	M	16	10	C	HG	20
154	F	17	10	C	SG	8
155	F	17	10	C	HG	12
156	F	18	10	S	SG	4
157	M	20	10	C	SG	16
158	M	17	10	S	HG	20
159	M	18	10	S	HG	21
160	M	17	10	C	HG	40
161	F	19	10	C	SG	17
162	F	20	10	C	SG	21
163	M	18	10	C	HG	25
164	F	18	10	C	HG	19
165	F	18	10	S	HG	32
166	M	21	10	S	HG	22
167	M	18	10	S	SG	28
168	F	17	10	S	SG	15
169	M	18	10	C	HG	19
170	M	15	10	C	HG	6
171	M	17	10	S	HG	18
172	M	19	10	S	HG	31
173	M	19	10	S	HG	17
174	M	17	10	S	HG	26
175	M	16	10	C	HG	39

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
176	F	21	10	C	HG	6
177	M	21	10	C	HG	32
178	F	29	10	C	HG	10
179	F	27	10	C	HG	20
180	F	21	10	C	HG	12
181	F	21	10	C	HG	8
182	F	21	10	C	HG	4
183	F	19	10	S	HG	23
184	F	17	10	S	HG	24
185	F	19	10	S	HG	18
186	M	21	10	S	HG	16
187	F	18	10	S	HG	14
188	F	18	10	S	HG	20
189	F	18	10	S	HG	22
190	M	19	10	S	HG	18
191	M	21	10	S	HG	2
192	F	18	10	S	HG	22
193	F	16	10	S	HG	20
194	F	17	10	S	HG	12
195	M	17	10	S	HG	16
196	F	17	10	S	HG	26
197	M	21	10	S	HG	17
198	M	21	10	S	HG	22
199	F	17	10	S	HG	33
200	M	20	10	S	HG	17

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
201	F	18	10	S	HG	16
202	M	19	10	S	HG	35
203	M	21	10	C	HG	10
204	M	20	10	C	HG	12
205	M	20	10	C	HG	8
206	F	18	10	C	HG	37
207	M	16	10	C	HG	20
208	M	20	10	C	HG	4
209	F	19	10	C	HG	37
210	M	16	10	C	HG	6
211	M	17	10	C	HG	10
212	M	15	10	C	HG	18
213	M	21	10	C	HG	6
214	M	18	10	C	HG	4
215	M	19	10	C	HG	4
216	M	21	10	C	HG	6
217	M	21	10	C	HG	8
218	M	20	10	C	HG	16
219	F	17	10	C	HG	18
220	M	20	10	C	HG	10
221	F	20	10	C	HG	18
222	M	20	10	C	HG	29
223	F	17	10	C	HG	19
224	M	17	10	C	HG	39
225	M	18	10	C	HG	37

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
226	M	16	10	C	HG	39
227	M	19	10	C	HG	27
228	M	19	10	C	HG	21
229	F	21	10	C	SG	13
230	F	21	10	C	SG	12
231	F	19	10	C	SG	18
232	F	17	10	C	SG	22
233	F	17	10	C	SG	22
234	F	21	10	C	SG	13
235	F	18	10	C	SG	16
236	M	20	10	C	SG	10
237	F	19	10	C	SG	9
238	F	21	10	C	SG	14
239	M	18	10	C	SG	32
240	F	16	10	C	SG	31
241	F	16	10	C	SG	28
242	F	21	10	C	SG	18
243	M	21	10	C	SG	28
244	F	19	10	C	SG	18
245	M	21	10	C	SG	12
246	F	20	10	C	HG	28
247	F	17	10	C	SG	34
248	F	21	10	S	HG	34
249	F	18	10	S	HG	28
250	M	21	10	S	HG	44

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
251	F	18	10	S	HG	18
252	M	17	10	S	HG	43
253	M	18	10	S	HG	34
254	M	17	10	S	HG	54
255	F	21	10	S	HG	60
256	F	17	10	S	HG	46
257	M	20	10	S	HG	25
258	M	17	10	S	HG	30
259	M	19	10	S	SG	29
260	M	21	10	S	SG	22
261	M	21	10	S	HG	42
262	M	19	10	S	HG	32
263	M	16	10	S	HG	40
264	M	21	10	S	HG	52
265	M	19	10	S	HG	43
266	F	20	10	S	HG	45
267	F	17	10	S	HG	40
268	M	18	10	S	HG	43
269	M	20	10	S	HG	42
270	M	19	10	S	HG	28
271	F	18	10	S	HG	31
272	M	16	10	S	HG	29
273	M	18	10	S	HG	34
274	F	18	10	S	HG	50
275	F	10	10	S	HG	58

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
276	M	21	10	S	HG	40
277	F	19	10	S	HG	26
278	M	19	10	S	SG	19
279	M	19	10	S	HG	45
280	M	21	10	S	HG	34
281	M	17	10	S	HG	40
282	F	20	10	S	HG	38
283	F	19	10	S	HG	51
284	M	15	10	S	HG	48
285	M	17	10	S	HG	22
286	M	18	10	S	HG	28
287	F	21	10	S	HG	20
288	F	18	10	S	SG	24
289	F	18	10	S	SG	25
290	F	18	10	C	HG	26
291	F	18	10	C	SG	40
292	M	18	10	C	SG	42
293	F	16	10	C	SG	46
294	F	17	10	C	SG	52
295	F	19	10	C	HG	28
296	F	19	10	C	HG	28
297	F	18	10	C	HG	42
298	M	21	10	C	HG	30
299	M	21	10	C	HG	24
300	F	19	10	C	HG	30

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
301	F	19	10	C	SG	34
302	M	21	10	C	HG	22
303	F	19	10	C	HG	30
304	M	19	10	S	HG	52
305	M	21	10	S	HG	22
306	F	21	10	S	HG	54
307	F	19	10	S	HG	26
308	F	18	10	S	HG	64
309	M	21	10	S	HG	45
310	M	21	10	S	HG	62
311	F	18	10	S	HG	74
312	F	20	10	S	HG	44
313	F	21	10	S	HG	40
314	M	20	10	S	HG	58
315	M	21	10	C	HG	38
316	M	16	10	S	HG	28
317	M	19	10	S	HG	17
318	M	17	10	S	HG	36
319	M	18	10	S	SG	20
320	M	18	10	S	SG	12
321	M	19	10	S	SG	10
322	M	20	10	S	SG	21
323	M	17	10	S	SG	8
324	M	18	10	S	SG	18
325	M	20	10	S	SG	10

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
326	F	16	10	C	HG	46
327	F	16	10	C	HG	44
328	F	19	10	C	HG	42
329	F	18	10	C	HG	47
330	M	18	10	C	HG	51
331	F	21	10	C	HG	45
332	F	20	10	C	HG	48
333	M	17	10	C	HG	50
334	F	17	10	C	HG	46
335	F	16	10	C	SG	32
336	F	17	10	C	HG	62
337	F	18	10	C	HG	50
338	F	18	10	C	HG	45
339	F	17	10	C	HG	55
340	F	17	10	C	HG	33
341	F	20	10	C	HG	45
342	F	17	10	C	HG	34
343	F	21	10	S	HG	48
344	F	18	10	S	HG	54
345	M	17	10	S	HG	67
346	F	18	10	S	HG	42
347	F	21	10	S	HG	24
348	M	21	10	S	HG	22
349	F	16	10	S	HG	34
350	M	21	10	S	HG	27

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
351	F	18	10	S	HG	41
352	M	17	10	C	SG	34
353	M	20	10	C	HG	36
354	F	18	10	C	HG	30
355	F	16	10	S	HG	41
356	F	15	10	S	SG	20
357	F	20	10	S	HG	20
358	M	21	10	S	HG	20
359	F	19	10	S	HG	34
360	F	19	10	S	HG	34
361	F	21	10	S	HG	20
362	M	17	10	S	HG	30
363	F	21	10	S	HG	31
364	M	19	10	S	HG	20
365	F	18	10	S	HG	30
366	M	20	10	C	SG	16
367	M	18	10	C	HG	22
368	F	19	10	C	SG	18
369	M	18	10	C	HG	20
370	M	19	10	C	HG	26
371	F	20	10	C	SG	14
372	F	17	10	C	SG	22
373	F	18	10	C	SG	14
374	M	17	10	C	SG	40
375	M	19	10	C	SG	10

1 PUPIL	2 SEX	3 AGE	4 CLASS	5 STREAM	6 GRADE	7 TOTAL SCORE
376	F	19	10	C	SG	20
377	F	19	10	C	SG	30
378	F	19	10	C	SG	22
379	M	21	10	C	SG	4
380	F	16	10	C	SG	28
381	M	21	10	C	SG	14
382	M	21	10	C	SG	12
383	F	19	10	C	HG	26
384	F	17	10	S	HG	32
385	F	17	10	S	HG	34
386	M	21	10	S	HG	14
387	F	20	10	S	HG	22
388	F	16	10	S	HG	30
389	F	16	10	C	HG	49
390	F	20	10	C	SG	18
391	F	19	10	C	HG	14
392	F	21	10	C	HG	22
393	M	19	10	C	SG	38
394	F	18	10	C	HG	36
395	F	19	10	C	SG	33
396	F	16	10	C	SG	34
397	M	19	10	C	HG	32
398	F	19	10	C	SG	28
399	M	17	10	C	SG	9
400	F	17	10	C	SG	36