THE NEED FOR A MULTICULTURAL APPROACH TO MATHEMATICS CURRICULUM DESIGN FOR THE SENIOR SECONDARY SCHOOL PHASE: A CASE STUDY CONDUCTED AT THE WOOLHOPE SECONDARY SCHOOL, PORT ELIZABETH

THESIS

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ABSTRACT

Multicultural countries such as England have recognised the need to multiculturalise their mathematics curricula to cater for the needs of all ethnic/cultural groups, to encourage racial harmony and have pupils of a specific culture learn about, and accord respect to, another culture (Duncan, 1986; Dyson, 1986; Gilbert, 1984)

However, in South Africa, a multicultural country with its large Black majority, such an approach has not been given the necessary attention. Laridon (1990) has criticised the way in which curriculum development in mathematics is conducted in South Africa. He describes it as a "top-down" approach and based on input from non-representative samples of teachers and not taking into account the needs of all cultural groups in South Africa. He criticises the manner in which topics are added to or removed from the syllabus and calls this "syllabus tinkering".

With a number of, mostly English medium, schools opening their doors to all races, it is possible that certain cultural groups are at a disadvantage when compared with others if modifications to the syllabus, to accommodate their needs, are not made.

This study is a small scale case-study, conducted at Woolhope

Secondary, a predominantly Indian school, but with a significant number of Black pupils (approximately 25%). The study focusses on the need for a multicultural approach to mathematics curriculum design. The views of the senior mathematics pupils and mathematics teachers are considered in this regard, and together with the relevant literature, broad guidelines for a multicultural mathematics curriculum design in South Africa are suggested.

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CHAPTER 1: INTRODUCTION - RATIONALE FOR DOING THE RESEARCH

1.1 Opening of schools

This study was prompted by the opening of a number of of mostly English-medium white government schools to all races from January 1991. One of the problem areas with regard to the opening of the schools is that the Department of National Education stipulated that the cultural norms and values be essentially 'white' and 'Christian National' in character (Bot,1990). However, due to the rapid pace of change this may no longer be the case although the legacy of past practices still lingers on.

The Education Departments, presently under the Houses of Delegates and Representatives, which administer so-called 'Indian' and 'Coloured' education have also opened their doors to all races.

Under the so-called 'Apartheid' system, schools under the control of the government were separated with each race group having its own schools. With significant changes over the last two years, the schools have become 'mixed', with pupils from different cultural and racial backgrounds being enrolled at the same schools.

1.2 Teaching of subject matter

With schools becoming multicultural in nature, teachers may face the task of integrating new syllabus material while handling existing material in an imaginative manner. Teachers may have to reassess their teaching methodology in classes which have pupils from different cultural groups. This study focusses on mathematics teaching. Teaching the present mathematics syllabus in the same traditional way may pose problems to those in the minority cultural group in a specific class. Questions may be raised about the composition of the present mathematics syllabus and how it should be modified or adapted to suit multicultural classrooms. The extent to which having English as a second or third language affects performance in mathematics needs to be examined in the South African context. Other questions may also be posed. How will or should teachers adapt their teaching styles, methods and approaches in a multicultural mathematics class? How will pupils of different cultural backgrounds work together and socialise in the mathematics classroom?

1.3 Purpose of the study

The purpose of this study will be to develop broad guidelines and make recommendations for a multicultural mathematics curriculum at the senior secondary level. It is important, therefore, to examine the the concept of multicultural education. There is a need also to consider the importance of mathematics as a school subject.

1.4 Multicultural education - definition

Multicultural education was defined by the National Council for the Accreditation of Teacher Education (NCATE) in the U.S.A. in its standards as early as 1977. This body defines multicultural education as a process of preparing individuals for the social, political and economic realities which they will and do experience in culturally diverse and complex human encounters. Through this process the individual develops competencies for perceiving, believing, evaluating and behaving in different cultural settings to become more responsive to the conditions of all human beings, the cultural diversity of the individual and the diversity of the society.

1.5 Education, social structure and culture

An educational system does not exist in an historical vacuum. It is an integral part of a specific social structure by which it is profoundly shaped. A social structure, further, is not a homogeneous whole but is composed of different classes, religions and communities. Of the diverse and even conflicting cultures that are found in any lively society, one generally acquires dominance. It is presented as the culture of that society and is embodied in its legal, moral, political, economical, educational and other institutions and becomes its official or dominant public culture. The educational system disseminates the dominant culture among the young and ensures its preservation and reproduction across the generations. Its structure, organisation, ethos, pedagocical techniques, its view of what constitutes knowledge and what is worth teaching are all profoundly shaped by the dominant culture. The school is an authoritarian institution in the sense that the teachers wield both intellectual and legal authority. They know the subject matter whereas their pupils do not and they have the power to punish and discipline their pupils. By deciding to teach 'X' rather than 'Y' they proclaim that topic 'X' is worth studying and 'Y' is not. Similarly by teaching 'X' in a certain manner, they imply that this is the only correct way of looking at it.

Education then is not culturally neutral. Its intellectual content and orientation is permeated by the world view characteristic of the dominant culture. Further, education is not apolitical either. It cultivates specific attitudes and values.

1.6 Mono-cultural education

A mono-cultural educational system, which for long has characterised the South African situation, is not an ideal way of stimulating creativity and independent thinking in a school pupil and is fraught with many areas of concern. Some of these according to Parekh (1986) are:

1) It is unlikely to awaken the pupil's curiosity about other societies and cultures, either because the pupil is not exposed to them at all or because they are presented in uncomplimentary terms.

2) Mono-cultural education is unlikely to develop the faculty of imagination. Imagination represents the ability to conceive alternatives; that is, it is the capacity to recognise that things can be done, societies can be organised and activities can be performed in several different ways of which the most familiar is but one and not necessarily the best.

3) Mono-cultural education may stunt the growth of the critical faculty. A child taught to look at the world from the narrow perspective of one culture and not exposed to any other may reject all that cannot be accommodated within the narrow categories of one way of looking at the world.

4) Mono-cultural education tends to breed arrogance and insensitivity. The child who is not encouraged to

study other cultures and societies, to study them with sympathy and imagination cannot develop a respect for them.

5) Mono-cultural education provides a fertile ground for racism. A pupil who knows very little about other societies and cultures can only respond to them in terms of superficial generalisations and stereotypes. These in turn are not haphazard products of an individual imagination but are culturally derived. A culture not informed by a sensitive appreciation of others cannot but judge them in terms of its own norms. The Victorians built up a hierarchy of human societies; they placed Africans at the bottom, Asians a little higher, the Mediterraneans still higher and so on until they got to the English whom they regarded as representing the highest stage of human development (Parekh, 1986).

1.7 Multicultural education and democracy

Multicultural education is an attempt to release a child from the confines of one culture and to awaken the child to the existence of other cultures, societies and their way of life. It is an education in freedom - freedom from inherited biases and narrow feelings and sentiments as well as freedom to explore other cultures and perspectives and make one's own choices in full awareness of available and practicable alternatives. The author firmly believes that multicultural education should be an integral part of an educational dispensation for a 'new', democratic South Africa.

Cohen and Manion (1983) describe a democratic society as one which protects and provides opportunities for ethnic pluralism. This clearly fits in with multicultural education. According to Banks (1981), cited in Cohen and Manion:

1) Ethnic diversity should be recognised and respected at individual, group and societal levels:

   - In schools pupils should have access to resource materials that provide accurate information on all aspects of the different ethnic groups.
   - Learning centres, libraries and resource centres should provide comprehensive resources on the history,literature, music and arts of different ethnic groups.

2) Ethnic diversity provides a basis for societal cohesiveness and survival:

   - The policies and procedures of the school should foster positive multicultural interaction among pupils, teachers and ancillary staff.
   - Every school requires rules and regulations to

guide behaviour and achieve its specified goals. One such goal is to encourage harmony and understanding among different ethnic groups.

3) Equality of opportunity should be afforded to members of all ethnic groups:

. School staff members should reflect the ethnic pluralism within society and staff development programmes should be a mandatory feature of school life.

Although there may be good reasons why it may not be so, it is desirable that members of different ethnic groups be a part of school life. This means not only among teaching staff but also among the administrative and ancillary staff, for all can make an important contribution to the multicultural environment. However, while there are different departments of education in South Africa, this may take a longer time to attain. It is possible that a single ministry of education may speed up this process.

The focus should be on helping staff to:

. Clarify and analyse their feelings on, attitudes to and perceptions of their own and other ethnic groups.

. Acquire knowledge and understanding of the historical experiences and characteristics of the different ethnic groups.

- Improve their instructional skills particularly with respect to the multicultural context.
- Develop their skills in creating, selecting and evaluating appropriate instructional materials.
- Develop curricula in so far as they relate to multicultural needs.

4) Ethnic identification should be optional for individuals.

1.8 Multicultural education and the curriculum

Multicultural education is most relevant in curriculum matters. A curriculum conceived in a multicultural perspective has two features. First, it is not unduly narrow. No curriculum can cover all aspects of a subject and must of necessity be selective. Selection based on a multicultural perspective would aim to ensure that the child acquires some familiarity with the major representative forms of the subject in question and while the child would concentrate on some, the child's curiosity would be sufficiently stimulated to lead the child to follow up the rest independently. Second, the curriculum should be taught in a manner that is as little biased and dogmatic as possible. The teacher needs to be cautious when teaching pupils who do not belong to the same cultural group as the teacher. The teacher should elucidate their beliefs and practices with sympathy and sensitivity and give an account of them as close as possible to one that would be given by someone belonging to their cultural group; ideally the teacher should let the culture speak for itself.

Multicultural education in schools is about what happens via the curriculum whether planned or hidden. A good education cannot be based on one culture alone and should therefore be multicultural by definition. It should enable pupils to understand their own society and culture and to know about other societies and cultures to enhance that understanding.

1.9 The importance of mathematics as a school subject

One of the most important subjects in the school curriculum is mathematics. Mathematics is the foundation of science and technology and serves as a key to opportunity and careers. Education in any discipline helps students learn to think, but education must also help students take responsibility for their thoughts. While this objective applies to all subjects, it is especially appropriate in mathematics education because mathematics is an area in which children can solve a problem and have confidence that the solution is correct - not because the teacher says it is, but because its inner logic is so clear. Mathematics offers special opportunities for children to learn the power of thought as distinct from the power of authority. This is a very important step in the promotion of independent thinking.

School mathematics has a strong service element. It serves to equip students to study other subjects and also helps them to cope with mathematical demands and problems which they encounter out of school. These are usually qualitative judgements concerning taste, desirability, pride, etc., as well as probabilistic arguments involved in asking questions such as 'Can I afford to ...?', 'Is it time to trade in ...?', 'Which should I buy ?', etc. This raises the question of whether or not the utility of mathematics is best demonstrated in mathematics lessons, in the form in which they currently exist.

Unlike other occupations, mathematicians tend to mature and achieve fame at an earlier stage in their lives. The pupil at school can act as a mathematician. There are various mathematics competitions and olympiads in which a pupil can participate and demonstrate his problem solving skills as a mathematician. It has been observed that in the International Mathematical Olympiads (IMOs) the participants act as problem solvers and it is in this area that outstanding talent is most readily displayed.The ability to acquire and restructure mathematical knowledge, to see new order and connections in what were formerly disparate parts of mathematics, is a different kind of mathematical talent. Yet, attention can still be given at school level to these aspects of mathematics. Pupils can be alerted to and given examples of the way in which mathematicians search for common structures and they can be encouraged to record their mathematics and develop the skills of writing and talking about the subject.

Pupil motivation to study mathematics will hinge on two aspects, namely, 'profit' and 'pleasure' (Howson and Wilson, 1986). The profit to be derived from studying mathematics is too often thought of in an extra-mathematical sense; learning mathematics can be seen as a means of satisfying 'entry' requirements, of gaining necessary qualifications to enter the competitive job market. This is a legitimate type of motivation to use, but if it is the sole motivation then it will seriously distort mathematics teaching. 'Profit' must be tied with more mathematical ends. Pupils must appreciate that with mathematical knowledge and understanding they acquire desirable power. They must learn that mathematics can help in the solution of their problems and in their own decision making.

Pleasure is too infrequently associated with school mathematics. When it does occur it is often the pleasure that the pupil gets when the pupil has grasped a technique, when the pupil can readily acquire ticks, marks and the teacher's favour. This is justifiable but 'success' can also bring pleasure of a deeper, more aesthetic nature. 'Pleasure' must not only be provided for students; it is equally important that curricula are such as to encourage teachers to obtain 'pleasure' from their work (Howson and Wilson, 1986).

1.10 The cultural biases of science and mathematics

Science and mathematics teachers have often endorsed the multicultural curriculum as a worthy goal but not applicable to their subjects (Duncan, 1986).

These areas are regarded as culture free and neutral in their presentation. However, several writers such as Nickson (1989) and Presmeg (1988) have countered this notion. These subject areas can make a significant contribution in altering the prejudiced and stereotyped preconception held of non-white groups.

For example, in a Biology lesson on genetics to mostly Black pupils the teacher may use the terms 'blue eyes', 'pink skin', 'blond hair', etc. Close attention to the language and illustrations used in a science lesson will soon put paid to the idea of neutrality. Science teachers should be more selective about the types of textbooks and other teaching materials needed in order to avoid the stereotyping image of Black people. Science lessons could do much to explode some of the myths popularised about race genetics and evolution theory. Science curricula are biased towards a European/North American viewpoint ignoring both the current and historical contributions of Africans, Indians, Chinese and Arabs.

Mathematics teachers can draw upon the history of mathematics by way of illustration at the appropriate times during mathematics lessons to enable pupils to get a sounder perspective on the nature of mathematical activity. It should be realised that this science has developed and is still developing out of the efforts of various societies to come to terms with some of the numerous problems with which they have been faced. The horizons of the traditional ethnocentric approach to mathematics could be extended to include the contributions of the various societies in the development of mathematics.

A further discussion on the use of history of mathematics in teaching and the contributions made by various cultural groups in the development of mathematics is outlined in chapter 5, section 5.8.2, pages 84-88.

1.11 Goals for mathematics in the senior secondary phase

The National Council of Teachers of Mathematics (NCTM), 1989, in America has listed five general goals for pupils in mathematics in the senior secondary phase:

1) **They learn to value mathematics**

The experiences of pupils should be numerous and varied and related to the cultural, historical, and scientific evolution of mathematics. This will enable them to appreciate the role of mathematics in the development of contemporary society and explore relationships among mathematics and the disciplines it serves: the physical and life sciences, the social sciences, and the humanities. Throughout the history of mathematics, practical problems and theoretical pursuits have stimulated one another to such an extent that it is not possible to separate them. Today, as theoretical mathematics has diversified and become more complex and abstract, it has also become more concrete and vital to our technologically oriented society. The intention of this goal is to focus attention on the need for pupil awareness of the interaction between mathematics and the historical situations from which it has developed and the impact that interaction has had on our culture and our lives.

2) <u>They become confident in their ability to do mathematics</u>

As a result of studying mathematics, pupils need to use their growing mathematical power to make sense of new problem situations in the world around them. Pupils should realize that doing mathematics is a common human activity. With numerous and varied experiences students are able to trust their own mathematical thinking.

3) <u>They become mathematical problem solvers</u>

Each pupil has the ability to solve problems and should be given the opportunity to develop this ability. In so doing, the pupil becomes a productive citizen. The focus of school mathematics should be problem solving. To develop problem solving abilities, pupils need to work on problems that may take hours, days, and even weeks to solve. Some problems may be undertaken independently while others may involve group work or the entire class working co-operatively.

4) <u>They learn to communicate mathematically</u>

The development of a pupil's power to use mathematics involves learning the signs, symbols, and the terminology of mathematics. This is best accomplished in problem situations in which pupils have an opportunity to read, write, and discuss ideas in which the language of mathematics is used. In the communication of their ideas, pupils can learn to clarify, refine, and consolidate their thinking.

5) **They learn to reason mathematically**

Making conjectures, gathering evidence, and building an argument to support such notions are fundamental to doing mathematics. The emphasis should be more on good reasoning than the ability to get the correct answer.

These goals are set with the intention of pupils becoming mathematically literate. This denotes an individual's ability to explore, to conjecture, to reason logically, and to use a variety of mathematical methods to solve problems. In the process of becoming mathematically literate, their mathematical power should develop.

Although such goals have been formulated by the NCTM in America for American pupils, such goals may also have relevance for South African pupils. Developers of new mathematics curricula in South Africa may be able to adapt the goals outlined for the South African situation.

Everyone depends on the success of mathematics education;

everyone is hurt when it fails. It is vitally important for all the citizens of a nation to benefit equally from high quality mathematics education. The widening gap between those who are mathematically literate and those who are not tends to coincide with racial and economic categories ("Everybody counts", 1989). The consequences of this can be disastrous for the economic well-being and race relations in a country such as South Africa.

Pupils who are successful in mathematics at school are likely to be able to pursue scientific and professional careers. If, without dropping standards, more students of all races are going to be successful in mathematics then the mathematics curriculum has to be re-examined and adapted to meet multicultural needs.

CHAPTER 2: LITERATURE SURVEY

2.1 Mathematics and its social responsibility

In the last ten years or so there has been concern about the social responsibility of scientists. Radical scientists have come to realize that the fruits of technology and science are not ethically or morally neutral in view of their potentially enormous power. However, this has not occurred in mathematics The view that mathematics is neutral with regard to social and political issues is an isolationist one which divorces mathematics from its social and political context.
Ernest (1989) found that in an official survey of 10% of English schools, 78% of the mathematics departments sampled were criticised for their lack of co-operation with other subjects. This illustrated the isolation of mathematics and mathematicians.

Ernest (1989) lists four ways in which mathematics is linked to its social and political context: the military aspect of the mathematical sciences, the monoethnicity and sexism of mathematics, the dehumanization of mathematics, the use of mathematical abstraction to dehumanize social issues.

The military associations of mathematics include the study of projectiles and ballistics, and the development of miniaturized computers as on-board guidance systems for missiles. Without military funding the computer revolution would not have taken place, and the superpowers' military capabilities owe as much to mathematics for their computer networks and control and communications systems as they owe to nuclear physics.

The divorce of mathematics from its social context leads to monoethnic, sexist and possibly even racist, mathematics. The mathematics taught in schools is often presented as the product of White Western men.

Mathematics is said to be isolationist as a result of its dehumanization. The classical philosophies of mathematics ignore the role of humanity in creating mathematics. The traditional philosophical questions addressed are: What are the objects of mathematics? What is the basis of mathematical truth? These questions ignore the human involvement in mathematics.

Mathematics is said to be isolated or separatist as it is used to dehumanise social issues. One of the characteristics of mathematics is the intrinsic role of abstraction. A training in mathematical and abstract thought allows social decision makers to consider and adjudicate social issues without feeling the human consequences of their decisions. Mathematics tends to focus on quantity rather than quality.

A person's IQ score is highlighted rather than that person's intelligence. Numerical scores are used to represent academic achievement.

In the field of economics we have the rate of inflation, percentage wage increases, profitability and cost accounting, productivity and the financial calculations of the IMF. These concepts are used to make decisions which materially affect the lives of millions of people.

Gilligan, cited in Ernest (1989), has distinguished between 'separatist' and 'connectivist' modes of reasoning. The separatist approach has just been discussed. The 'connectivist' approach examines the full social context surrounding a moral issue. Ernest proposes that a more 'connectivist' approach to the social significance of mathematics be adopted.

2.2 Ethnomathematics

Bishop has raised the issue of social construction of meaning in mathematics, and reports that simple actions such as counting on the fingers differ regionally. He noted many examples of cultural differences in significant mathematical conceptual structures (Woodraw, 1989).

In any social group there exists a great variety of tools for classifying, ordering, quantifying, measuring, comparing, dealing with spatial orientation, perceiving time and planning activities, logical reasoning, and so on. Although these are mathematical activities, the tools are not usually mathematically explicit. However, they constitute the basic components of mathematical behaviour and should be developed. D'Ambrosio, cited in Woodraw (1989), argues that the very learning of mathematics creates a conflict with the 'natural' or 'folk' processes which the learner might utilize; he calls this 'ethnomathematics'. The mathematics with which a child first comes to school will contain elements of such ethnomathematics. However, in traditional primary school education such ethnomathematical knowledge is largely ignored. This is in sharp contrast to the teaching of language where the teacher deliberately uses what the children know and feel in order to develop their linguistic skills.

Bishop and Pompei (1991) describe a research study in Brazil concerning the influence of an ethnomathematical teaching approach on teacher attitudes to mathematics education. The teachers preferred views were that:

1) Mathematics should be seen as an exploratory and explanatory subject, investigating situations.

2) The mathematics curriculum should be formative, emphasising analysis, synthesis, thinking, a critical stance, understanding and usefulness.

3) Teachers should teach mathematics as a debatable subject where mathematical knowledge is discussed among pupils and teachers.

4) Pupils should be able to analyse problems, and understand the structure of problems.

Visser (1991) looks at ethnomathematics on two levels. On one level it may be referred to as 'mathematics in the environment or mathematics in society'. On another level it may be viewed as a method of presenting mathematical concepts embedded in everyday lifestyles of different cultural groups and societies. Ethnomathematics is an attempt to change the status of mathematics from an elitist subject in which only a few privileged individuals participate to a subject for all. Visser lists the following ways in which ethnomathematics tries to democratize mathematics:

- redefining school mathematics
- acknowledging the needs of under-represented groups in present mathematics curricula
- building up self confidence and positive attitudes in

mathematics

- reducing Eurocentrism in mathematics education
- overcoming cultural, social, political, and economic oppression transmitted in present mathematics curricula
- demonstrating that mathematical practices can emerge out of the real needs and activities in society
- expanding the curriculum so that it includes skills essential for development in all communities and societies.

Ethnomathematics is an important component of mathematics and its relevance in the South African context should be given recognition by mathematics curriculum developers in South Africa.

Woodraw (1989) notes that the attempt to convey ideas and concepts to the learner must take place using the metaphor and imagery available to the learner and these are clearly the consequences of the society and culture within which the learner lives. Mathematics exists within the compulsory curriculum because it is effective in educating pupils; the creation of mathematicians is a secondary consideration. There is also a need for mathematics education to relate to people.

Mathematics teachers have asked what they can do to contribute to a genuinely pluralist society which is free from racism. Woodraw (1989) outlines the following which identifies with this goal; pupil-centred learning styles, the need to develop ideas from those which pupils already hold, active rather than passive learning, problem-centred objectives, group work and methods using the power of discussion.

2.3 <u>Mathematics, culture and Eurocentrism</u>

Woodraw (1989) comments on the inclusion of aspects such as Islamic art patterns, Rangoli patterns, Vedic arithmetic, etc. in the mathematics curriculum. All topics provide excellent opportunities for mathematical activity and belong in the mathematics curriculum without requiring the justifications of multicultural concerns. The Eurocentric view commonly held with regard to the development of mathematics must be countered. According to Woodraw (1989), most English people tended to think that mathematics started with the Greeks and gradually moved up north. Although they acknowledge the early contributions of the Chinese and Indian mathematicians, they feel that this was a long time ago and tend to indirectly question what they have done since. Such attitudes are at the centre of the issue of multicultural mathematics and concern the views and attitudes of teachers rather than pupils. In a culturally mixed classroom it is important that pupils bring their own cultures into the classroom and that those cultures are acknowledged and respected. The mathematics lesson becomes more pupil-centred and leads to a constructivist view of learning. This is particularly important with younger children who are less likely to impose their own views than those presented.

In presenting pictures, images and illustrative references, it is important that teachers should not present only those that come from their own experiences. Where a classroom is monocultural the significance of presenting alternative images and viewpoints takes on quite a different but no less important aspect. It is particularly in such classrooms that open and accepting attitudes to alternative ideas and customs need to be fostered and encouraged. It is possible that such situations may give rise to racist and discriminatory comments and attitudes. It is important that schools have rules and regulations to deal with such situations, since without such professional support teachers may seek to suppress rather than expose such views which unless made public are difficult to change.

As South Africa evolves into a non-racial society, there is a need for openness and constructive debate in the classrooms. Mathematics teachers may play an important role in presenting alternative viewpoints to pupils and encouraging pupils to examine and investigate problems from a non-racial perspective.

2.4 The formal nature of mathematics and multiculturalism

The 'formalist' view of mathematics where it is accepted as as unchallengeable, received knowledge is firmly grounded in logical positivism (Nickson, 1989). According to Lakatos, cited in Nickson (1989), this allows a view of mathematics in formal systems to dominate at the expense of a more open and exploratory interpretation. He describes those having such a view as 'dogmatists' who see mathematical ideas as having been 'purged of all the impurities of earthly uncertainty'. If mathematical knowledge is by definition pure and unadulaterated then the task is to see that it is received as such and it is not tampered with. This suggests that any changes in the mathematics curriculum to accommodate cultural differences of learners is unlikely to be of a very fundamental nature but rather of a superficial kind. This approach can be seen in attempts to adopt a multicultural approach to the curriculum which set out to provide different cultural contexts for traditional types of mathematical problems. The words change but content and methodology remain the same.

Another approach is to introduce the history of mathematics, and thus show its multicultural nature by identifying the important roles played by the Chinese, Indians and Mayans, and not to leap in time from the Greeks to Western culture in the development of mathematics.

Zaslavsky (1970) describes the traditional mathematics used in Black Africa. There is evidence to show that mathematics was used in the complex and highly organised societies in Black Africa over the past 3000 years. Zaslavsky mentions the stable agricultural societies in Africa which required the evolution of a calendar and the development of a system of weights and measure. Evidence to show the advanced nature of certain societies in Africa includes the ancient practice of hillside terracing still found in Ethiopia and the building of pyramids and temples which required the use of geometry. Geometry must have also been used in the construction of elliptical temples and other stone buildings in Zimbabwe. Thus, one can also note the important contributions made by Africa in the development of mathematics.

2.5 <u>Mathematics and cultural influences</u>

Nickson (1989) views mathematics as being 'culture-bound' as opposed to 'culture-free'. The essential difference from that of the formalist perspective lies in accepting that mathematics is founded in social activity and humam intercourse as is any other kind of knowledge. Cultural influences must be recognized both at the broad societal level and at the level of the individual. Although one may look for aspects of different cultures to exemplify mathematical ideas, it is important to find out how their cultural perspective may affect their mathematical mode of thought.

This is being done at a national level, for example, in Mozambique where the mathematics embedded in local cultural activities (such as basket-weaving) is used as the foundation for curricular activities.

Presmeg (1988) reports that the idea that the home culture of the child may influence the way in which he or she learns mathematics in school is one which is becoming important to mathematics educators in many parts of the world.

Industrialized countries tend to reflect the nature of their multicultural societies in their school curricula. In Papua New Guinea, Mozambique and Iran there is a tendancy to reject a 'colonial' or 'western' educational experience in favour of an education which fits in with the home culture of the society. This is also the case in the mathematical educational experience of Aborigines, Amerindians and

Eskimos. There is also growing awareness of the important role which 'ethnomathematics' may have to play in the mathematical education of pupils in schools.

All these issues are particularly relevant in the South African situation with its diversity of cultures and ethnic groups. However, the mathematics taught at schools in South Africa was developed in and for a particular culture and the hidden assumptions and cognitive patterns of that culture are implicit in the subject itself. Pupils from a different cultural background may not have access to these patterns and assumptions but would have access to those implicit in their own culture.

2.6 Mathematics instruction in a second language

The Cockcroft Report (1982) revealed that there was a considerable increase in the number of pupils at school in England who came from home backgrounds where English was not the first language. The report proposed that these pupils should take part in oral work to assist in the development of general language skills and also to enable them to become familiar with the language which is used in mathematics.

Presmeg and Frank (1990) investigated the effects of family cultural background and home language on the learning of mathematics and any modification to these effects which may result from prolonged multicultural schooling. They found that prolonged multicultural schooling tended to reduce the differences between English home language pupils and those for whom English is not the home language. They concluded that a shared school experience provides sufficient elements of a common culture to make it possible to use a common mathematics curriculum.

Brodie (1989) criticised the fact that black pupils in South Africa are taught through the medium of English, use English texts and write their examinations in English. Many pupils experience difficulties in understanding their teachers and the material and struggle to express themselves in English. Brodie found that learning in a foreign language can result in serious cognitive difficulties. Brodie contends that the bilingual education policy in South Africa has not had satisfactory results, whether with regard to the level of English competence among students or their success in other academic subjects, especially mathematics.

In South Africa where there is a shortage of qualified mathematics teachers, the textbook assumes an important role in assisting pupils to learn mathematics. It is therefore, important for pupils to enjoy using their textbooks and to be able to use them successfully. For bilingual pupils both of these factors are sure to be related to the kind of language in which the text is written. Whether the text is written in the pupils' first or second language, an important factor is readability. Berry, cited in Brodie (1989), noted that even when the medium of instruction, for pupils learning in the African context, is the venacular, the curricula, methodology and materials are heavily influenced by Western educational ideas. The curriculum materials are often translated into the particular African language. Thus, African pupils are using texts which are linguistically and culturally remote. Any meaningful educational experience must build upon the natural cognitive modes of the children in question. Berry emphasises the need for members of the same language and cultural community as the learners to be integrally involved in the drawing up of curricula and the writing of texts.

Brodie (1989) concludes that the desirability of second language learning in mathematics depends on various factors, including the emphasis on maintainance of first language skills, the acknowledgement of the natural thought modes of the child, as determined by the child's first language and home culture, and the interaction of these with concept formation and mathematical symbolism. In order to ensure meaningful mathematics learning there must be explicit teaching of the language of mathematics with due emphasis on concept formation.

Language is thus a crucial factor. The experience in independent schools in South Africa has been that the work of Black pupils improves dramatically when they are given support programmes in English, and their examination marks are much better when they are allowed to check with invigilators if their interpretation of questions is correct (Henning, 1990).

2.7 Mathematical discussion in the classroom

Brodie (1991) emphasised the need for mathematical discussion in mathematics lessons. She attempted this with her Std. 6 class which was a mixed ability group. The students were able to verbalise and hence clarify their thoughts and to communicate them to others. At the same time she was able to listen to the students and became more aware of their difficulties and misconceptions. The classroom discussions were extremely useful in developing mathematical ability in students. She found that the interaction of language and mathematics could create problems. Sometimes introducing new terminology in mathematics lessons may provide obstacles to learning. Brodie used the following techniques and activities to try and integrate language and mathematics:

1) Holding mathematics discussions.
2) Explicitly teaching mathematical language.
3) Developing concepts before naming them.

4) Encouraging students' questions.

5) Asking open-ended questions.

6) Teaching the history of mathematics.

7) Encouraging students to write down explanations and to write about mathematical ideas.

8) Encouraging students to verbalise their sense of pattern and generality before using symbols.

2.8 School influences and mathematics education

Research in England has shown that school influences play an important role in the school performance of minority ethnic groups, and that some school processes can disadvantage ethnic minority students who do not necessarily enter school with educational disadvantages, but who fall behind because of the way schools interact with them. This problem could be prevalent at schools in South Africa which have recently opened their doors to all races. This problem could be resolved by adopting a multicultural approach to education. Although such an approach could be applied to all subjects, its influence on mathematics education could be far reaching and enable mathematics to become accessible to students of all race groups and not the domain of an elitist few.

Dyson (1986) outlines the following justifications for a multicultural approach to mathematics teaching in England:

"1. It enables ethnic minority children to see themselves in a more positive way.
2. It enables indigenous white children to see their ethnic minority peers in a more positive light.
3. It encourages greater harmony amongst the races.
4. It contributes to the concept of equality in education.
5. It provides new ways of approaching mathematics.
6. It encourages better academic performance amongst children; in particular ethnic minorities whose performance tends at present to be lower than [that of] their peers."

According to Duncan (1986), by including the contributions of different societies in the development of mathematics in the mathematics curriculum the following benefits may emerge:

1) Ethnic minority children become more knowledgeable about their own cultural backgrounds. In this way they are more likely to grant respect and meanings to their origins.
2) Other children are allowed to share in the delight and richness of various other cultures.
3) The quality of mathematical work will itself be enhanced by drawing upon such cultural diversity.

The approaches to mathematics outlined by Dyson and Duncan have definite advantages and benefits for all pupils and have relevance in the South African context. However, the 'ethnic minority children' that Dyson and Duncan speak of in England are mostly Blacks (West Indian or Indian) while in South Africa, Blacks are in the majority.

Nonetheless, the White, Indian and Coloured schools which have opened their doors to all races tend to have a minority of Black pupils. This is also the case at Woolhope secondary where there is approximately a 3:1 ratio of Indian to Black pupils.

With the rapid political changes taking place in South Africa and the move towards a new democratic order, it is vitally important for the future of the country as a whole and for technological development, in particular, that the aims and objectives of the mathematics curriculum be broadened and redefined in order to reflect the needs of pupils from all cultural backgrounds.

Laridon (1990) said that what was needed in South Africa was "proper curriculum development based on classroom research relevant to this country and all its peoples, resulting in some principles on which to proceed". A multicultural approach to mathematics could play a significant role in this regard.

CHAPTER 3: DESCRIPTION AND JUSTIFICATION OF RESEARCH METHODOLOGIES

3.1 Changing school enrolments at Woolhope

Prior to 1990, Woolhope Secondary School was reserved for the so-called 'Indian' population group in Port Elizabeth. This was in keeping with the government policy of separate development. In 1990, 2 Black pupils were admitted to the school, one in standard 8 and the other in standard 10. In 1991, in the light of the changing political climate in South Africa as well as falling school enrolments, 43 Black pupils were admitted to Woolhope (3 left). In 1992 a further 120 Black pupils were admitted to the school (10 left). The following figures illustrate the breakdown of Black pupils standard - wise:

Table 1 Enrolment of new Black pupils at Woolhope

	1991	1992
Std 5	9	--
Std 6	5	50
Std 7	14	41
Std 8	9	20
Std 9	3	8
Std 10	3	1
Total	43 (3 left)	120 (10 left)

Presently (in 1992) the total enrolment of the school is 617 of which 150 are Black pupils. This figure of 150 Black pupils is arrived at from a net intake of 40 pupils in 1991 and 110 in 1992. Woolhope can thus be classified as a multicultural school.

3.2 Procedures for admitting Black pupils

In general, Black pupils were admitted to the school on the basis of their passing the previous standard and being of a suitable age in a specific standard. The selection process for standards 8, 9 and 10 was more intensive resulting in more junior pupils being admitted to the school than senior pupils. In addition to the above criteria, the pupil's previous symbols were scrutinized. They were also interviewed to assess their competency in English and to lesser extent in Afrikaans. The pupils did not write any selection tests.

3.3 Purpose of the research

The purpose of the research was to conduct a small scale case -study of the need for multicultural mathematics education with a special emphasis on syllabus design. The target population of the research was 'all pupils who do mathematics in the senior secondary phase at Woolhope'. There are some 230 pupils who do mathematics in this phase, including 42 Black pupils.

The author acknowledges that the sample is 'skewed' because the number of Black pupils is small in comparison to the number of Indian pupils. However, the author sincerely believes that a study of this nature is valuable because demographic trends indicate that, in the next few years, Blacks should form the majority at Woolhope and other schools.

3.4 Research methods - pupils' responses

Permission was sought from the principal of the school to administer questionnaires to all pupils taking mathematics in the senior secondary phase. Another mathematics teacher who also teaches senior classes assisted the writer in administering the questionnaires. Time constraints at school resulted in pupils completing the questionnaire at home. (The school day begins at 7:45 and ends at 14:45 and transport exigencies require the Black pupils to board a bus immediately after school.)

The questionnaire method was the main research technique used to gather information because of the descriptive nature of the research. It was a suitable way of canvassing the wide-ranging views and comment from the pupils. Since all pupils were given questionnaires, it meant that the survey covered a mixed ability group. Further, the pupils were from different cultural backgrounds.

The questionnaire was divided into 5 sections. Section A had general questions such as the reason for doing mathematics and whether they were coping with the subject. As recorded earlier (in Section 1.9 on pages 10-13), mathematics is a very important school subject. The author felt it necessary to find out the reasons as to why the pupils were doing mathematics at school and whether they were having any problems with the subject.

In section 2.5 on pages 28-30, the influences of culture on mathematics were discussed and the relevance to the South African situation briefly outlined. Laridon (1990) spoke of the need for curriculum development to be based on classroom research relevant to South Africa and all its peoples. With Woolhope being a multicultural school, section B of the questionnaire was concerned with cultural aspects where pupils were asked if the mathematics syllabus catered for the needs of pupils from different cultural backgrounds. The pupils had to provide reasons for their responses, irrespective of whether they had replied in the affirmative or not. The pupils were also asked questions on their relationships with other racial groups.

In section 2.6 on pages 30-33, the Cockcroft Report (1982), Presmeg and Frank (1990) and Brodie (1989) comment on mathematics instruction in a second language and make certain recommendations. Brodie (1991) emphasised the need for mathematical discussion in mathematics lessons. She used various techniques and activities in attempting to integrate language and mathematics. Thus, section C of the questionnaire examined language issues. Pupils were also given the opportunity to comment on whether schools should have special programmes for pupils having difficulty with English as a medium of instruction.

In section 2.2 on page 25, Woodraw (1989) briefly outlines some procedures which mathematics teachers could use in their classrooms to identify with the goal of the attainment of a pluralist society which is free from racism. Thus, in section D of the questionnaire, the pupils had to comment on whether their mathematics teachers should adapt or modify their teaching styles to cater for pupils from different cultural backgrounds. If their reply was in the affirmative, the pupils had to suggest ways in which it could be done.

Pupils' attitudes in respect of issues such as the importance of mathematics, whether mathematics caters for needs of pupils of all races, the contributions by various cultural groups in the development of mathematics, participation in mathematics lessons (amongst others) were analysed in section E of the questionnaire.

To clarify their points of view on certain issues in the questionnaire, some pupils were interviewed. These were structured interviews and were conducted in the mathematics periods or during the breaks. Again, time constraints did not allow the interviews to take place after school. Although the pupils were selected on a random basis, care was taken to ensure that a certain number of Black pupils were also interviewed. Most of the questions asked in the interviews were directed to both the Indian and Black pupils and included the following:

"Why did you choose mathematics as a subject in Std. 8?" Most pupils replied in their questionnaires that they chose mathematics for its utilitarian purposes. This question was repeated in the interview to find out if they chose the subject for other reasons.

Pupils who had replied in their questionnaires that the mathematics syllabus catered for the needs of all pupils were asked to supply reasons for this particular response. This resulted in further discussion on this particular aspect with pupils acknowledging that there were some problems with the current mathematics syllabus. The following question was then asked:

"How do you feel that the current mathematics syllabus could be adapted/modified for the benefit of all pupils?"

The final question directed to the pupils was

"What could mathematics teachers do in order to make pupils of all races understand what they are teaching?".

This was a similar question to that which appeared in section D of the questionnaire and this was to elicit further responses from the pupils on the role of the mathematics teacher in promoting understanding of the subject among the different cultural groups.

The author found in conversation with some of the Black pupils at the school that they had sought admittance at Woolhope because they and/or their parents believed that the work at Woolhope was of a high standard. Therefore, one of the questions specifically directed to the Black pupils was "How do you find Woolhope?" (in comparison to their previous schools)

Another question directed specifically to the Black pupils was "How do you get along with Indian pupils?" This was to find out if there were amicable social interactions between the Black pupils and the Indian pupils or whether problems existed. A similar question was directed to the Indian pupils to get their views on how they got along with the Black pupils.

A meeting with representatives of the senior classes was called to discuss which sections of the present syllabus may suit a multicultural approach in their presentation, the involvement of pupils in mathematics lessons, the language used by the teacher in class and the language used in text books. Pupils had to meet in different groups and discuss the different issues at hand. A follow up meeting was held to analyse the various responses and to reach consensus on certain matters.

The pupils were also observed in the classroom situation. These observations were made by the author as well as their teachers. This was to view the kind of social relationships that transpired in the mathematics classroom. These included the following:

- The attentiveness of pupils in class and their participation in mathematics lessons. Are the Black pupils afraid of participating?
- How pupils from different cultural backgrounds communicate and interact with each other.
- The responses by pupils to the language used by the teacher. Do they ask the teacher to clarify certain mathematical terms or expressions which he uses in the classroom?
- Did Indian pupils assist Black pupils and vice versa ?

3.5 Research methods - teachers' responses

Other than the writer, there are only two other teachers who teach mathematics to senior classes. Therefore, to get further responses, the questionnaires which teachers had to complete were extended to the teachers of the junior classes. Altogether five teachers (4 Indian, 1 Coloured) were given questionnaires to complete.

The profiles of the teachers are as follows:

Table 2 Profiles of mathematics teachers at Woolhope

Teacher	Qualifications	Standard and grade taught
A	B. Paed. Maths III 5th year	10 higher, 9 higher & standard.
B	4 year college diploma Maths and Computer Stud. 3rd year (since transferred)	10 standard & lower 6
C	B. Sc. Maths III 1st year (took B's place)	10 standard & lower 6
D	B. A. & B. Ed. Did a small amount of maths. in his diploma 30th year	7
E	B. A. Did a small amount of maths. in his diploma 24th year	6

There were eight questions in the teachers' questionnaire. Question 1 asked the teachers if the present mathematics syllabus catered for the needs of pupils from different cultural backgrounds. This was a similar question to the question in section B, question 1 of the pupils' questionnaire but now called for the views of the teachers.

Question 2 examined the teaching methods/techniques to be used by mathematics teachers to cater for pupils from different cultural backgrounds. Bishop and Pompei (1991) and Visser (1991) list ways in which ethnomathematical teaching approaches may take place (see section 2.2, pages 22-24 for a detailed explanation). Some of these approaches may overlap with those used by the teachers of Woolhope.

Questions 4 and 5 dealt with how pupils of different cultural backgrounds got along with each other in the mathematics classrooms and whether Black pupils participated in the mathematics lessons. There were similar questions in section B of the pupils' questionnaire.

Question 6 was concerned with Teacher training. With many schools now becoming multicultural, the training of teachers to cope with multicultural classes assumes great importance. The teachers' views on this matter were elicited.

Dyson (1986) and Duncan (1986) outline the merit of adopting a multicultural approach to mathematics teaching (see section 2.8, pages 34-35 for details). Thus, in question 7 of their questionnaire the teachers had to list the advantages (if any) of adopting a multicultural approach to mathematics teaching.

Question 8 was an open-ended question where any other comments could be recorded.

Some lessons of the teachers were observed in order to see how pupils of different cultural backgrounds interact with each other as well as with their teacher (see page 44 for details). Discussions were also held with the teachers on a one-to-one basis.

The entire staff of Woolhope were invited to a workshop on 'Communication problem solving at schools' held at the Independent Teachers' Resource Centre in Port Elizabeth on the 9th June 1992. The focus of the workshop was on children from disadvantaged communities, having English as their second language and belonging to a cultural group which differed from that of their teachers. The discussion leader of the workshop was Mrs Lulu Tshiwula, a social worker. The different views and ideas emanating from the workshop and their effect on this study will be outlined in the next chapter.

CHAPTER 4: ANALYSIS OF DATA

A broad overview of the responses to the questionnaires and interviews is given in the analysis of the data.

Of the 230 questionnaires issued to pupils taking mathematics as a subject in the senior secondary phase of Woolhope, 189 (82,2%) were returned. This included responses from 31 Black pupils. Although the number of Black pupils in the sample is small (16,4%) the author, nevertheless, believes that the research undertaken is valuable in the light of the changing school enrolments at Woolhope and other schools.

4.1 Reasons for choosing mathematics

The response to the question "What is the reason for you selecting mathematics as a subject in standard 8?" drew a variety of replies from the pupils. 183 (96,8%) of the pupils chose the subject for career/job purposes or the fact that it was a pre-requisite for studying a number of degrees/diplomas at university and other tertiary institutions. However, just 21 (11,1%) included 'a love for the subject' as a reason for choosing mathematics. The author notes that while mathematics is a 'service' subject for many of the pupils surveyed, the other virtues of the subject are unfortunately relegated to the background.

In the subsequent interviews carried out with 18 of the pupils, 15 of them reaffirmed the view of choosing mathematics because it is a requirement for many jobs/careers or the fact that for pupils seeking entry into universities, mathematics is a major requirement for pursuing a number of degrees. On further probing, some pupils indicated that they chose mathematics because they found it to be an "interesting" and "challenging" subject and the fact that it "exercises the mind".

Thus one can see that pleasure is too infrequently associated with school mathematics (See Chapter 1, page 12-13 for further explanation).

4.2 <u>Are pupils coping with mathematics?</u>

According to the responses from the pupils, it appears that the majority of them (139 pupils, i.e. 73.5% of the respondents) are coping with mathematics at the senior secondary level. Those who are coping tend to take the subject on the higher grade. They enjoy doing tasks assigned to them by their mathematics teacher. They are attentive in class and, most of the time, understand what is taught to them. They have a good relationship with their teachers and are never afraid to ask questions in class if they have problems with any aspect of the work. They also do a lot of work in mathematics at home in order to consolidate what they learnt in class.

Most of the those who are not coping with the subject tend to take the subject on the standard grade. A small number take the subject on the lower grade. They find the subject to be very difficult. Their teachers have indicated that these pupils often get low marks and, as a result, become frustrated and demotivated. They cannot concentrate for long periods and tend to be inattentive in class. They are afraid of asking questions for fear of being ridiculed. They tend to do very little work in mathematics at home because they do not understand the work or cannot find the time to attempt the work because of various social pressures exerted on them (Juglal and Simon, June 1992).

4.3 Sections of the syllabus which pupils like/dislike

142 (75%) of the pupils surveyed liked the algebra and/or trigonometry sections of the syllabus while 99 (52,3%) of the pupils indicated a dislike for geometry. There are probably a variety of reasons for this dislike of geometry. Pupils tend to learn geometry by rote. While they may be able to prove theorems with little or no errors, many pupils have difficulty in applying them in geometry riders. Pupils are unable to understand and interpret questions in geometry as

well as recognise or identify key information in geometric diagrams (Juglal and Simon, June 1992).
In order to improve their results in geometry, some pupils have sought mathematics tuition from outside agencies. Other pupils have sought help from their friends. A number of pupils have decided to make a desperate effort to understand what is taught to them in class and to follow it up with even harder work at home. Surprisingly, none of the pupils have made requests to their teachers to have extra classes in geometry.

To understand what is required in the learning of geometry it is necessary to examine the relevant literature. According to the theory of Pierre and Dina van Hiele, students progress through levels of thought in geometry, from a Gestalt-like visual level through increasingly higher levels of description, analysis, abstraction, and proof. These levels are sequential and hierarchical. For students to function adequately at one of the advanced levels in the van Hiele hierarchy, they must have mastered large portions of the lower levels. Progress from one level to the next is dependent upon the instruction received rather than other factors. Teachers can reduce subject matter to a lower level, leading to rote memorization, but students cannot bypass levels and still achieve understanding. Acquiring understanding requires working through certain phases of instruction. Each level has its own language. There are linguistic symbols in each level. Each level has a system of relations connecting these symbols. Language plays an important role in the movement through the levels (Clements, 1992).

Teachers must take into account the previous geometry knowledge of the pupil and ascertain whether there are any gaps in the knowledge.

Brodie (1989) noted that one of the important factors in the selection of mathematics textbooks is "readibility". The language used in mathematics textbooks should be simple and within the grasp of the pupils. This may lead to a better understanding of geometry.

In the attempt to adopt a multicultural approach to mathematics teaching, there is a need to re-examine the way geometry is currently taught at schools. New ideas should emerge so that pupils of all cultural backgrounds are able to derive benefit from instruction in geometry.

4.4 Pupils' views on the current mathematics syllabus

121 (64%) of the pupils were of the opinion that the mathematics syllabus currently used in the senior secondary

phase did cater for the needs of pupils from different cultural backgrounds. Some of the reasons for this point of view include the following: Mathematics is universal and not dependent on one's cultural background. Everyone needs to do the same or a similar mathematics syllabus if they want to go to university. There are different grades to cater for the different ability levels of the pupils. There are a variety of sections to suit all pupils. Teachers treat all pupils alike and all cultural groups benefit from their teaching. These views also emerged from the subsequent interviews held.

68 (36%) of the pupils surveyed felt that the syllabus did not cater for the needs of pupils from different cultural backgrounds and advanced the following reasons:
Black pupils are doing mathematics through the medium of English which is their second language and would have difficulty in understanding certain terms, expressions and concepts in mathematics. Some Indian pupils also had problems with English. There was a need to simplify the language used in mathematics so that it is easily understood.

The 7 Black pupils who were interviewed said that 'word problems' posed difficulties for them. They were unable to understand the language used in the problems, had difficulty interpreting them, and most often, failed to solve them. They felt that the wording of such problems should be simplified and made easier to understand.

The problems experienced by pupils with regard to mathematics instruction in a second language have been highlighted by Brodie (1989) in section 2.6 on pages 31-33. There seems to be some concurrence between Brodie's views and the views expressed by the pupils.

In the meeting held with the senior pupils there was agreement among the pupils that those with English as a second language would have difficulty with geometry and 'word problems'. They also agreed that 'word problems' should be more realistic and be based on ideas which most pupils could identify with and not something foreign to them. They felt that sections such as statistics, the use of mathematics in business, and a bit of history of mathematics, especially the contributions of non-western mathematicians, could be included in the mathematics syllabus so that it becomes more balanced and acceptable to all pupils. For further details on the history of mathematics refer to page 14 of chapter 1, pages 27-28 in chapter 2 and chapter 5, section 5.8.2, pages 84-88.

4.5 Teachers' views on the current mathematics syllabus

The views of the teachers are examined collectively. In contrast to what the majority of the senior pupils felt, the mathematics teachers of Woolhope were of the opinion that the current syllabus does not cater for the needs of pupils from different cultural backgrounds. Laridon (1990) also expresses the same sentiments. Some of the reasons given by the teachers were:

1) All pupils do not require mathematics for the same purpose. It depends on their future careers. The syllabus should be broken down into different sections or papers, eg.,Basic mathematics, Commercial mathematics, Advanced mathematics. Pupils should be allowed to choose depending on their needs.

2) There is a need for continuity in the mathematics syllabus from std. 7 to std. 8. Some essential concepts learned in std. 7 should be repeated at the beginning of std. 8 to ensure continuity and instil confidence in those pupils selecting mathematics as a subject in the senior secondary phase.

3) As education ought to equip the pupil for life, that is, to take his place in society as a whole, the syllabus should cater for a more practical application of knowledge. Concepts taught must be related to everyday life.

4) The syllabus assumes that all pupils come from the same background. No allowance is made for pupils from

disadvantaged backgrounds.

4.6 Modification of areas of the mathematics syllabus to suit a multicultural approach to mathematics teaching

The teachers found the following areas of the syllabus which may be modified to suit a multicultural approach to teaching:

1) Problem solving needed to be reviewed. The 'word problems' that appeared in the textbooks tended to be out of the grasp of most of the pupils.

2) The problems based on the applications of equations, sine rule, cosine rule, maximum and minimum values, ratio and proportion, graphs, etc., can be formulated by choosing events from the child's real world, not something that the child is not familiar with.

3) Certain concepts, terminology and other expressions can be explained in a simpler, less complicated way.

4.7 Staff observations on the Black pupils

Although Woolhope used to be, almost exclusively, a so-called Indian school, the intake of a large number of Black pupils has occurred, almost entirely, without incident.

At the workshop on 'Communication problem solving at schools' at the Independent Teachers' Resource Centre in Port Elizabeth on the 9th June 1992, which the staff of Woolhope attended, the following points of view (amongst others), on children from disadvantaged communities, having English as a second language and being of a different cultural background from that of their teachers, emerged:

1) Xhosa is their home language and they have difficulty with English as a medium of instruction.
2) They have been victims of prejudice.
3) They are slightly older than the Indian pupils.
4) Religious practices and cultural phenomena differ from the Indian pupils.
5) They believe that Indian pupils have a lot of money which, on average, is not the case and reflects a stereotype claim and an in built inferiority complex.
6) They tend not to participate in class because they lack confidence in themselves and fear being embarrassed. Teachers agreed that there is a need to be more diplomatic and patient when dealing with these pupils.
7) They tend to keep to themselves thus maintaining their 'comfort zone'. By keeping to themselves they have little or no communication with the other pupils.
8) Homework seems to be a problem with many of the pupils. Excuses for not doing homework tend to be trivial with

pupils intent on using a 'dodging mechanism'.

9) It is difficult to identify creativity in these pupils.

10) They use their home language in their communication with each other and this may prevent others from communicating with them.

11) They spend a lot of time travelling long distances to and from school.

12) Although they are generally well-behaved, there is a tendancy to get up to 'a bit of mischief' in company.

4.8 Pupil responses on how pupils from different racial and cultural backgrounds socialise with each other at Woolhope

Despite the observations of the staff of Woolhope, it appears that from the responses outlined in the questionnaires, pupils from different racial and cultural backgrounds got along very well with each other at Woolhope. Only 2 Black pupils experienced problems in this regard. One of the pupils denoted a lack of trust in her class. In an interview conducted with her, she said that the students in her class "did not want to mix with us because they think that we have a poor knowledge than them, and they also undermine us because of our colour". However, another Black student from the same class said "I have a good relationship with all the pupils of the school because I appreciate talking with them as well as discussing some mathematics problems and we tease or joke with one another".

Most of the pupils said that they met other race groups at school. There were only 2 Indian and 3 Black pupils who did not have friends of other race groups. They, however, replied in their questionnaires that they would like to have friends of other race groups. It is, therefore, reasonable to claim that, for the majority of the pupils, the opening up of the school to all race groups has had many advantages for race relations. They enjoyed learning about each other's cultures and developed respect for each other. They encouraged and helped each other with respect to their schoolwork. The Black pupils who were interviewed enjoyed their experiences at Woolhope in comparison with their previous schools. They found the education to be of a better standard. The pupils and teachers were generally found to be friendly and helpful.

4.9 Mathematics teachers' responses on how pupils from different cultural backgrounds socialise in their mathematics classrooms

The mathematics teachers made the following observations in respect of how pupils from different cultural backgrounds get along in their mathematics classrooms:

1) At first, pupils from different cultural backgrounds tended to keep to themselves. They gradually learnt to accept each other, with a noticeable change in the attitudes of Indian pupils, who have become more accommodating and sympathetic.

2) Pupils are more inclined to go to others of their own culture when they need help in mathematics. However, this attitude is also changing.

3) Where teachers have not stipulated where pupils may sit in class, there is a tendency for them to sit next to pupils from their own cultural group.

4) Although the Black pupils do contribute to the mathematics lessons, some teachers believe that they have even more to contribute than at present. However, they fear being ridiculed if they make mistakes. Some of them have language difficulties and find it difficult to express themselves freely. Poor comprehension also affects their understanding. Pupils ought to be encouraged to speak freely in their mathematics class. Positive reinforcement should be used. Their fears of being laughed at must be allayed.

4.10 The home language of pupils

All the Black pupils surveyed listed Xhosa as being their home language while the Indian pupils listed English as being their home language (some also spoke Gujerati or Afrikaans). All pupils surveyed were in agreement that there was a need for schools, which have English second language pupils, to arrange special programmes to assist these pupils in upgrading their English language skills. These special support programmes should result in pupils improving their comprehension skills in English and enable them to cope even better with all subjects, including mathematics. At present, some Black pupils tend to misinterpret questions in mathematics, resulting in poor achievement levels in the subject. By attending special support programmes in English, this problem could be resolved and result in better marks in mathematics. With improved language skills in English, Black pupils ought not to be afraid of participating actively in mathematics lessons. Any misconception and misunderstanding on the part of the pupils could easily be resolved in direct communication with the teacher.

The Black pupils preferred the medium of English as they found mathematics to be "better in English" and the fact that English was an international language.

4.11 Modification of teaching styles

116 (61,3%) of the pupils surveyed agreed that mathematics teachers should modify their teaching styles to cater for pupils from different cultural backgrounds. This view also emerged from the interviews conducted. The pupils felt that teachers should explain slowly, clearly and in detail during mathematics lessons. All students should be encouraged to participate in the lessons. The teachers should not assume that all pupils have the same previous knowledge in mathematics. Teachers should not pressurise their pupils into giving answers and should exhibit a great deal of patience and understanding, especially with the Black pupils. Teachers should respect all pupils and make them feel at home in their mathematics classes. Extra classes should be arranged for the weaker pupils.

The mathematics teachers confirmed the views of the pupils. They had to modify their teaching methods and techniques in their mathematics lessons to suit pupils from different cultural backgrounds. Black pupils come into Woolhope at various stages of development in respect of their mathematics ability. Many of them had found it difficult to cope with the new situation because of poor communication skills and comprehension levels as a result of language difficulties and a lack of a solid foundation in the subject. Hence, teaching methods and techniques have to be modified to help the pupils to bridge the gap. This requires a great deal of planning and foresight on the part of the teacher.

The pace of teaching has to be slowed down and certain lessons need to be repeated or retaught. Different wording or comparisons are necessary when explaining certain concepts. Problem solving has to be simplified. However, if the Black pupils applied themselves conscientiously they soon got onto par with the other pupils.

4.12 Attitudes of the pupils

The attitudes of the pupils are recorded in tabular form to indicate the level of agreement or disagreement for the various statements.

Table 3 Attitudes of the pupils

	Number Agree	Number Disagree
1) I like mathematics.	155	34
2) Mathematics is very useful.	179	10
3) Mathematics is very easy to do.	46	143
4) I dont like to study mathematics.	70	119
5) Mathematics is very important in everyday life.	177	12
6) I get along with pupils of all races.	176	13
7) Mathematics should cater for the needs of pupil of all races.	185	4

8) The contributions made towards mathematics by all cultural groups should be emphasised.	183	6
9) Pupils of all races should be encouraged to participate in mathematics lessons.	189	-
10) Teachers should make pupils of all races feel at home in their mathematics classes.	181	8
11) I have difficulty with "word problems" in mathematics.	119	70
12) Mathematics contributes to science and other fields of knowledge.	189	-

From an analysis of the attitudes of the pupils, there are 10 statements which a majority of pupils agree with (from a low of 63% agreement for statement 11 to a high of 100% for statements 9 and 12); and there are 2 statements which pupils disagree with (75,7% disagreement with statement 3 and 63% disagreement for statement 4).

The attitudes of the pupils just listed serve to emphasise the following facts:

1) Mathematics is a very important subject and, although pupils tend to find it to be a difficult subject, it occupies a very significant place in the school curriculum and pupils who do mathematics in the senior secondary phase of school recognise this.

2) Pupils of all races get along well with each other if they are given the opportunity to mix with each other. They can learn a lot from each other, cultivate new friendships and develop a new understanding of different cultures. Racist attitudes are cast aside and positive attitudes emerge. Teachers can play a meaningful role in fostering good race relations. Mathematics teachers, in particular, can be accommodating and make pupils of all races feel at home in their mathematics classes. They should create opportunities for pupils of all racial groups to participate in the mathematics lessons.

3) In drawing up a mathematics syllabus for a multicultural society, the needs of all racial groups should be given due consideration. Also the contributions made towards mathematics by all cultural groups should be emphasised.

4.13 <u>Teacher training</u>

The teacher's role in the presentation of multicultural mathematics is an important one. The teachers of Woolhope are in agreement that teacher training institutions should train teachers to handle multicultural classes. This should be emphasised presently because of the changing nature of society. Teachers should be trained to accept pupils of different cultural backgrounds in their classes and also respect the different cultures. Training could take place in the form of workshops, discussions and lectures. For pre-service teachers this training should be ongoing. Once in-service teachers and pupils have successfully made the transition, that is, the teachers know how to deal with pupils of different cultures and the pupils have bridged the gap of their former deprivation, the programme can be discontinued.

4.14 The mathematics teachers' views on the advantages of adopting a multicultural approach to mathematics teaching

The teachers' views on the advantages of adopting a multicultural approach to mathematics teaching are as follows:

1) Pupils can learn to live with other cultures.
2) They appreciate, respect and accept each other.
3) They see each others' points of view.
4) Every culture has some rich heritage which others can learn from.
5) Acceptance/tolerance can be cultivated.
6) Pupils will identify themselves within the classroom and will feel part of the lesson. This will result in more effective learning.
7) Pupils are exposed to the reality of the South African

situation.

Although the majority of the pupils believed that the mathematics syllabus currently used in the senior secondary phase did cater for the needs of the pupils from different cultural backgrounds, the mathematics teachers thought otherwise. However, it is clear that, from an analysis of most of the findings in this chapter, there is a need for a review of the mathematics syllabus currently in use at schools. With an ever increasing number of schools in South Africa becoming multicultural in nature, a multicultural approach to the teaching of mathematics would have definite advantages for all pupils at school. A multicultural approach to mathematics curriculum design is, therefore, fundamental and necessary in the changing South African scenario.

CHAPTER 5: BROAD GUIDELINES FOR A MULTICULTURAL CURRICULUM DESIGN

Before considering broad guidelines for a multicultural curriculum design, it is necessary to examine what has been proposed by various authors on the development of new mathematics curricula.

5.1 Goals for mathematics education

The publication by the American National Council of Teachers of Mathematics (NCTM) called 'Curriculum and Evaluation Standards for School Mathematics' deals with bringing more relevant and better mathematics to all pupils. New societal goals for mathematics are proposed which also have relevance for a new South Africa. These goals are endorsed by Glencross (1991) and include the following:

5.1.1 Mathematically literate workers

This implies that a certain level of knowledge and understanding of mathematics are required. Although mathematics is not taught in schools solely for students to get jobs, there is some correlation between in-school experiences and those in today's workplace.

5.1.2 Lifelong learning

People tend to change jobs (typically 3-4 times over a

25 year period) and this indicates the need for a flexible workforce. Problem solving, which includes ways in which problems are represented, the meanings of language of mathematics, and the ways in which one is able to conjecture and reason, should therefore be central to schooling.

5.1.3 Opportunity for all

The social injustices of past schooling practices can no longer be tolerated. In South Africa, there is an underrepresentation of Blacks in scientific and technological careers. A just society in, which all people in the country enjoy equal opportunities and equitable treatment, is a priority in South Africa. Mathematics has become a critical filter for employment and full participation in society. South Africa cannot afford to have the majority of the population mathematically illiterate.

5.1.4 Informed electorate

This is necessary in any democratic society. Issues such as environmental protection, nuclear energy, defence spending, taxation, consumer price index, interest rates, etc. involve many interrelated questions. Citizens must be able to read and interpret complex, and sometimes conflicting, information.

Thus, it is important for the Education Department, in general, and for the schools, in particular, to ensure that all students have an opportunity to become mathematically literate, are capable of extending that learning, have an equal opportunity to learn, and become informed citizens, capable of understanding issues of a technological nature.

5.2 Objectives for mathematics

Glencross (1991) lists the following objectives for mathematics as suggested by the Department of Education and Science in England:

5.2.1 Facts

Pupils at each level should learn some basic mathematical facts in order to make progress in the subject with confidence.

5.2.2 Skills

Pupils should understand a variety of arithmetic and algebraic computational procedures with regular practice in these procedures required to ensure an appropriate level of performance.

5.2.3 Conceptual structures

Pupils should understand how concepts are related and use mathematics in its proper context.

5.2.4 General strategies

Pupils must be able to apply the appropriate skill or knowledge in the course of problem solving or carrying out an investigation.

5.2.5 Personal qualities

The development of a positive attitude towards mathematics and the development of good study habits are fundamental to learning mathematics. Negative attitudes tend to inhibit learning and often persist into adult life, thereby affecting the choice of job.

Each class of objectives is important in the all round mathematics education of all pupils, irrespective of race, colour or creed. However, objectives should not be thought of in separate categories. Each objective is likely to be present in most mathematical activities.

5.3 Proposed change to the mathematics syllabus

Proposed change to the mathematics syllabus for the senior secondary phase in South Africa has drawn criticism from certain quarters in that it does not take into account input from all the peoples of South Africa and tends to reflect the interests of a minority group.

Laridon (1990) critizes the way topics are included in or excluded from the mathematics syllabus in South Africa either to follow international trends, or on the basis of data gathered from questionnaires directed at a small non-representative sample of respondents. He calls this "syllabus tinkering". The department with the largest number of pupils had not written one matric examination on the 1983/1984 syllabus when opinions on a new syllabus were sought. A typical example of "syllabus tinkering" occured with the junior secondary syllabus when teacher opinion agreed that the standard 6 syllabus was overloaded resulting in certain sections being shifted to standard 5 and others to standard 7.

According to Laridon, "syllabus tinkering" is an inevitable result of the top-down approach adopted to curriculum development. Development of the mathematics syllabus is top-down in that it is decreed by committees at the top of the education hierarchy. These committees often go on what international trends are and on ill-timed questionnaires directed to non-representative samples of teachers. Input to these committees come largely from academics and researchers who are out of contact with what is happening in the classroom. Final decisions for the junior secondary phase are taken on the basis of a consensus among the four provincial departments of the House of Assembly with the other departments having observer status on the National Curriculum Committee for mathematics. The direction of mathematics education in South Africa is determined by the opinions of the representatives of 4 (white) departments. For a multicultural country, like South Africa, this is unacceptable as the needs of the majority (about 90%) are not officially taken into account. At the senior secondary level, the development is again by the DEC House of Assembly although 'other departments' can block proposals if they are not in agreement with them (Laridon, 1990).

Curriculum development is from the first world to the third world. This can create problems in the South African context. If the needs of the country and all its people are to be taken into consideration in the development of an appropriate mathematics syllabus then development should be from third to first world. The concerns of the DEC House of Assembly should not be the main thrust behind the development. If all pupils are to have access to a reasonable mathematics education in South Africa, a first world approach in a third world situation is definitely not on. This happened in Liberia where the Kpelle children had their lessons conducted in English. The child spent his first year just learning the English language. Out dated American books and methods were used in mathematics lessons. The children tended to rely on rote memorisation in their learning as they did not know how to apply the knowledge received to the problems that they encountered in their daily lives (Zaslavsky, 1970). The question of relevance is therefore very important in the development of suitable mathematics curricula. South Africans are ideally place to meaningfully contribute solutions to the problems presented. However, present approaches to curriculum development tend to ignore the issues involved.

The requirements of university and to a lesser extent other tertiary institutions overshadow developments at the secondary level. Nearly all our mathematics syllabuses are to a degree academic in nature. Differentiation at the secondary level is organised on the nesting principle which tends to be a characteristic of curricula in developed countries or where a top-down approach is followed. In the South African context, this means that the needs of our population are not taken into account when deciding on what content should go into the syllabus. This goes counter to the rationale of differentiation and cuts across any notion of providing 'mathematics for all'. If this is ignored, then it is done so at the cost of educating all the people in South Africa in the mathematics that they require for living and for appreciation of their society and culture (Laridon, 1990).

5.4 Catering for different ability levels in mathematics

One cannot expect every child to progress through the same mathematics curriculum at the same speed. Achievement in mathematics varies dramatically and there is a need to offer different mathematical diets to different pupils or different sets of pupils. In the past differentiation has often been by schools. In some countries, including South Africa, independent schools have had, or have been thought to have had higher academic standards than government funded schools and many set entrance examinations which served to reinforce the differences. Although such differences were based on student ability, in practice it was largely determined by social class and the ability of parents to pay the fees. Other systems allow for different kinds of schools, e.g. , 'grammar', 'technical', 'general', where different mathematics curricula operate.

Other strategies for differentiation may be used within a particular school. The most common are 'setting'; where students in a particular school year are placed in groups for mathematics lessons according to their previous levels of attainment in the subject; and 'streaming'; where students are grouped on criteria of a more general achievement in other subjects as well as mathematics. Where there are objections to such strategies, for example on sociological grounds, the class teacher may adopt groupwork or individualised learning materials in order to cater appropriately for pupils in a 'mixed-ability' class. No matter what system is in use, it results in different pupils doing different things according to their own rate of progress in mathematics. At the level of the individual classroom, the good teacher does provide some curriculum differentiation. He will pose complex problems to the high-fliers in order to stimulate their thought processes further, and less involved questions to the lower attaining pupils in order to build up their confidence and create a more positive attitude to learning mathematics (Howson and Wilson, 1986).

An appropriate model according to Laridon (1990) for differentiation at the secondary level is where the core syllabus is the centre and hierarchical strands of modules emanate from the centre. These strands would be designed to cater for the needs of various types of students or the directions they wished to pursue in mathematics relevant to further education or the requirements for employment.

5.5 The modular curriculum in mathematics

Jarvis (1989) criticises the modular curriculum as proposed by the Committee of Heads of Education in South Africa as it does not solve the problems that exist in secondary school mathematics and does not provide the flexibility to cater for the different needs of the secondary school pupil. Jarvis lists the weaknesses of the proposals as follows:

1) The retention of the 3 grades (higher,standard,lower) with options in each grade implies differentiation within differentiation.

2) The retention of the 3 grades, particularly with the proposal that each optional module, where suitable, be offered at the higher, standard and lower grades, to provide for the possibility of the different grades being taught in the same classroom, indicates that the linear model is to be retained. School mathematics will, therefore, still be strongly linked to 'higher' mathematics with those bound for university in mind. The contents of the one grade will be 'diluted' to form the contents of the next grade downward in the hierarchy, thus, retaining the 'top-down' approach to mathematics curriculum development.

3) The proposed modular structure is not flexible in that it does not allow sufficiently for the fact that pupils learn mathematics at different speeds (a point highlighted by the Cockcroft report and in Howson and Wilson (1986)), and it does not allow for the pupils

to be taught mathematics according to their abilities, aptitudes and interests.

Jarvis (1989) lists the following as points of departure in the development of a mathematics curriculum:

1) Nature and structure of mathematics, particularly with regard to its hierarchical nature and the level of abstraction it demands.

2) The curriculum must be developed from the bottom upwards.

3) Mathematical content needs to be differentiated according to the abilities, aptitudes and interests of the pupils.

4) Pupils learn mathematics at different speeds.

5) Mathematical content must include elements which are intrinsically interesting and important.

6) There must be equal educational opportunities for all.

7) Research work done on the capabilities of pupils in mathematics and how pupils learn mathematics.

The Cockcroft Report (1982) also emphasises the need for the mathematics curriculum to be developed from the bottom upwards. This implies that the range of work appropriate for lower-attaining pupils must be considered, and this must then be extended as the ability levels of the pupils increase. Opportunities must be created for those capable of going a long way.

Jarvis proposes a modular curriculum in mathematics for the benefit of the pupils, rather than the teachers. He suggests the following optional modules which are divided into four categories.

1) **Basic Skills Modules:** The main goal of this category is the mastery of skills. The order of priorities would be calculator based computation, and lower order thinking skills in comprehension and application.

2) **Conceptual Mathematics Modules:** The main goal of this category would be the understanding of quantitative and spatial relationships and concepts. The ability to generalise and transfer concepts to unfamiliar situations. Content knowledge would be required. The order of priorities would be comprehension, application, computation and analysis. The bulk of

the modules would fall into this category and the modules may incorporate some of the Basic Skills Modules so that the Basic Skills modules may be by-passed.

3) **Mathematical Applications Modules:** The main priority of this category would be to provide modules for study that would meet the aptitudes and interests of the pupils. For example, a pupil taking physical science as a matriculation subject would study a module relating to physical science.

4) **Higher Mathematics Modules:** The primary goal of this category would be mathematics for its own sake. The modules would be designed for those pupils whose ability and interests would lead them to higher mathematics. Intensive content knowledge would be required and a logico-axiomatic approach would be used to study the structures of mathematics. Order of priorities would be analysis, comprehension, application, and computation.

The modules would be designed to cater for three strands:

1) **Vocational Strand:** This strand would contain both a technical and a commercial component and would

prepare pupils for institutions such as the technikons and business colleges.

2) **General Strand:** This would be a semi-academic strand.

3) **Academic Strand:** This strand would be for the university bound.

Jarvis's modular curriculum for mathematics is a genuine attempt at developing suitable differentiated mathematics curricula for all the pupils of South Africa. However, such a curriculum requires a great deal of planning and appropriate resources when compared to a uniform curriculum. A significant feature of the modular curriculum is that the gap between school mathematics and higher mathematics will narrow for the higher achievers but will grow for the less able pupil.

5.6 Acceptance of new mathematics curricula in South Africa

For any new mathematics curriculum proposal to have acceptance and legitimacy in South Africa, there have to be consultations and negotiations with a variety of interest groups representing all the people of South Africa and based on a model appropriate to the South African situation. Thorough classroom based research relevant to South Africa and all its people is a very important part of this process. Although mathematics has often been thought of as being 'culture-free', from a review of the relevant literature, there is growing evidence to suggest that this is no longer the case and that culture does play an important role in the learning of mathematics.

5.7 Black pupils are disadvantaged by the mathematics curriculum

From an analysis of the data gathered from the research undertaken, it appears that the Black pupils at Woolhope tended to be at a disadvantage in mathematics compared to the Indian pupils if their needs are not taken into account. There are various reasons for this, some of which have been outlined previously. It is possible that Black pupils at other multicultural schools may face the same problems. The developers of new mathematics curricula in South Africa must address these needs if all pupils are going to benefit from mathematics instruction. A multicultural approach to mathematics curriculum design could assist in this process.

5.8 Broad guidelines for a multicultural curriculum design in mathematics

In the light of the research undertaken and a review of related literature, the following broad guidelines could be used in developing a mathematics curriculum with multicultural influences:

5.8.1 The social responsibility of mathematics

At many schools, there is a tendancy for the mathematics departments to adopt an 'isolationist' approach. This has been more of a liability than an asset in the teaching of mathematics because the majority of pupils viewed mathematics as being 'aloof' and difficult which only a minority of pupils could successfully do (Gilbert, 1984). Such a view of mathematics can demoralise pupils and lead to negative attitudes. To counter such a view, Ernest (1989) proposes a 'connectivist' approach to mathematics. In other words, mathematics may be seen as a subject in the school curriculum which is not isolated from other subjects and that it has an important social role to play. Like language, mathematics plays a part in the development of other school subjects. Mathematics has many applications and can be seen as a unifying force in the school curriculum leading to a reduction of 'compartmentalism' in the school curriculum. Mathematics teachers can co-operate with teachers of other subjects in planning the year programme to avoid duplication. When other subjects need the use of mathematics, the applications of mathematics tend to be more realistic than what one finds in some mathematics textbooks.

Noble (1990) lists various problems for which school mathematics assisted in providing solutions. These problems could easily be encountered in one's home environment. An inclusion of such realistic problems in mathematics syllabuses and texts could result in creating a greater interest in mathematics by all pupils. This will counter the 'isolationist' approach, and mathematics can be seen as a subject that pupils of all cultural persuasions can identify with since its applications and usefulness can be experienced by all.

5.8.2 Use of history of mathematics in teaching and contributions made by various cultural groups

An historical approach to mathematics teaching can help the pupil realize that mathematics is not static but constantly changing. Noble (1990) lists the following reasons for introducing the history of mathematics whenever appropriate:

a) Mathematics is a human activity and like all human activity is sometimes untidy, sometimes incomplete, sometimes creative, sometimes elegant. Certain concepts such as fractions and irrationality were stumbling blocks in man's mathematical progress and therefore likely to present problems in the pupil's learning of mathematics.

b) The real world provides a constant stimulation to the proliferation of mathematics and that foundations to mathematics sometimes come after the mathematics has been developed.

c) The discussion on mathematicians themselves can provide human interest which is attractive to those pupils of a caring disposition.

d) Including some history of mathematics means that assessment can be done partly by essay writing. This would require pupils to conduct research on various topics. This involves the skills of referencing, which is not given the necessary emphasis at schools but is so often required later on in life.

While the important contributions made by western mathematicians such as Newton, Galileo, Einstein, etc., are often noted in various text books, there tends to be a lack of information on the contributions by non-western mathematicians. Thus, there is an emphasis on a Eurocentric development of mathematics, often ignoring the contributions of the Arabs, Chinese, Indians and others. This entrenches racism in mathematics, something we can ill-afford in a multicultural syllabus design.

Joseph (1991) discuss the foundations of Eurocentrism in mathematics. Mathematics is perceived as an exclusive product of white men and European civilisations. While a number of books tend to regard the Greeks as being the originators of mathematics as we know it, there is evidence to show that early Indian mathematics contained in the 'Sulbasutras' (800 - 500 BC) were at least contemporaneous with the earliest known Greek mathematics.

There had also been significant development in mathematics in Mesopotamia, Egypt, China and pre-colombian America. Both Thales (546 BC), the legendary founder of Greek mathematics, and Pythagoras (500 BC) were reported to have travelled widely in Egypt and Babylonia and learned much of their mathematics from these areas. Some sources mention that Pythagoras went as far as India in search of knowledge, which may explain some similiarities between Indian and Pythagorean philosophy and geometry. There is also evidence to show that a high level of mathematics was practised in Mesopotamia and to a lesser extent in Egypt from the beginning of the second millenium BC. In particular, the Babylonian mathematicians invented a place value number system, understood the theorem of Pythagoras and evolved an iterative method of solving quadratic equations which was only improved upon in the 16th century AD. The Arabs brought about the technique of measurement, and with the instrument of computation (our number system), which originated in India, which eventually led to the development of algebra. As recorded earlier (in section 2.4 on page 28), Zaslavsky (1970) uncovered evidence of stable agricultural societies that existed in Africa over the past 3000 years which required the evolution of a calendar and the development of a system of weights and measurements. Evidence of examples of the technically advanced societies that existed in Africa include the hillside terracing still found in Ethiopia, the pyramids and temples of the ancient community of Kush (south of Egypt) and the elliptical temples and other stone buildings of Zimbabwe. The builders of such structures were familiar with geometry but the extent of the knowledge is not known. Trade with the rest of the world necessitated the use of weights, measures and means of exchanges. Some sources concluded that the 15th century level of culture among Black Africans was higher than that of northern Europe in the same period. The necessary spurt in mathematics development did not take place due to the geography of the continent, destruction of African societies by invasions and the scramble for Africa. European powers redrew the maps of Africa, disregarding existing boundaries and missionaries renounced traditional beliefs and introduced European orientated education.

Thus, a mathematics curriculum which emphasises the contributions of the various cultures in the development of mathematics would do much to counter the Eurocentric view of the development of mathematics and reject a racist approach to mathematics. This would contribute to the concept of equality in education, pupils would develop a respect for each other's cultures and greater harmony among the races would be encouraged. It is possible that the academic performance of all pupils, especially the Black pupils, would be greatly improved.

5.8.3 The exploratory nature of mathematics

Mathematics is a subject that is often regarded as a difficult, abstract subject which is 'disliked' by many pupils. However, this view can easily be countered if curriculum developers recognise the need to create sufficient interest in the subject and emphasise its exploratory nature. Mathematics is an explanatory subject and requires certain situations to be investigated. Project/experimental work should be set at regular intervals and pupils may work in groups where different racial groups are represented. This encourages co-operation among the different cultures in the pursuit of mathematical investigations. Pupil-centred learning styles are encouraged and pupils may use ideas which they already hold in the development of new ideas.

5.8.4 Mathematics connected with the art and religion of different societies

Muslim societies have developed art forms which are based on the geometry of the circle and also stress tesselation. These designs can be very complex and make a good introduction to the study of regular geometric shapes as well as the circle properties. Classes may try to reproduce these traditional patterns using ruler and compass or may use computers to simulate them.

Basket-weaving and other arts and crafts activities in Southern Africa, Rangoli patterns, Vedic arithmetic, etc., are other examples showing the link between mathematics and culture. It may be possible to find relationships between culturally based mathematics and school mathematics. If relationships exist, then ideas from culturally based mathematics may be used in the teaching of mathematics at school.

Thus, cultural influences may be used to enhance the presentation of mathematics lessons at schools by enabling pupils to share in the delight and richness of other cultures.

5.8.5 The English second language pupil (ESL) in mathematics

For many pupils in South Africa, English is a second or third language and learning mathematics through the medium of English may pose problems to these pupils. Many of these pupils experience difficulties which can clearly be related to their ability to comprehend English mathematical terms and the patterns of discourse found in oral and written texts. Learning the language of mathematics involves learning how to make and share mathematical meaning using language appropriate to the context and is more than recognising and responding to words in isolation. Teachers must become aware of this or many second language learners will continue to be disadvantaged.

According to research done by Brodie (1989) and others, the English language skills of such pupils should be upgraded through various support programmes. One strategy would be to improve the linguistic skills and fluency in English accompanied by the development of skills in and support for the mother tongue. Another strategy is to teach an integrated course in which English and mathematics are taught as interrelated topics. This could involve language teachers spending a proportion of their teaching time concentrating on linguistic skills which are relevant to mathematics or mathematics teachers could teach the language of mathematics as an integral part of teaching mathematics.

ESL pupils tend to have difficulty with word problems. Specific language skills involved in solving word problems need to be taught. Pupils can be asked to concentrate on the meanings of words in the context of the problems, to look for the underlying mathematical relationships and to translate them into symbols.

However, in addition to the teaching of the language of mathematics, subtle differences in context must be examined and there should be an emphasis on concept formation. Pupils can be encouraged to talk themselves into understanding the new concepts through use of their mother tongue (Graham, 1988).

Hunter (1990) listed the following mathematical activities which may be useful in teaching ESL pupils:

1) Writing summaries: what, why, how ...
2) Translating visual images into verbal form: describe,

predict, guide another student's drawing ...

3) Synopsizing tactics: how to, the difference between ...

4) Giving an algorithm: writing out an explicit procedure ...

5) Giving a definition, stating a theorem.

6) Paraphrasing, rewriting from memory, outlining.

7) Inventing a problem, given certain elements or parameters.

8) Generalizing a concept: give a simple set of definitions to help talk about.

9) Group projects: writing a theorem to explain, anticipate a generality from a given scenario.

A mathematics curriculum must cater for the needs of ESL pupils. Such a requirement is a priority in the South African context to ensure that pupils are not disadvantaged in the learning of mathematics.

5.8.6 Mathematics Textbooks

All cultural groups must be consulted in drawing up of suitable mathematics textbooks in South Africa. The language used in such textbooks must be clear, unambiguous and within the grasp of all pupils. Careful thought must be given to the types of problems set in such textbooks to reduce certain biased views and reflect the experiences of all cultures. Consider the following examples which appear in certain mathematics textbooks:

(1) "Plane A flying at 240 km/h leaves Cape Town for Windhoek at the same time a plane B leaves Windhoek for Cape Town. If the distance from Cape Town to Windhoek is 826 km and if they meet at the end of x hours, find x."

Such an example would have little or no meaning to the majority of the pupils in South Africa because they have not experienced air travel. Furthermore, how many pupils are aware of where Cape Town or Windhoek is? The statement 'they meet at the end of x hours' is ambiguous because planes cannot meet while flying but could possibly pass each other. Pupils who have difficulty with English may misunderstand the meaning of the word 'meet' used in the context above. A realistic problem on distance, speed and time would be to use the distance from home to school in the mini-bus taxi or in the school bus. Black pupils at multicultural schools would identify with such examples because they do travel long distances to school.

(2) "A farmer has 50 hectares available for planting two crops, P and Q. The seed for crop P costs R10 per hectare and the seed for crop Q costs R15 per hectare. The total cost of labour of labour will amount to R40 per hectare for crop P and R20 per hectare for crop Q. The expected income for crop P is R220 per hectare and for crop Q it is R300 per hectare. If the total expenditure on seed should not exceed R960 and that on labour should not exceed R2000, how many hectares of each crop should the farmer plant to obtain a maximum profit? What is the maximum profit?"

This example, like other linear programming problems, deals with the need to maximize profit and to minimize cost. Although such a problem may tend to appear 'harmless', in the South African context, it sketches a scenario of profiteering with cheap labour. Thus, this example has a 'hidden message' which entrenches the 'master-servant' relation and may cause resentment in Blacks since they comprise the majority of the labour force. In order to foster racial harmony at schools and in society at large, examples of this type should not be given because of their wider political ramifications.

(3) "Mr Jones owns a factory employing 100 people. He drew a salary of R80000 p.a. , paid each of the 20 supervisory staff R55000 p.a. and the other 80 employees R33000 p.a., what will the total wage bill be per annum? The company has done well in the past year and Mr Jones gives himself a 15% rise,the supervisory staff a 10% rise and the non-supervisory staff a 5% rise. What will be the new wage bill?" (adapted from Maxwell).

Such a question serves to highlight the inequalities of the industrial situation. In the South African context, that will mean that those at the top of the job hierarchy (mostly Whites) get wealthier, while those at the bottom end (mostly Blacks) get lower increases in salary and, because of inflation, become poorer over a period of time. Such an example does not fit in with a multicultural approach to mathematics.

The examples discussed are among the many found in various textbooks which contain 'hidden messages' and should be avoided. Authors of mathematics text books must be sympathetic to the needs of all races when formulating problems on the various topics. Mathematics curriculum developers should emphasise the need for sensitivity and tact when stipulating the types of problems to be discussed under various topics.

5.8.7 Applications of mathematics

Historically, the teaching of mathematics has always had a strong vocational component by being linked with institutions such as schools and universities. Its links with reality were either neglected or distorted.

If pupils understand how mathematical applications are used in society, then pupils will realise the usefulness of mathematics as a subject in school and show more interest and dedication to the subject. Applications in society include knowledge of taxes, hire purchase agreements, and other borrowing arrangements. Mathematics can serve as a unifying force in this regard since all South Africans pay taxes in some form, may purchase certain items on credit or may take out a home loan. Other examples include where a goal-keeper should stand to narrow his opponents angle of shot, how far back from where a try is scored should the goal kicker bring the ball so as to maximise the angle which the goal posts subtend from his kicking position, etc. Such examples are useful and can have interest and appeal for pupils of all cultural backgrounds. These examples provide links with the real world and legitimise the mathematics being studied. Mathematics may be applied in mathematics lessons resulting in immediate motivation for the pupils. Extra mathematical knowledge will be required if the content is to be meaningful. Mathematics may also be applied in other lessons. This can bind together mathematics teaching with subjects such as biology, geography and physical science. However, the problem of co-ordination may arise of matching the needs of other subjects with pupils' mathematical preparedness and maturity. The applications of mathematics has a wide appeal and can be appreciated by pupils of the various cultural backgrounds because it contributes to the concept of equality in education. This must be one of the major focusses of a multicultural mathematics curriculum design.

The broad guidelines for a multicultural mathematics curriculum design just outlined are by no means exhaustive and can be expanded further. However, the guidelines do represent some fundamental principles to be considered in the drawing up of a curriculum in mathematics to represent the needs and aspirations of all cultural and racial groups in South Africa.

CHAPTER 6: FINDINGS, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER STUDY

6.1 Findings

The modification of the school curriculum to suit the increasingly multicultural nature of our schools in South Africa has not been given the necessary attention by curriculum developers. Black pupils, in a multicultural school such as Woolhope, experience difficulty if the school curriculum is taught in the traditional way. One of the subjects affected is mathematics where the curriculum has not been modified or adapted to suit multicultural needs. This has resulted in Black pupils being at a disadvantage in mathematics when compared to the other pupils (see Chapter 4, Sections 4.4, 4.7, 4.9, 4.10).

For a country to be on a sound footing both economically and technologically, it has to offer a mathematics education programme which satisfies the needs and aspirations of all its inhabitants ("Everybody counts", 1989).
However, as Presmeg (1988) has found that the mathematics usually taught at school was developed in and for a particular culture, it is reasonable to claim that the mathematics curriculum in South Africa tends to favour the Whites.

Studies undertaken in England and other countries have indicated the need for multicultural societies to multiculturalise their mathematics curricula (Gilbert, 1984; Presmeg, 1988; Nickson, 1989). In a culturally and linguistically complex country like South Africa, such an approach would be particularly relevant and broad guidelines for a multicultural mathematics curriculum design have been suggested (in Chapter 5) in this regard. It is hoped that such a modification of the mathematics curriculum would have a positive influence on the mathematical performance of all pupils, especially those who are disadvantaged by the current mathematics curriculum. Mathematics might no longer be regarded as a 'difficult' subject which only certain pupils can attain high achievement levels.

It is now worth re-examining some key aspects which are central to the establishment of a multicultural mathematics curriculum.

6.1.1 The role of the school

The school has a vital role to play in creating the appropriate climate for the implememtation of a curriculum with a multicultural bias.

Lynch (1986) lists the following principles for the introduction and revival of multicultural education in schools:

1) Multicultural education needs to be continuous and coherent throughout the school life of the child and therefore carefully sequenced.
2) The school must foster positive ethnic interactions. This should ensure that harmony and understanding among the different ethnic groups is encouraged.
3) Teaching/learning styles compatible with multicultural ideals should be encouraged.
4) Intercultural competence needs to be developed.
5) The aesthetic dimension must be considered.
6) The needs of the different cultural groups must be taken into account when considering assessment procedures.
7) There is a need for ongoing systematic evaluation of the goals, methods and instructional materials used in teaching.

6.1.2 Mathematics as a filter

Mathematics is one of the more important subjects of the school curriculum. Pupils take mathematics at the senior secondary level for various reasons, perhaps the most important being that it is a pre-requisite for study of a number of degrees/diplomas at tertiary institutions. Pupils who are not successful in mathematics at schools are at a disadvantage. There is a large number of pupils who are filtered out of programmes leading to technical, scientific and certain professional careers. When mathematics acts as a filter, it not only filters pupils out of certain careers but sometimes out of school itself. Pupils who continually fail mathematics may become demotivated and eventually drop out of school.

The gulf between those who are mathematically literate and those who are not, appears to be widening ("Everybody counts", 1989). This has serious implications for economic and social upliftment in South Africa.

It is, therefore, vitally important in the South African context, that all citizens, irrespective of race, colour or creed are given equal opportunity to derive benefit from high-quality mathematics education.

6.1.3 Mathematics and cultural influences

Culture has an important role to play in the mathematics education of the child. The influence of culture on mathematics has been discussed by several writers, including Bishop (1991), D'Ambrosio cited in Woodraw (1991), Visser (1991), Presmeg (1988). Current practice with regard to mathematics curriculum development in South Africa does not take into account the cultural diversity of the country (Laridon, 1990). It is possible that this is one of the contributory factors for the low levels of attainment of the majority of our pupils (mostly Black) in mathematics.

Mathematics curriculum developers in South Africa should ensure that a new mathematics curriculum reflects the needs and aspirations of all cultural groups. If pupils identify with what they are being taught in mathematics and can see the mathematics in its context, it is possible that this would result in pupils becoming more enthusiastic and interested in the subject. Such a situation is bound to lead to an improved performance in the subject.

6.1.4 Mathematics in a second language

In South Africa, pupils may do mathematics through the medium of English or Afrikaans. However, the schools which have opened their doors to all races, have been mostly English medium.

Although Black pupils in South Africa prefer English as a medium of instruction, for the majority of them English is a second or third language (Brodie, 1989). While Black pupils may speak or write the language, many have difficulty in comprehending English mathematical terms and the language of mathematics found in certain mathematics textbooks, something the teacher and other pupils may take for granted. The solution to this problem is not an easy one but this problem must be addressed to ensure that pupils are not disadvantaged in learning mathematics.

Solutions proposed by Brodie (1989), Hunter (1989) (see Chapter 5), offer some positive attempts at dealing with this problem. A comprehensive package based on their findings and those of others could be developed to tackle the problem on a national scale in South Africa.

6.1.5 Teacher training and teacher roles

Mathematics education in South Africa is handicapped by a chronic shortage of suitably qualified mathematics teachers (Glencross, 1991). This problem should be addressed as a matter of national urgency.

Thus, teacher training should be looked at from two points of view: Firstly, a massive programme of mathematics teacher training should be established to ensure that all pupils receive mathematics instruction from teachers who are suitably qualified in the subject. This could improve the attainment levels of the vast majority of pupils. Secondly, programmes of multicultural studies should be incorporated in teacher training courses. All teachers, including mathematics teachers, should be thoroughly prepared to handle multicultural classes. Courses, workshops and lectures could also be arranged to assist in-service teachers in this process. Suitable ways of dealing with problems currently experienced by teachers of multicultural classes should be found.

The mathematics teacher has a fundamental role to play in the implementation of a multicultural mathematics curriculum. Some classroom procedures are listed below (adapted from Johnson and Rising, 1972):

1) All pupils, irrespective of ability or cultural background, should be given the chance to participate in mathematics lessons. One way for a teacher to achieve maximum participitation is for the teacher to ask individual pupils questions which they are capable of answering. To do this the teacher must prepare a lesson plan that lists questions to be directed at specific pupils. The teacher must ensure that the questions are asked in clear, simple language, especially for pupils who are English second language speakers. The teacher should try to ensure that pupils are not afraid of making mistakes or asking questions which may be regarded by the teacher as being 'trivial'. By referring to a reticent pupil's homework, the

teacher can identify areas which the pupil knows well and other areas which the pupil has difficulty with.

2) Within reason, the teacher must ensure that each lesson is related to what the pupil thinks is important. Furthermore, the teacher must exercise caution in imposing the teacher's objectives on pupils of a different culture or ability.

3) Lessons must be well-prepared and presented with enthusiasm. This will be appreciated by all pupils, including the high-fliers and the culturally deprived.

4) Teachers should provide a climate in the classroom that stimulates excellence and at the same time avoids the frustration of continued failure. The work given to pupils must be commensurate with their ability.

5) The teacher should take time to meet pupils of different cultural groups out of the classroom, either during the break or after school. It is difficult for the reluctant learner to reject a teacher who shows genuine interest and concern for

that pupil's difficulty with mathematics.

6) Special help on study methods, the correct use of text materials and how to locate information may be given to promote individual progress in mathematics.

7) To encourage interaction and co-operation between the different cultural groups in the mathematics classroom, the teacher can set tasks which involve group work with different cultural groups represented in each group. The more capable pupils may act as group leaders. All pupils must actively participate in the groups and their contributions, no matter how small, must be given due recognition.

6.2 Recommendations

The following recommendations are made to the education departments in respect of a multicultural mathematics curriculum:

1) A new mathematics curriculum based on sound educational principles and thorough, representative classroom based research, with input from a wide range of interested parties who are genuinely concerned about the state of mathematics education in

South Africa, should be developed as a matter of national urgency. Such a curriculum should cater for differing abilities and aptitudes of the pupils as well as all the cultural groups in South Africa. Jarvis (1989), Laridon (1990) and Glencross (1991) offer some relevant and pertinent suggestions in this regard. The broad guidelines for a multicultural curriculum design in mathematics as outlined by the author in Chapter 5 can also make a significant contribution to the development of a new mathematics curriculum in South Africa.

2) Drop-outs occur at every stage of a school system. If a child drops out at an early age, then the child has gained very little from the study of mathematics. Mathematics curriculum developers should ensure that pupils, who terminate their schooling prematurely, gain the maximum possible value from the years of mathematics teaching they have received.

3) Many of the mathematics textbooks used in South Africa tend to have 'hidden' messages which may reflect a cultural stereotype. These culturally biased textbooks should be removed from the standard lists. Textbooks that reflect the cultural diversity of South Africa should be recommended. New texts

should be compiled if such texts are not readily available.

4) Multicultural studies should form an integral part of any teacher training course in South Africa.

5) English second language support programmes should be conducted at schools to upgrade the English language skills of, especially, the Black pupils. This would definitely assist mathematics teaching.

6) Flexible school programming is necessary if all pupils are to participate in activities after school. It must be noted that Black pupils at multicultural schools travel long distances to school and are dependent on public transport. Thus, if the school bus leaves immediately after school, it would be very difficult for them to participate in extra-curricular mathematical activities after school.

6.3 Suggestions for further study

Several questions may be raised as a result of the research undertaken. These questions may lead to further research in the field of multicultural education in general, and multicultural mathematics education in particular. Some of these questions are:

1) What have mathematics teachers, especially in multicultural schools, done to promote a multicultural approach to mathematics teaching?

2) Do all pupils participate in mathematics lessons? What steps have the mathematics teachers taken to encourage all pupils to participate in their lessons? Have they been successful?

3) Are the Black pupils at multicultural schools coping with mathematics in a new environment or has the new environment restricted their performances in mathematics in any way?

4) How are pupils graded in mathematics at multicultural schools? Are the newer pupils given an opportunity to adapt before being graded?

6.4 Conclusion

A multicultural approach to a mathematics curriculum design offers one solution to the problems experienced in mathematics education in South Africa. The solution to other problems requires massive state intervention in training more mathematics teachers, building more schools to prevent overcrowding of classrooms and allocating appropriate teaching materials to schools.

Although the present government in South Africa has ploughed large amounts of money into Black education, many of the inherent problems still remain. One of the priorities of a single ministry of education, under the jurisdiction of a government of national unity, in South Africa would be to address current imbalances in the field of education. Mathematics education will definitely benefit from this process.

However, one cannot wait for a new government to initiate curriculum development in mathematics or any other subject. This must commence immediately. A multicultural approach to mathematics curriculum design would not change the entire face of mathematics education. It would, however, change the way the subject is taught and could make school mathematics more appealing, interesting and accessible to all the inhabitants of our country.

APPENDIX

A MULTICULTURAL APPROACH TO MATHEMATICS TEACHING

PUPIL QUESTIONNAIRE

NB. 1. ALL INFORMATION WILL BE TREATED CONFIDENTIALLY.
2. WHERE ALTERNATIVES ARE GIVEN PLEASE UNDERLINE YOUR RESPONSE.

A. GENERAL QUESTIONS

1. WHAT IS THE REASON FOR YOU SELECTING MATHEMATICS AS A SUBJECT IN STD. 8?______________________

2. ARE YOU COPING WITH MATHEMATICS IN THE SENIOR SECONDARY PHASE AT SCHOOL? YES/NO
   PLEASE EXPLAIN:

3. WHAT AREAS/SECTIONS OF MATHEMATICS DO YOU
   a) LIKE?______________________
   b) DISLIKE?______________________

4. a) ARE YOU DOING ANYTHING ABOUT THE SECTIONS YOU DISLIKE? YES/NO
   b) GIVE REASONS______________________

B. CULTURAL ASPECTS

1. DO YOU FEEL THAT THE MATHEMATICS SYLLABUS FOLLOWED AT YOUR SCHOOL CATERS FOR THE NEEDS OF PUPILS FROM DIFFERENT CULTURAL BACKGROUNDS? YES/NO

2. IF YOUR RESPONSE IN B1 IS "NO" HOW DO YOU FEEL THAT YOUR MATHEMATICS SYLLABUS COULD BE ADAPTED/MODIFIED TO SUIT THE NEEDS OF ALL PUPILS?

3. IF YOUR RESPONSE IN B1 IS "YES" WHY DO YOU FEEL THAT YOUR MATHEMATICS SYLLABUS CATERS FOR THE NEEDS OF ALL PUPILS?

4a) DO YOU HAVE FRIENDS OF OTHER RACIAL GROUPS? YES/NO

b) IF YOUR ANSWER IS "YES" WHERE DID YOU MEET THEM?
(i) IN SCHOOL
(ii) OUT OF SCHOOL (PLEASE SPECIFY)

c) IF YOUR ANSWER IN 4a IS YES DESCRIBE YOUR RELATIONSHIP WITH THEM

d) IF YOUR ANSWER IN 4a IS NO WOULD YOU LIKE TO HAVE FRIENDS OF OTHER RACIAL GROUPS ? YES/NO GIVE REASONS

5a) DO YOU HAVE PUPILS OF DIFFERENT CULTURAL BACKGROUNDS IN YOUR MATHEMATICS CLASS? YES/NO

b) IF YOUR RESPONSE IS "YES" HOW DO YOU GET ALONG WITH THEM?

C. LANGUAGE ASPECTS

1. WHAT IS YOUR HOME LANGUAGE?
   (a) ENGLISH (b)AFRIKAANS (c)XHOSA (d)OTHER - PLEASE SPECIFY

2. ARE YOU COPING WITH MATHEMATICS INSTRUCTION THROUGH THE MEDIUM OF ENGLISH? YES/NO

3. SHOULD ENGLISH MEDIUM SCHOOLS WHICH HAVE PUPILS WITH ENGLISH AS A 2ND OR 3RD LANGUAGE HAVE SPECIAL PROGRAMMES TO UPGRADE THE ENGLISH LANGUAGE SKILLS OF THE PUPILS? YES/NO
   PLEASE ELABORATE

D. TEACHING ASPECTS

1. DO YOU FEEL THAT MATHEMATICS TEACHERS SHOULD ADAPT/MODIFY THEIR TEACHING STYLES TO CATER FOR PUPILS OF DIFFERENT CULTURAL BACKGROUNDS IN THEIR CLASSES? YES/NO

2. IF YOUR ANSWER IN D1 IS "YES" PLEASE SUGGEST WAYS IN WHICH THIS COULD BE DONE:

E. PLEASE COMPLETE THE FOLLOWING ATTITUDE SURVEY BY PLACING AN X IN THE COLUMN THAT BEST SUITS YOUR RESPONSE:

	AGREE	DISAGREE
1. I LIKE MATHEMATICS		
2. MATHEMATICS IS VERY USEFUL		
3. MATHEMATICS IS VERY EASY TO DO		
4. I DONT LIKE TO STUDY MATHEMATICS		
5. MATHEMATICS IS IMPORTANT IN EVERYDAY LIFE		
6. I GET ALONG WITH PUPILS OF ALL RACES		
7. MATHS SHOULD CATER FOR THE NEEDS OF PUPILS OF ALL RACES		
8. THE CONTRIBUTIONS MADE TOWARDS MATHEMATICS BY ALL CULTURAL GROUPS SHOULD BE EMPHASISED		
9. PUPILS OF ALL RACES SHOULD BE ENCOURAGED TO PARTICIPATE IN MATHEMATICS LESSONS		
10. TEACHERS SHOULD MAKE PUPILS OF ALL RACES FEEL AT HOME IN THEIR MATHEMATICS CLASSES		
11. I HAVE DIFFICULTY WITH "WORD PROBLEMS" IN MATHEMATICS		
12. MATHEMATICS CONTRIBUTES TO SCIENCE AND OTHER FIELDS OF KNOWLEDGE.		

THANK YOU FOR YOUR CO-OPERATION :

TEACHER QUESTIONNAIRE ON A MULTICULTURAL APPROACH TO MATHEMATICS TEACHING

INSTRUCTIONS

1. **PLEASE ANSWER THE FOLLOWING QUESTIONS TO THE BEST OF YOUR ABILITY. ALL INFORMATION WILL BE TREATED CONFIDENTIALLY.**
2. **WHERE ALTERNATIVES ARE GIVEN PLEASE UNDERLINE THE ONE WHICH BEST SUITS HOW YOU FEEL.**

QUESTIONS

1a) DOES THE PRESENT MATHEMATICS SYLLABUS FOLLOWED AT YOUR SCHOOL IN THE SENIOR SECONDARY PHASE CATER FOR THE NEEDS OF PUPILS FROM DIFFERENT CULTURAL BACKGROUNDS? YES/NO

b) IF YOUR RESPONSE IN 1a IS "YES" WHY DO YOU SAY SO ?

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c) IF YOUR RESPONSE IN 1a IS "NO" HOW DO YOU FEEL THAT THE PRESENT MATHEMATICS SYLLABUS COULD BE ADAPTED/MODIFIED TO SUIT THE NEEDS OF ALL PUPILS?

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2. DO YOU HAVE TO MODIFY/CHANGE YOUR TEACHING METHODS/ TECHNIQUES IN YOUR MATHS. LESSONS TO SUIT PUPILS OF DIFFERENT CULTURAL BACKGROUNDS? YES/NO
PLEASE EXPLAIN: ____

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3. LIST SOME AREAS (if any) IN THE SENIOR SECONDARY MATHEMATICS SYLLABUS WHICH MAY BE ADAPTED TO SUIT A MULTICULTURAL APPROACH:

4. HOW DO PUPILS OF DIFFERENT CULTURAL BACKGROUNDS GET ALONG WITH EACH OTHER IN YOUR MATHEMATICS CLASSES?

5a) DO THE NON-INDIAN PUPILS IN YOUR MATHS CLASSES ACTIVELY PARTICIPATE IN YOUR LESSONS? YES/NO

b) IF THE ANSWER TO 5a IS "NO" WHY DO YOU THINK IT IS SO AND SUGGEST WAYS IN WHICH NON-INDIAN PUPILS COULD BE ENCOURAGED TO ACTIVELY PARTICIPATE IN YOUR LESSONS:

6a) DO YOU FEEL THAT TEACHER TRAINING INSTITUTIONS IN SOUTH AFRICA SHOULD TRAIN TEACHERS TO HANDLE MULTICULTURAL CLASSES? YES/NO

b) IF YOUR ANSWER IN 6a IS "YES" WHAT FORM SHOULD THIS TRAINING TAKE FOR PROSPECTIVE MATHEMATICS TEACHERS?

7. WHAT DO YOU THINK ARE THE ADVANTAGES (if any) OF ADOPTING A MULTICULTURAL APPROACH TO MATHEMATICS TEACHING AT OUR SCHOOLS?

8. ANY OTHER COMMENTS?

THANK YOU FOR YOUR CO-OPERATION!

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